EXPERIMENTAL STUDY

Comparison of intra-abdominal adhesions formation following implantation of synthetic, biosynthetic, and biologic meshes in a rat model

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ABSTRACT

BACKGROUND: Intra-abdominal adhesions remain a significant challenge in incisional hernia repair, often resulting in complications such as bowel obstruction and chronic pain. Although various prosthetic meshes have been developed, their comparative adhesion profiles have not been fully elucidated. This experimental study aimed to compare the severity of intra-abdominal adhesions and the associated histopathological responses induced by synthetic, biosynthetic, biological, and chemically treated meshes in a standardized rat model.

METHODS: Fifty Wistar albino rats were randomly assigned to five groups (n=10 each): control, polypropylene mesh (Prolene®), polypropylene mesh impregnated with tissue adhesive (Tisseel®), dual mesh (Gore® DualMesh®), and biological mesh (Permacol®). A standardized 2×2 cm full-thickness abdominal wall defect was created in each animal, followed by intraperitoneal mesh implantation. On post-operative day 30, macroscopic adhesions were assessed using the Modified Diamond Scale. Histopathological evaluation included grading of fibrosis, inflammation, vascular proliferation, and giant cell reaction. Statistical analysis was performed using the Kruskal–Wallis test and post hoc multiple comparison analyses.

RESULTS: The Prolene mesh group demonstrated the highest adhesion severity (mean Modified Diamond score: 2.80±1.23), which was significantly greater than that observed in the biological mesh (p=0.010), dual mesh (p=0.002), and tissue adhesive-impregnated Prolene groups (p=0.033). Fibrosis and inflammation were also most pronounced in the Prolene and dual mesh groups, whereas the biological mesh group exhibited milder responses (fibrosis p=0.028; inflammation p=0.033 compared to Prolene). Vascular proliferation and giant cell counts were significantly lower in the biological mesh group (p=0.004 and p<0.001, respectively).

CONCLUSION: Biological and dual meshes, as well as tissue adhesive-treated meshes, were associated with significantly reduced adhesion formation and milder histopathological responses compared to untreated polypropylene mesh. Although no material completely prevented adhesion formation, low-porosity meshes and anti-adhesive strategies appear promising for reducing adhesion-related morbidity in intraperitoneal hernia repair. Further studies are warranted to confirm these findings and optimize mesh selection.

Keywords: Biologic mesh; dual mesh; ıntra-abdominal adhesions; polypropylene mesh; rat model.

INTRODUCTION

Ventral, incisional, and inguinal hernias are common conditions encountered in general surgical practice, affecting millions of individuals worldwide. Incisional hernias develop following surgical procedures, with an incidence reported to be approximately 12.8%, and nearly one-third of affected patients undergo surgical repair.[1]

Over time, a wide range of synthetic and non-synthetic mesh materials have been developed for the repair of anterior ab-

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dominal wall defects. When autologous tissue is insufficient, large defects are commonly managed using prosthetic materials. Among these, polypropylene mesh, introduced in 1962, remains one of the most widely used options, along with polyester, polytetrafluoroethylene (PTFE), and polyglactin (Vicryl®). Despite extensive clinical experience, there is no universally accepted ideal mesh material, as each option presents inherent advantages and limitations.

Meshes placed within the peritoneal cavity elicit a foreign body reaction, leading to adhesion formation in adjacent tissues. Following peritoneal injury, inflammatory exudate is converted into a fibrin matrix, resulting in fibrous bands that connect neighboring structures.[2,3] Intra-abdominal adhesions represent a significant source of post-operative morbidity, including chronic pain and mechanical bowel obstruction.[4] Consequently, numerous experimental and clinical studies have aimed to mitigate adhesion formation associated with mesh use in incisional hernia repair.

Therefore, a comprehensive evaluation of multiple mesh types under identical experimental conditions remains limited in the current literature.

The aim of this study was not only to compare intra-abdominal adhesion formation among different mesh types but also to provide a comprehensive head-to-head evaluation of polypropylene mesh (Prolene®), tissue adhesive-impregnated polypropylene mesh (Tisseel®), dual mesh (Gore® DualMesh®), and biologic mesh (Permacol®) under standardized experimental conditions.

MATERIALS AND METHODS

Animals and Experimental Design

This study was approved by the Ankara University Local Ethics Committee for Animal Experiments (decision number: 2013-16-125, date: 25.09.2013).

The experimental procedures were conducted between November 2013 and April 2014.

In this study, 50 Wistar albino rats weighing 200–250 g, obtained from the same laboratory, were used. The animals were housed at room temperature in standard cages in groups of five. Standard laboratory chow and tap water were provided ad libitum before and after the procedures. The rats were randomly divided into five groups of 10 animals each: Group I (control), Group II (polypropylene mesh, Prolene®), Group III (polypropylene mesh impregnated with tissue adhesive, Tisseel®), Group IV (dual mesh, Gore® DualMesh®), and Group V (biological mesh, Permacol®).

Surgical Procedure

All procedures were performed under sterile conditions. Anesthesia was induced intramuscularly using ketamine (40 mg/kg) and xylazine (5 mg/kg). Spontaneous respiration was maintained throughout the procedure. A single pre-operative intramuscular dose of ceftazidime pentahydrate (20 mg/kg) was administered for antibiotic prophylaxis.

The anterior abdominal wall was shaved and cleansed with 10% povidone-iodine (Fig. 1). A 3 cm midline incision was made, extending above and below the umbilicus, and skin flaps were prepared by separating the subcutaneous tissue from the fascia bilaterally (Fig. 2,3). A standardized 2×2 cm full-thickness abdominal wall defect, including muscle, fascia, and peritoneum, was created using a 2 cm transverse incision (1 cm to the left and right of the midline) and 2 cm longitudinal pararectal incisions. The abdominal wall segment was excised to directly expose the intra-abdominal contents.

Sterilized mesh materials measuring 3×2.5 cm were placed intraperitoneally using the inlay technique. Each mesh was fixed to the abdominal wall fascia approximately 0.5 cm behind the wound edges using 6/0 polypropylene sutures (Prolene®, Ethicon, USA) at the upper corners and along the medial and lateral borders. The skin was closed continuously with 3/0 silk sutures (Fig. 1).

On post-operative day 30, the animals were euthanized with high-dose ether anesthesia. A U-shaped relaparotomy incision was made from the lateral abdominal walls, extending from below the costal margins to the pelvis, to avoid disruption of the implantation site (Fig. 2).

Evaluation of Adhesions

Adhesions were assessed macroscopically using the Modified Diamond Scale, which grades adhesion extent, vascularity, and tenacity. The scoring criteria are summarized in Table 1. Histopathological assessment included grading of fibrosis, inflammation, vascular proliferation, and foreign body giant cell reaction, according to the criteria presented in Table 2.

Statistical Analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 11.5 (SPSS Inc., Chicago, IL, USA). For continuous variables, descriptive statistics were presented as mean±standard deviation (SD) (median [minimum–maximum]). Comparisons between independent groups were performed using the Kruskal–Wallis test. When statistically significant differences were identified, post hoc



Figure 1. An experimental animal prepared for surgery.

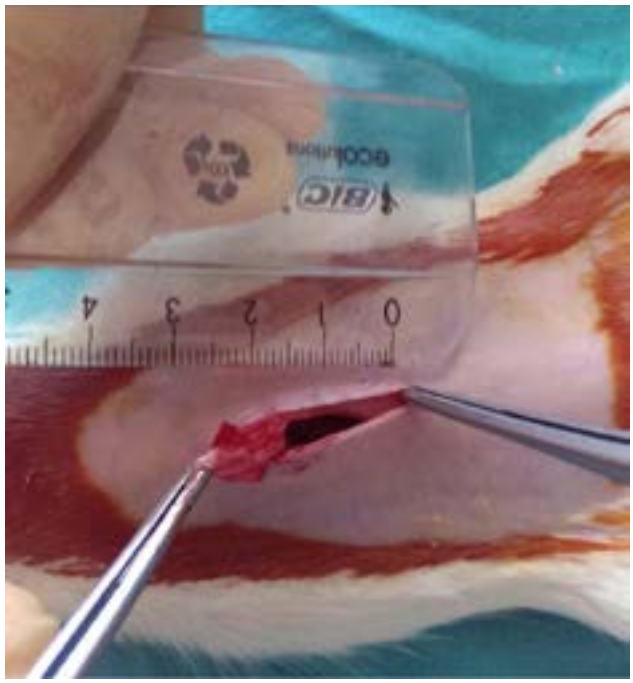


Figure 2. A 3 cm midline laparotomy was performed on the subjects.

multiple comparison tests were applied to determine the specific group differences.

RESULTS

Macroscopic Adhesion Assessment

The Modified Diamond Scale scores differed significantly among the groups (p=0.002). The Prolene mesh group demonstrated the highest adhesion severity (mean±SD: 2.80±1.23; median [1–4]), which was significantly greater than that observed in the control (p<0.001), tissue adhesive-impregnated Prolene (p=0.033), dual mesh (p=0.002), and biological mesh groups (p=0.010). The tissue adhesive-impregnated Prolene group exhibited lower adhesion scores compared to Prolene alone but remained higher than the control group (p=0.026). Overall, adhesions requiring sharp dissection were most frequently observed in the Prolene group, whereas the biological and dual mesh groups exhibited less extensive adhesions.

Fibrosis

Fibrosis scores also showed significant variation among the groups (p<0.001). The Prolene and tissue adhesive-impregnated Prolene groups exhibited the highest fibrosis levels (both 2.60±0.52), significantly exceeding those of the control (p<0.001) and dual mesh groups (p<0.001). The biological mesh group demonstrated moderate fibrosis (2.00±0.67), which was significantly lower than that observed in the Prolene group (p=0.028) but higher than the control group (p=0.006). The dual mesh group showed significantly lower fibrosis compared to both the Prolene (p<0.001) and tissue adhesive-impregnated Prolene groups (p<0.001) (Fig. 3).

Inflammation

Inflammation differed significantly among the groups (p<0.001). The dual mesh group demonstrated the highest inflammation scores (2.20±0.42), significantly exceeding all other groups (dual vs. control: p<0.001; dual vs. biological mesh: p=0.001; dual vs. tissue adhesive-impregnated Prolene: p=0.001). The Prolene group also exhibited moderate inflam-

Table 1. Adhesion scores

Score	Extent (percentage of silastic surface covered by adhesions (%)	Type	Tenacity
0	None	None	None
1	25<	Filmly, no vessels (trans-parent)	Adhesions essentially fell apart
2	25–50	Filmly, no vessels (transpar-ent)	Adhesions lysed with traction
3	50–75	Dense, vascular, small vessels	Adhesions required sharp dissection
4	75>	Dense, vascular, and big ves-sels	

Table 2. Histopatological observation scores

Score	Fibrosis	Inflamation	Vascular proliferation	Giant cell
0	None	None	None	None
1	Mild intensity	giant cells in all areas intestinal lymphocyte and plasma cells	Mild intensity	A small number
2	Moderate intensity	at each site (giant cells eosinophil neutrophil)	Moderate intensity	Medium number
3	Intense	many inflammatory cells and micro-abscesses at each site	İntense	Large number

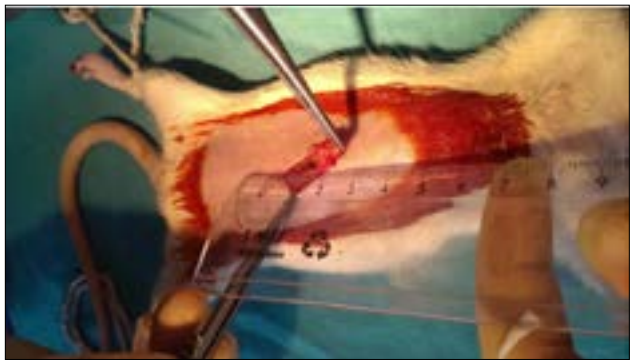


Figure 3. A 2×2 cm anterior abdominal wall defect was prepared.

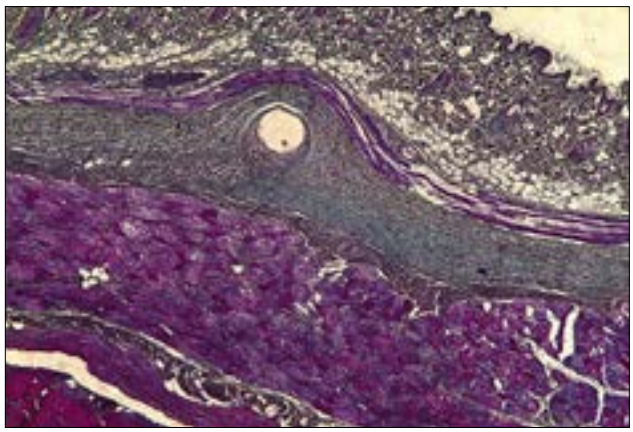


Figure 4. Biological mesh. Mild fibrosis was observed (Masson Trichrome, ×40).

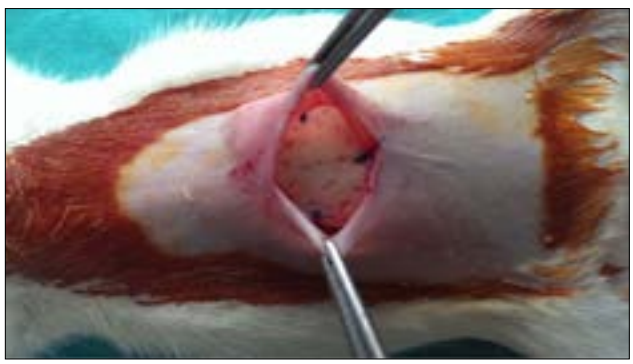


Figure 5. Mesh fixed to the abdominal wall.

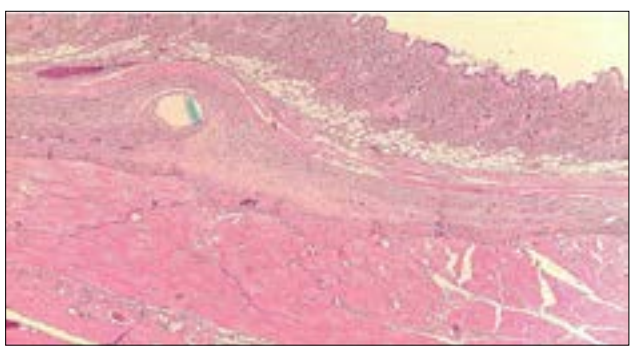


Figure 6. Biological mesh. No significant multinucleated giant cells were observed in the abdominal wall (Hematoxylin and Eosin, ×40).

mation (1.90±0.57), which was significantly higher than that observed in the control ($p<0.001$) and biological mesh groups ($p=0.033$) (Fig. 5). The biological mesh group demonstrated mild inflammation, similar to that observed in the tissue adhesive-impregnated Prolene group (both 1.40±0.52) (Fig. 4).

Vascular Proliferation

Vascular proliferation scores differed significantly among the groups ($p<0.001$). The dual mesh group exhibited the highest vascular proliferation (2.10±0.57), which was significantly greater than that observed in the Prolene ($p=0.011$), tissue adhesive-impregnated Prolene ($p=0.001$), and biological mesh groups ($p<0.001$). The biological mesh group demonstrated minimal vascular proliferation (0.50±0.71), which was significantly lower than that observed in the Prolene group ($p=0.004$) (Fig. 5).

Foreign Body Giant Cell Reaction

Giant cell counts also differed significantly among the groups ($p<0.001$). The dual mesh group elicited the most prominent giant cell response (2.80±0.42), significantly exceeding all other groups ($p<0.001$). The Prolene and tissue adhesive-impregnated Prolene groups demonstrated moderate reactions (1.80±0.63 and 1.50±0.53, respectively), whereas the biological mesh group exhibited minimal giant cell presence (0.30±0.48) (Fig. 6). Comparisons between the biological mesh and Prolene groups ($p<0.001$), as well as between the dual mesh and Prolene groups ($p<0.001$), were statistically significant (Fig. 6). A detailed comparison of all findings is presented in Table 3.

DISCUSSION

Abdominal wall defects may occur following trauma, infection, incisional hernia, or resection of large abdominal wall tumors. Such defects are managed either by primary closure or by the use of prosthetic materials. Despite their clinical utility, adhesions frequently develop following elective intra-abdominal procedures or the placement of prosthetic meshes. These adhesions may result in serious complications, including intestinal obstruction, chronic abdominal pain, enterocutaneous fistula formation, technically challenging reoperations, and infertility in women.[5]

The primary objective in the repair of abdominal wall defects is to restore tensile strength through fibrous tissue regeneration. During fascial healing, proliferating myofibroblasts produce collagen, which subsequently forms scar tissue. However, as remodeling progresses, only approximately 20% of the original tensile strength of the fascia is restored. Because this scar tissue lacks the mechanical properties of native fascia, it is insufficient to withstand normal intra-abdominal pressures. Therefore, reinforcement with synthetic grafts has become standard practice. Various materials, including silver, steel, tantalum, cellulose, polyvinyl, nylon, silastic, and carbon fibers, have been investigated; however, most were abandoned over time due to technical challenges and associated complications.

Intra-abdominal adhesions are among the most concerning complications for surgeons. Adhesions are abnormal fibrous connections between serosal surfaces that normally remain separate and typically form following peritoneal injury. Predisposing factors include advanced age, malnutrition or obesity, pulmonary disease, and repeated surgical interventions at the

Table 3. Comparison of groups by degree of adhesion

Parameter	Group	Descriptive Statistics*	p	Compreation	p
Modified diamond scale	Control (1)	0.30±0.48 (0 [0–1])	0.002	1–2	<0.001
	Prolen (2)	2.80±1.23 (3 [1–4])		1–3	0.026
	Tissue adhesive-impregnated prolene (3)	1.40±1.27 (1 [0–4])			
				2–3	0.033
	Dual (4)	0.90±1.29 (0.5 [0–4])		2–4	0.002
	Biological mesh (5)	1.30±1.49 (1 [0–4])		2–5	0.010
Fibrosis	Control (1)	1.10±0.74 (1 [0–2])	<0.001	1–2	<0.001
	Prolen (2)	2.60±0.52 (3 [2–3])		1–3	<0.001
	Tissue adhesive-impregnated prolene (3)	2.60±0.52 (3 [2–3])		1–5	0.006
	Dual (4)	1.50±0.53 (1.5 [1–2])		2–4	<0.001
				2–5	0.028
	Biological mesh (5)	2.00±0.67 (2 [1–3])		3–4	<0.001
				3–5	0.028
Inflamation	Control (1)	0.60±0.52 (1 [0–1])	<0.001	1–2	<0.001
	Prolen (2)	1.90±0.57 (2 [1–3])		1–3	0.005
	Tissue adhesive-impregnated prolene (3)	1.40±0.52 (1 [1–2])		1–4	<0.001
	Dual (4)	2.20±0.42 (2 [2–3])		1–5	0.005
				2–3	0.033
	Biological mesh (5)	1.40±0.52 (1 [1–2])		2–5	0.033
				3–4	0.001
				4–5	0.001
Vascular	Control (1)	0.50±0.53 (0.5 [0–1])	<0.001	1–2	0.004
	Prolen (2)	1.30±0.48 (1 [1–2])		1–3	0.027
	Tissue adhesive-impregnated prolene (3)	1.10±0.57 (1 [0–2])		1–4	<0.001
	Dual (4)	2.10±0.57 (2 [1–3])		2–4	0.011
				2–5	0.004
	Biological mesh (5)	0.50±0.71 (0 [0–2])		3–4	0.001
				3–5	0.028
				4–5	<0.001
Giant cell	Control (1)	0.00±0.00 (0 [0–0])	<0.001	1–2	<0.001
	Prolen (2)	1.80±0.63 (2 [1–3])		1–3	<0.001
	Tissue adhesive-impregnated prolene (3)	1.50±0.53 (1.5 [1–2])		1–4	<0.001
	Dual (4)	2.80±0.42 (3 [2–3])		2–4	<0.001
				2–5	<0.001
	Biological mesh (5)	0.30±0.48 (0 [0–1])		3–4	<0.001
				3–5	<0.001
				4–5	<0.001

same site.[6] Ischemia is a major contributor to adhesion formation. Experimental studies have demonstrated that adhesions are less likely to develop in the absence of ischemia. Conversely, when ischemia affects intact mesothelial surfaces, adhesion formation becomes more likely. Local fibrinolytic activity increases in non-ischemic tissues and decreases in ischemic areas, thereby promoting adhesion development.

Although numerous studies have compared different mesh types, to our knowledge, no previous study has simultaneously evaluated biological mesh alongside synthetic, biosynthetic, and tissue adhesive-impregnated meshes within a single experimental model. In experimental rat models, several anti-adhesion strategies have been investigated, demonstrating varying degrees of efficacy in reducing adhesion formation following peritoneal injury, including crystalloids such as methylene blue and Ringer's lactate, as well as barrier agents such as Seprafilm and Interceed.[7-9] Matthews et al.[10] compared intraperitoneally placed Prolene and PTFE meshes in rabbits, assessing adhesion rates by microlaparoscopy at 1, 3, 9, and 16 weeks. They reported a higher incidence of adhesions with Prolene (55%) compared to PTFE (30%) meshes.

Peritoneal injury initiates the cascade leading to adhesion formation, with the extent of tissue damage determining the severity of the inflammatory response and subsequent adhesion development. Accordingly, meticulous surgical technique – minimizing tissue trauma, maintaining hemostasis, avoiding thermal injury, and preventing contamination – has been shown to reduce post-operative adhesions.[11] In addition, Minardi et al.[12] suggested that hernia repair outcomes may be improved by enhancing early vascularization through the incorporation of elastin into collagen-based meshes. In the present study, macroscopic assessment using the Modified Diamond Scale revealed significantly fewer severe adhesions in the biological mesh group compared to the Prolene mesh group ($p=0.001$). Adhesions requiring sharp dissection were predominant in the Prolene group, whereas most adhesions in the biological mesh group could be separated by traction. A significant reduction in adhesion severity was also observed in the tissue adhesive-impregnated Prolene mesh group compared to untreated Prolene ($p=0.033$). Experimental studies have also explored the use of fibrin sealants for mesh fixation, reporting adequate mechanical stability and favorable tissue response without increased adverse effects.[13]

Meshes with lower porosity, such as dual mesh and biological mesh, tend to form encapsulated barriers associated with reduced adhesion formation. In these materials, fibrin deposition is limited to discrete areas, resulting in a milder inflammatory response. Overall, all mesh types were associated with some degree of adhesion formation; however, adhesions were less extensive in low-porosity meshes and in those treated with tissue adhesives. Furthermore, histopathological analysis in the present study demonstrated significantly lower levels of inflammation, fibrosis, and foreign body giant cell reaction in the biological mesh group compared to the other groups.

Recent experimental studies have focused on evaluating composite and barrier-coated meshes to minimize adhesion formation following intraperitoneal implantation.[14] Several clinical and experimental studies have reported increased adhesion-related complications following intraperitoneal placement of uncoated polypropylene meshes, whereas composite barrier-coated and biologic meshes have been associated with reduced adhesion severity and improved biocompatibility.[4,15]

More recent animal studies support these findings, demonstrating that the use of barrier-coated or biological meshes reduces foreign body reaction, fibrosis, and vascular proliferation, and suggesting their preferential use in intraperitoneal applications.[16] In line with these data, the present study confirms that biological and dual meshes, as well as tissue adhesive-treated polypropylene meshes, elicit significantly milder macroscopic and histopathological responses compared to conventional polypropylene meshes, thereby supporting current approaches aimed at optimizing mesh selection and surface modification strategies in abdominal wall reconstruction.

More recent evidence has emphasized the importance of mesh composition and biomechanical properties. Deeken and Lake demonstrated that the structural and mechanical characteristics of mesh materials significantly influence tissue integration and host response.[17]

In addition, available evidence highlights the importance of careful mesh selection, particularly when considering biologic and biosynthetic materials in abdominal wall reconstruction.[18]

Furthermore, biosynthetic and biologic meshes have been shown to provide favorable outcomes in selected high-risk settings, supporting their role in reducing inflammatory response and improving tissue compatibility.[19]

Recent randomized evidence has demonstrated differences between biologic and synthetic meshes in contaminated ventral hernia repair, further highlighting the importance of appropriate mesh selection.[20]

However, most of these studies are limited to pairwise comparisons or focus on a single mesh type or modification strategy. In contrast, the present study provides a comprehensive head-to-head comparison of polypropylene mesh (Prolene®), tissue adhesive-impregnated polypropylene mesh (Tisseel®), dual mesh (Gore® DualMesh®), and biologic mesh (Permacol®) within a standardized experimental model. This design enables direct comparison of both macroscopic adhesion formation and detailed histopathological responses across multiple mesh types.

Importantly, the present study extends the existing literature by offering a multi-dimensional evaluation that integrates both macroscopic and histopathological outcomes under identical experimental conditions. This approach provides a more robust and clinically relevant comparison than previous studies.

CONCLUSION

This study differs from most previous investigations that have focused on the effects of coating on mesh structure or have evaluated meshes with different pore characteristics.

Given the high cost and technical challenges associated with biological meshes, this study aimed to assess whether these approaches provide a meaningful clinical advantage at the experimental level. Accordingly, we sought to address not only the hypothesis that "different materials yield better outcomes" but also whether the additional cost and complexity are justified.

Although previous studies – particularly those comparing coated meshes with biological meshes – have contributed substantially to the field, experimental studies incorporating a four-group comparison under conditions that preserve mesh structure and evaluate practical applicability remain limited. In this context, the present study contributes to both scientific understanding and potential clinical application.

Unlike previous studies, this work provides a comprehensive comparative evaluation of multiple mesh types under standardized experimental conditions.

This experimental study demonstrated that biological and dual meshes, as well as polypropylene meshes treated with tissue adhesive, resulted in significantly reduced adhesion formation and milder histopathological reactions compared to conventional Prolene mesh. Although no material completely prevented adhesion formation, lower-porosity meshes and anti-adhesive strategies consistently reduced adhesion severity. These findings support the preferential use of biologic or composite meshes in intraperitoneal applications to minimize adhesion-related complications. Further research is required to identify strategies that can completely prevent adhesion formation.

Ethics Committee Approval: This study was approved by the Ankara University Local Ethics Committee for Animal Experiments (Date: 25.09.2013, Decision No: 2013-16-125).

Peer-review: Externally peer-reviewed.

Authorship Contributions: Concept: Ş.O.; Design: Ş.O.; Supervision: A.Ç.; Resource: Ş.O.; Materials: Ş.O.; Data collection and/or processing: Ş.O.; Analysis and/or interpretation: Ş.O.; Literature review: A.Ç.; Writing: Ş.O.; Critical review: Ş.O.

Conflict of Interest: There are no conflicts of interest in our study.

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REFERENCES

1. Bosanquet DC, Ansell J, Abdelrahman T, Cornish J, Harries R, Stimpson A, et al. Systematic review and meta-regression of factors affecting midline incisional hernia rates: analysis of 14,618 patients. PLoS One 2015;10:e0138745. [CrossRef]
2. Pereira-Lucena CG, Artigiani-Neto R, Lopes-Filho GJ, Frazao CV, Goldenberg A, Matos D, et al. Experimental study comparing meshes made of polypropylene, polypropylene + polyglactin and polypropylene + titanium: inflammatory cytokines, histological changes and morphometric analysis of collagen. Hernia 2010;14:299–304. [CrossRef]
3. Delibegovic S, Koluh A, Cickusic E, Katica M, Mustedanagic J, Krupic F. Formation of adhesion after intraperitoneal application of TiMesh: experimental study on a rodent model. Acta Chir Belg 2016;116:293–300. [CrossRef]
4. Soare AM, Cârțu D, Nechita SL, Andronic O, Șurlin V. Complications of intraperitoneal mesh techniques for incisional hernia - a systematic review. Chirurgia (Bucur) 2021;116(6 Suppl):S36–S42.
5. Alimoglu O, Akcakaya A, Sahin M, Unlu Y, Ozkan OV, Sanli E, et al. Prevention of adhesion formations following repair of abdominal wall defects with prosthetic materials (an experimental study). Hepatogastroenterology 2003;50:725–8.
6. Fuziy RA, Artigiani Neto R, Caetano Junior EM, Alves AKS, Lopes Filho GJ, Linhares MM. Comparative study of four different types of intraperitoneal mesh prostheses in rats. Acta Cir Bras 2019;34:e201900703. [CrossRef]
7. Mahdy T, Mohamed G, Elhawary A. Effect of methylene blue on intra-abdominal adhesion formation in rats. Int J Surg 2008;6:452–5. [CrossRef]
8. Poehnert D, Grethe L, Maegel L, Jonigk D, Lippmann T, Kaltenborn A, et al. Evaluation of the effectiveness of peritoneal adhesion prevention devices in a rat model. Int J Med Sci 2016;13:524–32. [CrossRef]
9. Wallwiener M, Brucker S, Hierlemann H, Brochhausen C, Solomayer E, Wallwiener C. Innovative barriers for peritoneal adhesion prevention: liquid or solid? A rat uterine horn model. Fertil Steril 2006;86(4 Suppl):1266–76. [CrossRef]
10. Matthews BD, Pratt BL, Pollinger HS, Backus CL, Kercher KW, Sing RF, et al. Assessment of adhesion formation to intra-abdominal polypropylene mesh and polytetrafluoroethylene mesh. J Surg Res 2003;114:126-32. [CrossRef]
11. Voskerician G, Jin J, Hunter SA, Williams CP, White M, Rosen MJ. Human peritoneal membrane reduces the formation of intra-abdominal adhesions in ventral hernia repair: experimental study in a chronic hernia rat model. J Surg Res 2009;157:108–14. [CrossRef]
12. Minardi S, Taraballi F, Wang X, Cabrera FJ, Van Eps JL, Robbins AB, et al. Biomimetic collagen/elastin meshes for ventral hernia repair in a rat model. Acta Biomater 2017;50:165–77. [CrossRef]
13. Krpata DM, Blatnik JA, Harth KC, Phillips MS, Novitsky YW, Rosen MJ. Evaluation of fibrin sealant for biologic mesh fixation at the hiatus in a porcine model. Surg Endosc 2012;26:3120–6. [CrossRef]
14. Zhang X, Hu K, Xue J, Wang Z, Jiang Y, Zou Z, et al. Experimental methodology used for testing in vivo adhesion of composite meshes for incisional hernia repair: a scoping review. RSC Adv 2025;15:36319–30. [CrossRef]
15. Halm JA, de Wall LL, Steyerberg EW, Jeekel J, Lange JF. Intraperitoneal polypropylene mesh hernia repair complicates subsequent abdominal surgery. World J Surg 2007;31:423–9; discussion 430. [CrossRef]
16. Schreinemacher MH, van Barneveld KW, Dikmans RE, Gijbels MJ, Greve JW, Bouvy ND. Coated meshes for hernia repair provide comparable intraperitoneal adhesion prevention. Surg Endosc 2013;27:4202–9. [CrossRef]
17. Deeken CR, Lake SP. Mechanical properties of the abdominal wall and biomaterials utilized for hernia repair. J Mech Behav Biomed Mater 2017;74:411–27. [CrossRef]
18. Köckerling F, Alam NN, Antoniou SA, Daniels IR, Famiglietti F, Fortelny RH, et al. What is the evidence for the use of biologic or biosyn-

thetic meshes in abdominal wall reconstruction? Hernia 2018;22:249–69. [CrossRef]

19. Rosen MJ, Krpata DM, Ermlich B, Blatnik JA. A 5-year clinical experience with single-staged repairs of infected and contaminated abdominal wall defects utilizing biologic mesh. Ann Surg 2013;257:991–6. [CrossRef]

20. Rosen MJ, Krpata DM, Petro CC, Carbonell A, Warren J, Poulose BK, et al. Biologic vs synthetic mesh for single-stage repair of contaminated ventral hernias: A randomized clinical trial. JAMA Surg 2022;157:293–301. [CrossRef]

DENEYSEL ÇALIŞMA - *ÖZ*

Rat modelinde sentetik, biyosentetik ve biyolojik ağların implantasyonunu takiben karın içi yapışıklık oluşumunun karşılaştırılması

AMAÇ: İntraabdominal adezyonlar, insizyonel herni onarımında bağırsak obstrüksiyonu ve kronik ağrı gibi komplikasyonlara yol açabilen önemli bir sorun olmaya devam etmektedir. Çeşitli prostetik mesh materyalleri geliştirilmiş olmakla birlikte, bu materyallerin adezyon profillerinin karşılaştırmalı değerlendirmesi tam olarak ortaya konulamamıştır. Bu deneysel çalışmada, standartlaştırılmış bir sıçan modelinde sentetik, biyosentetik, biyolojik ve kimyasal olarak modifiye edilmiş meshlerin oluşturduğu intraabdominal adezyon şiddeti ve buna eşlik eden histopatolojik reaksiyonların karşılaştırılması amaçlanmıştır.

GEREÇ VE YÖNTEM: Elli Wistar albino sıçan rastgele beş gruba ayrıldı (her grupta n=10): kontrol, polipropilen mesh (Prolene®), doku yapıştırıcısı emdirilmiş polipropilen mesh (Tisseel®), dual mesh (Gore® DualMesh®) ve biyolojik mesh (Permacol®). Her hayvanda standart 2×2 cm tam kat abdominal duvar defekti oluşturuldu ve ardından meshler intraperitoneal olarak implante edildi. Postoperatif 30. günde makroskopik adezyonlar Modified Diamond Skalası kullanılarak değerlendirildi. Histopatolojik incelemede fibrozis, inflamasyon, vasküler proliferasyon ve dev hücre reaksiyonu derecelendirildi. İstatistiksel analiz Kruskal–Wallis ve çoklu karşılaştırma testleri ile gerçekleştirildi.

BULGULAR: Prolene mesh en yüksek adezyon şiddetini gösterdi (ortalama Modified Diamond Skoru: 2.80±1.23) ve biyolojik mesh (p=0.010), dual mesh (p=0.002) ve doku yapıştırıcısı emdirilmiş Prolene grubuna (p=0.033) kıyasla anlamlı derecede daha yüksek bulundu. Fibrozis ve inflamasyon en belirgin olarak Prolene ve dual mesh gruplarında gözlenirken, biyolojik mesh grubunda daha hafif reaksiyonlar saptandı (Prolene ile karşılaştırıldığında fibrozis için p=0.028; inflamasyon için p=0.033). Vasküler proliferasyon ve dev hücre sayıları biyolojik mesh grubunda anlamlı derecede daha düşüktü (sırasıyla p=0.004 ve p<0.001).

SONUÇ: Biyolojik ve dual meshler ile doku yapıştırıcısı ile modifiye edilmiş meshler, işlenmemiş polipropilen mesh ile karşılaştırıldığında anlamlı derecede daha az adezyon oluşumu ve daha düşük histopatolojik yanıt ile ilişkili bulunmuştur. Hiçbir materyal adezyonları tamamen önleyememiş olsa da, düşük poroziteli meshler ve antiadezif stratejiler intraperitoneal herni onarımında adezyona bağlı morbiditenin azaltılmasında umut verici görünmektedir. Bu bulguların doğrulanması ve optimal mesh seçiminin belirlenmesi için ileri çalışmalara ihtiyaç vardır.

Anahtar sözcükler: Cerrahi mesh; hayvan modeli; insizyonel herni; karın içi yapışıklıklar.

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