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Experimental Study

Effects of Different Abdominal Closure Techniques on Wound Healing

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Keywords: Abdomen closing technique; incisional hernia; wound healing.

ABSTRACT

Objective: Incisional hernias that are the type of anterior abdominal wall hernia (ventral hernia) are common surgical problems after abdominal procedures. Although these types of hernias are seen after every abdominal operation, they are mostly seen after the midline and transverse incisions. However, the incidence of incisional hernia is 20%, according to the latest data, the incidence of incisional hernia is 2-11%. Only in the U.S.A., 190 000 incisional hernia operations are carried out per year. Incisional hernias that are seen after abdominal surgical procedures cause important loss of labour, morbidity and adversely affect the quality of life. Because of the high incidence and morbidity rate, it is one of the important problems of surgery. Incisional hernias originated from previous insufficient healing of abdominal closure. Factors that cause incisional hernias are obesity, tight closure of wound edges, wound infection, hematoma, seroma, type of incision, the technique of abdominal closure, steroid use, malnutrition (hypoproteinemia), smoking, COPD, diabetes and mellitus.

Methods: In this study, experimentally, we aimed to show the pathologic and biochemical effects of different closure techniques on wound healing into the cellular level of rats.

Results: In this study, we used 40 female rats that were Wistar Albino types and their mean-weight was 200–250 gr. Rats were divided into five groups. Each group included eight rats. U-shaped samples were taken from mid-line incision, previously made, for pathologic (inflammation, angiogenesis and collagen activity) and biochemical [MDA (malondialdehyde), NO (nitric oxide), caspase 3 activity, MMP 2-9 (Metalloproteinases 2 and 9), TNF alfa (tumor necrosis factor alfa), IL6 (interleukin 6)] study, and after these procedures, rats were sacrificed.

Conclusion: The findings obtained in this study show that there was no statistically significant difference between abdominal closure techniques one by one or continue suturing concerning incisional hernia if the fascia was closed optimally (not very tight, not to deteriorate the vascularity and end to end closing).

INTRODUCTION

Abdominal hernia is one of the most common pathologies encountered in general surgery. Although abdominal hernia is most commonly seen after midline and/or transverse laparotomy, this type of hernia may occur after any abdominal incision. The incidence of hernia was observed after a small incision and the incidence of incisional hernia was reported up to 20% in the last reports.[1,2] In the United States, there were about 190 000 inpatient abdominal wall hernia repairs performed in 2012.[3]

Incisional hernias following abdominal surgery may result in significant labor losses, morbidity and adversely affect the quality of life. Incisional hernias remain one of the major problems of surgery due to their high incidence and high morbidity.[4,5] Type of incision, closure technique of incision and suture material are important factors to prevent hernia occurrence.[6,7]

The only treatment option of incisional hernia is surgical repair. Treatment of incisional hernia includes primary repair and/or repair with prosthetic material. After primary repair of incisional hernia, 30–50% recurrence is reported. The recurrence of incisional hernia rate decreases to 0–15% primary repair with mesh.[7,8]

The etiologic risk factors that cause incisional hernia have been related to patient characteristics (e.g., older age, obesity, diabetes, smoking, immunosuppression), hernia characteristics (e.g., transverse diameter, location, recurrence, mesh),[9] and surgical performance (e.g., experience, incision closure technique, suture material, dexterity, previous training).[10,11]

This study aims to investigate whether there are differences in the cellular level by applying abdominal closure techniques in animal models that we frequently apply in clinical practice.

MATERIALS AND METHODS

This study was started in Experimental Animal Research Laboratory University of Istanbul Istanbul Medical Faculty after approval of the Ethics Committee of the University of Istanbul, Istanbul Medical Faculty. Forty Wistar Albino species rats, which had an average of 200–250 gr weight, were used in this study. Rats were fed with standard laboratory feed and water on average 22 °C temperatures before and after the experiment. Rats were divided into five groups, which had eight animals in each group.

The operation was performed in groups, under sterile condition. 75 mg/kg Ketamine HCl and Xylazine HCl (Rompun) were applied intramuscularly for each rat (Fig. 1a).

In Group 1 (Sham group n=8), the histopathologic sample was taken from the abdominal wall without laparotomy.

In Group 2 (n=8), after laparotomy, the abdomen was closed with one by one suture and the histopathologic sample was taken from the abdominal wall at 72nd hours.

In Group 3 (n=8), after laparotomy, the abdomen was closed by continuous sutures and the histopathologic sample was taken from the abdominal wall at 72nd hours.

In Group 4 (n=8), after laparotomy, the abdomen was closed with one by one suture and the histopathologic sample was taken from the abdominal wall at 21st days.

In Group 5 (n=8), after laparotomy, the abdomen was closed by continuous sutures and the histopathologic sample was taken from the abdominal wall at 21st days. View of abdominal wall of the rat was seen in Figure 1b and the sample was taken from the abdominal wall was seen in Figure 1c.

Specimens were fixed with formalin and then embedded in paraffin blocks. 5-micron section was painted with H&E s and evaluated by a light microscope.

Histopathologic examination

Specimens, which were painted with H&E, were evaluated by a pathologist without knowledge about groups. Inflammation, collagen accumulation and angiogenesis were examined in specimens with the magnification of 10 and 40 (Figs. 2a–d).

Biochemical methods

MDA (malondialdehyde), NO (nitric oxide), caspase 3 activity, MMP 2-9 (Metalloproteinases 2 and 9), TNF alfa (tumor necrosis factor alfa), IL6 (interleukin 6) were evaluated biochemically.

Table 1. Comparisons of biochemical parameters in Group II and III

Biochemical parameters	Group II	Group III	p
	Mean±SD	Mean±SD	
TNF-α	3.52±1.23	3.65±1.38	0.2
Interleukin 6	4.12±1.34	4.05±1.45	0.063
Nitric oxide	1.4±0.445	1.45±0.21	0.08
Malondialdehyde	1.05±0.27	1.045±0.2	0.15
Metalloproteinases-2	1.82±0.62	1.85±0.6	0.072
Metalloproteinases-9	1.43±0.44	1.34±0.4	0.065

TNF-α: Tumor necrosis factor alfa; SD: Standard deviation.

Table 2. Comparisons of the biochemical parameters in Group IV and V

Biochemical parameters	Group IV	Group V	p
	Mean±SD	Mean±SD	
TNF-α	3.52±1.23	3.65±1.38	0.2
Interleukin 6	4.12±1.34	4.05±1.45	0.063
Nitric oxide	1.4±0.445	1.45±0.21	0.08
Malondialdehyde	1.05±0.27	1.045±0.2	0.15
Metalloproteinases-2	1.82±0.62	1.85±0.6	0.072
Metalloproteinases-9	1.43±0.44	1.34±0.4	0.065

TNF-α: Tumor necrosis factor alfa; SD: Standard deviation.

Statistical analysis

SPSS version 18.0 (SPSS, Chicago, IL, USA) was used for all measurements and a p-value lower than 0.05 was considered as statistically significant. Chi-Square test, Kruskal-Wallis test and Mann-Whitney U test were used for the analysis of data.

RESULTS

There was not any morbidity and mortality in this study. According to the oxidative injury parameters, there were

Figure 1. (a) Preoperative view of abdominal wall of rat. **(b)** View of abdominal wall of rat after laparotomy. **(c)** Sample was taken after laparotomy for histopathologic examination and biochemical evaluation.

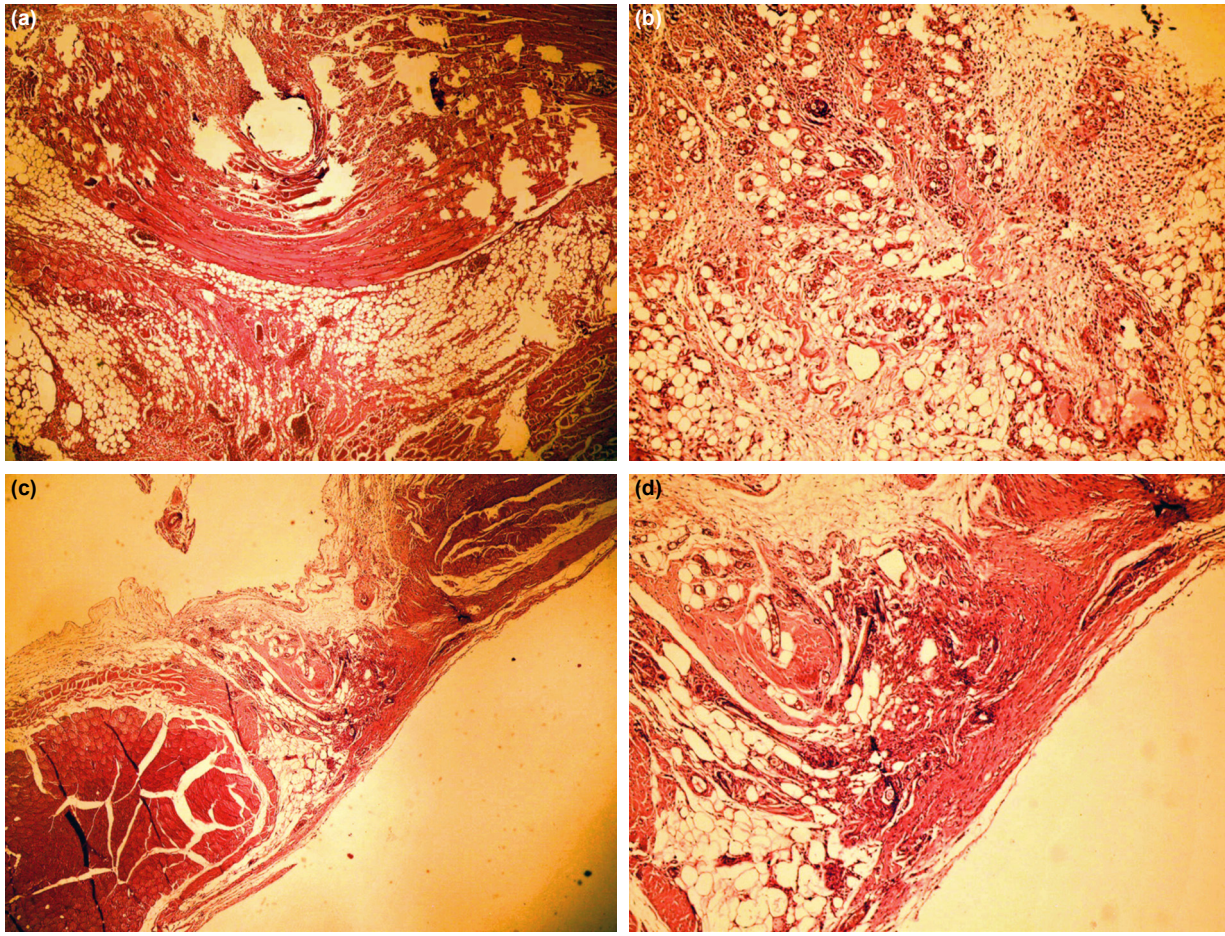

Figure 2. (a) Early period continue closure at x10 magnification with H&E staining; intense mix type inflammatory cell infiltration and vascular proliferation in striated muscle, fat and connective tissue. **(b)** Early period one by one closure at x40 magnification with H&E staining; vascular proliferation and intense inflammatory cell infiltration. **(c)** Late period continue closure at x10 magnification with H&E staining; mild inflammatory cell infiltration and vascular proliferation. **(d)** Late period one by one closure at x10 magnification with H&E staining; mild inflammatory cell infiltration and moderate vascular proliferation.

statistically significant differences between group I (Sham group) and experimental groups, but there were not any statistically significant differences in the paired comparisons between other groups.

When comparing the parameters, such as TNF-α, IL-6, NO, MDA, MMP-2, MMP-9, to evaluate oxidative damage, there were not any statistically significant differences between group I and group 2 (Table 1) and group 4 and group 5 (Table 2).

Histopathologically, early and late wound healing, collagen activity and angiogenesis were evaluated. There were not any statistically significant differences between groups (Table 3, 4).

DISCUSSION

The abdominal hernia is one of the most common pathologies encountered in general surgery. The incidence of hernia was observed after a small incision and the inci-

Table 3. The early period of histopathologically comparison of the groups according to the collagen accumulation, angiogenesis and inflammation

Early (72 hours)	Collagen accumulation	Angiogenesis	Inflammation
Chi-square	0.065	1.24	0.743
df	I	I	I
p	0.62	0.385	0.24

Kruskal-Wallis Test.

Table 4. The Late period of histopathological comparison of groups according to the collagen accumulation, angiogenesis and inflammation

Late (21. days)	Collagen accumulation	Angiogenesis	Inflammation
Chi-square	0.60	2.471	0.763
df	2	2	I
p	0.970	0.491	0.28

Kruskal-Wallis Test.

dence of incisional hernia was reported up to 20% in the last reports.[1] In the United States, there were about 190 000 inpatient abdominal wall hernia repairs performed in 2012.[3]

The etiologic risk factors that cause incisional hernia have been related to patient characteristics (e.g., older age, obesity, diabetes, smoking, immunosuppression), hernia characteristics (e.g., transverse diameter, location, recurrence, mesh),[9] and surgical performance (e.g., experience, incision closure technique, suture material, dexterity, previous training).[10,11] Type of incision, closure technique of incision and used suture material are important factors to prevent hernia occurrence.[6,7]

Mudges and Huges evaluated 337 patients who underwent laparotomy in a 10- year prospective study and reported 62 incisional hernias. Hernia development occurred in 56% of the patients in the first year, and 35% in the five years. [7] Ellis et al.[12] reported that there was not any statistically significant difference in the development of hernia in different types of incisions in patients undergoing elective abdominal surgery.

When the findings obtained in this study are evaluated and literature review is conducted, the most important point is that there are not enough studies on this subject in the literature.[13] According to the classical surgical view, the closure of the fascia as a continuation decreases the blood supply at the wound site, and when the intraabdominal pressure increases, fascial separation is easier.[14] However, in our study, there were not any significant differences between the closure of the abdominal wall one by one and continue, either biochemically and histopathologically. The early phase of wound healing starts with inflammatory activity, and inflammation is high level in this phase, which lasts approximately 72 hours. In this study, it was found that the inflammatory process was not affected by early closure techniques. In the literature, it has been observed that, wound healing is disrupted, especially in sutures that pass about 1 cm from the wound margins. It was reported that disruption of the inflammation zone and wound healing were interrupted during this early period.[15,16] In our study, abdominal wall closures were made by passing a 0.5 cm distance between the fascial wound margins in all groups. Thus, the healing zone was not compromised. In the late phase of wound healing, proliferation and remodelling start at 4th days, and it takes a long time to complete. In this study, for the evaluation of the late phase of wound healing, 21th days was preferred because more than 60% of the tensile strength is regained at the end of the second week, and the accumulation of collagen increases intensively during this period. We evaluated histopathological collagen accumulation on day 21 and biochemical levels of MMP 2–9, which play important roles in collagen synthesis. There was not any statistically significant difference between these levels between different abdominal closure techniques.

CONCLUSION

In conclusion, when the abdominal incisions were closed appropriately (tension-free, not to disturb the blood supply and end-to-end), it was found that one by one or continued closure technique did not cause a statistically significant difference in wound healing. We believe that further and prospective studies are needed on this subject.

Ethics Committee Approval

Approved by the local ethics committee (date: 24.06.2010, no: 95/2010).

Peer-review

Internally peer-reviewed.

Conflict of Interest

None declared.

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Sıçanlarda Farklı Batın Kapama Tekniklerinin Yara İyileşmesi Üzerine Etkisi

Amaç: Ön karın duvarı fıtıkları (ventral herniler) karın cerrahisi sonrasında sık karşılaşılan problemlerdendir. Bu tip fıtıklar çoğunlukla orta hat ve transvers kesilerden sonra görülmesine rağmen her tip karın operasyonundan sonra görülebilirler. Sıklığı %20 olmasına rağmen son verilere göre insizyonel fıtık sıklığı %2–11'dir. Sadece Amerika Birleşik Devletleri'nde yılda 190.000 insizyonel herni operasyonu yapılmaktadır. Karın operasyonlarından sonra oluşan insizyonel fıtıklar ciddi iş gücü kaybına, morbiditeye ve kötü yaşam kalitesine neden olmaktadır. Yüksek insidansı ve morbiditesi nedeniyle önemli bir cerrahi sorundur. İnsizyonel fıtıklar karının kapatılmasındaki yetersiz iyileşmeden kaynaklanmaktadır. Obezite, yara kenarlarının sıkı kapatılması, yara yerinde enfeksiyon, hematom, seroma, karın kapama tekniği, steroid kullanımı, malnutrisyon (hipoproteinemi…), sigara kullanımı, kronik obstrüktif akciğer hastalığı (KOAH), diyabet gibi.

Gereç ve Yöntem: Bu çalışmada, sıçanlarda farklı karın kapama tekniklerinin hücresel düzeyde yara iyileşmesi üzerine patolojik ve biyokimyasal etkilerinin deneysel olarak gösterilesi amaçlanmıştır.

Bulgular: Bu çalışmada, ortalama ağrılığı 200–250 gr olan Wistar Albino cinsi dişi sıçan kullanıldı. Denekler her grupta 8 sıçandan oluşan beş gruba ayrıldı. Önceden yapılan orta hat kesisinden patolojik (enflamasyon, anjiyogenez ve kollojen aktivitesi) ve biyokimyasal [MDA (malondialdehit), NO (nitrik oksit), kaspaz 3 aktivitesi, MMP 2-9 (metalloproteinaz 2 ve 9), TNF alfa (tumör nekrosis faktor alfa), IL6 (interlökin 6)] inceleme için 'U' şeklinde örnekler alındı, tüm bu işlemlerden sonra sıçanlar sakrifiye edildi.

Sonuç: Bu çalışmanın sonucuna göre, eğer batın fasyası optimal (vaskülariteyi bozmayacak derecede sıkı kapatılmamalı ve uç-uca kapatılmalı) kapatılırsa, tek tek veya sürekli karın kapama tekniği arasında insizyonel fıtık gelişimi açısından istatistiksel olarak anlamlı fark yoktur.

Anahtar Sözcükler: Batın kapama tekniği; insizyonel herni; yara iyileşmesi.