INDEX COPERNICUS INTERNATIONAL

ORIGINAL ARTICLE

A new criterion to predict recurrence after laparoscopic ventral hernia repair: mesh/defect area ratio

Nowe kryterium przewidywania wznowy po laparoskopowej plastyce przepukliny brzusznej: stosunek powierzchni siatki do powierzchni uszkodzenia

Authors' Contribution:
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Manuscript Preparation
E – Literature Search
F – Funds Collection

Ramazan Kozan[ACDE], Ahmet Ziya Anadol[ABF], Mustafa Sare[BDF]

Department of General Surgery, Faculty of Medicine, Gazi University, Ankara, Turkey

Article history: Received: 18.01.2021 Accepted: 06.07.2021 Published: 08.07.2021

ABSTRACT:

Introduction: Minimizing recurrence in hernia surgery is one of the major aims. Defining surgeon-dependent risk factors for recurrence is therefore of great importance in laparoscopic ventral hernia repair (LVHR). This study aims to analyze the predictive value of the mesh area/defect area ratio (M/D ratio) in terms of recurrence as a new criterion in LVHR.

Methods: A total of 124 patients were enrolled in the study. Age, gender, hernia type, body mass index, defect size, size of the mesh, mesh overlapping, area of the defect, area of the mesh, M/D ratio, postoperative complications, follow-up time, recurrences and timing of recurrence were also recorded. The potential variables that may affect recurrence were examined by univariate and multivariate analysis.

Results: There were 12 (9.7%) recurrences in our series. A statistically significant difference was found if either the mesh/defect ratio was ≤6 or >6 (p = 0.012). Multivariate analysis confirmed that M/D ratio was the only independent parameter for recurrence.

Conclusion: Understanding M/D ratio concept and using it in surgical clinical practice may help reduce recurrence rates after LVHR.

KEYWORDS: hernia, laparoscopy, mesh/defect area ratio, recurrence, ventral

STRESZCZENIE:

Wprowadzenie: Jednym z głównych celów plastyki przepukliny jest zminimalizowanie odsetka wznów. W związku z tym, kluczowe znaczenie w laparoskopowej plastyce przepuklin brzusznych (LVHR) stanowi określenie czynników ryzyka zależnych od chirurga. Celem niniejszego badania jest analiza wartości predykcyjnej stosunku powierzchni siatki do powierzchni uszkodzenia (stosunku M/D), w kontekście występowania wznów przepukliny jako nowego kryterium w LVHR.

Metody: Do badania włączono 124 pacjentów. Rejestrowane dane obejmowały: wiek, płeć, rodzaj przepukliny, współczynnik masy ciała, szerokość zewnętrznego marginesu siatki, pole powierzchni uszkodzenia, pole powierzchni siatki, stosunek M/D, powikłania pooperacyjne, czas obserwacji kontrolnej, wystąpienie wznowy i czas wystąpienia wznowy. Potencjalne zmienne, mogące mieć wpływ na wystąpienie wznowy, zbadano w analizie jedno- i wielozmiennowej.

Wyniki: W naszej serii przypadków zaobserwowaliśmy 12 (9,7%) wznów przepukliny. Stwierdzono istotną statystycznie różnicę między grupami o współczynniku stosunku M/D, wynoszącym odpowiednio ≤ 6 i > 6 (p = 0,012). Analiza wielozmiennowa potwierdziła, że stosunek M/D był jedynym niezależnym czynnikiem predykcyjnym wznowy przepukliny.

Wnioski: Zrozumienie koncepcji stosunku M/D i korzystanie z niej w chirurgicznej praktyce klinicznej może pomóc w zmniejszeniu częstości wznów przepukliny po leczeniu LVHR.

SŁOWA KLUCZOWE: brzuszna, laparoskopia, przepuklina, stosunek powierzchni siatki/uszkodzenia, wznowa

ABBREVIATIONS

BMI – body mass index
CI – confidence interval
CT – computed tomography
EHS – European Hernia Society
LVHR – laparoscopic ventral hernia repair
M/D – mesh area/defect area
OR – odds ratio
SD – standard deviation

INTRODUCTION

The technique of laparoscopic intraperitoneal repair of abdominal hernias using on-lay mesh (bridging) has gained increasing popularity since it was first described by LeBlanc and Booth, in 1993 [1]. As pointed out in the literature, laparoscopic ventral hernia repair (LVHR) is safe, reduces the risk of infection, and has shorter surgery time with fewer complications and better patient satisfaction [2–6]. However, the risk of inadvertent enterotomy has been shown to be higher during laparoscopic procedures [5].

Despite continued improvements in the technique, recurrence after LVHR is still one of the major clinical problems. The main obstacle in determining the rate of real recurrence after LVHR seems to be the difficulty of standardizing patients, as seen in the literature [7]. The recurrence rate of the bridging technique varies from 2.6% to 16.7% [8, 9]. The impact of primary closure of the defect before mesh placement is still controversial [9, 10].

This study aims to analyze the predictive value of the mesh to defect area ratio (M/D ratio) in terms of recurrence as a new criterion in LVHR. Preoperative assessment and the use of this ratio alone (or combined with other factors) may contribute to better patient selection and minimize the risk of recurrence.

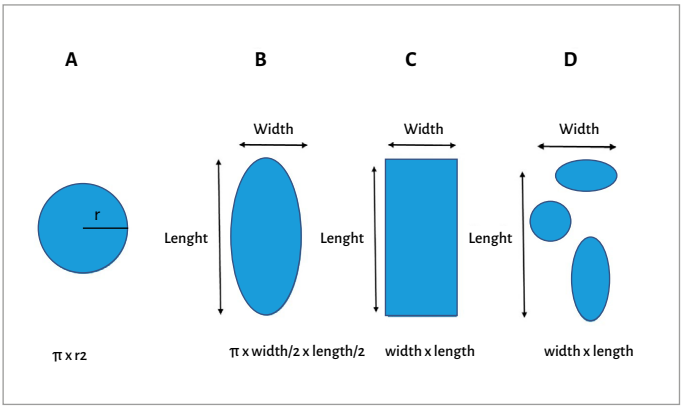


Fig. 1. Area calculation formulas for different types of defects. (A) Circular defect, (B) Elliptical defect, (C) Rectangular defect, (D) Multiple defects.

METHODS

Study Design and Patient Selection

Patients with ventral hernia who underwent laparoscopic repair at the Department of General Surgery, University Hospital between December 2013 and December 2019 were evaluated with a database retrospective analysis. The inclusion criteria for the study consisted of several parameters: (1) the operation was performed electively, (2) the same mesh type and fixation method were used for all the patients, (3) the fascial defect was closed only with intraperitoneal on-lay mesh without primary repair (bridging technique) and (4) the patient could be contacted by phone for clinical outcomes. The exclusion criteria were as follows: (1) emergency surgery, (2) patients who also underwent primary repair, (3) patients with previous mesh repair and (4) patients who could not be contacted by phone. All procedures performed in this study conformed to the ethical standards of the institutional and/or national research committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the local ethical committee (reference: 01/13/2020-32).

Out of a total of 142 ventral hernia patients, 124 patients were included in this study. Age, gender, hernia type, body mass index (BMI), shape and width of the defect, mesh dimensions, mesh overlap size, defect and mesh areas in cm^2, the M/D ratio, postoperative complications, follow-up time and time of recurrence were recorded. The data and clinical outcomes of all patients were verified by telephone interviews. All symptoms (such as increased pain and decreased abdominal core function or bulging that interferes with quality of life) were taken into consideration. Even if the physical examination was normal, the patients underwent non-contrast CT screening by both the radiology department and the surgical team. The rationale for these radiological tests was to identify a possible mesh bulge, even in the absence of an actual fascial defect. However, computed tomography (CT) revealed actual fascial defects only in all the symptomatic patients. In other words, the rates of suspected and radiological recurrence in our study group were identical.

The dimensions of the defect were determined by evaluating the preoperative radiological tests and intraoperative records. The distance between the endpoints of the defect in each axis was calculated in centimeters to determine the horizontal and vertical size in the greatest dimension. The defect area was expressed in cm^2 in single-circular defects and calculated using the formula $\Pi \times r^2$ (where $\Pi = 3.14$ and r = radius of a circle). The defect area for single-elliptical defects was calculated according to the formula $\Pi \times$ width/2 x length/2. The defect area for single-rectangular defects was calculated using the formula width x length. For multiple defects, calculations were done according to the "weak defect area" model, which is defined by the European Hernia Society (EHS) [10]. The most lateral edges in each axis of the multiple defects were measured and calculated as a rectangular area (Fig. 1.). All patients were classified in accordance with the EHS classification of primary ventral hernia and incisional hernia [11].

Surgical Technique

All surgeries were performed under general anesthesia with the patient placed in the supine position. For pneumoperitoneum, a Veress needle was inserted over the midclavicular line from the left upper quadrant. Under a pressure of 12 mm Hg, the first trocar (5 mm) was placed over the left anterior-axillary line. Intraabdominal exploration was performed by using a camera angled at 30°. The major advantage of choosing a 5 mm camera was that it could be used interchangeably from all trocars. In most patients, the use of a second trocar 5 mm in diameter on the same side was sufficient. In order to introduce a larger mesh into the abdomen, if necessary, a 10-mm trocar was definitely required. Intraabdominal adhesions, if present, were removed using sharp dissection and/or energy devices (LigaSure™ 5-mm Blunt Tip, Medtronic, Dublin, Ireland). Special care was taken to completely cleanse the edges of the hernia defect from extraperitoneal adipose tissue. The defects were not closed with sutures at all (the bridging technique). The diameter of the defect in each axis was measured and a suitable mesh with at least 3 cm overlap was chosen. As for multiple defects, this measurement was taken on the most lateral edges of the most lateral defects. ParieteneTM Composite Mesh (CovidienTM, Medtronic, Minneapolis, USA) was used in all the patients. One side of this mesh is made of macroporous polypropylene, while the other side facing the abdominal cavity is covered with absorbable collagen film to prevent adhesion with the intestine. To guide the fixation of the four trans-fascial sutures, the projection of these points was marked on the skin. The mesh was then inserted into the abdomen. The trans-fascial fixation sutures on the mesh were pulled outward using a suture passer, tied, and the knots were left in the subcutaneous space. Nonabsorbable 5 mm titanium helical tacks (ProtacTM, CovidienTM, Medtronic, Minneapolis, USA) were used to fix the mesh. The surgeon applied hand pressure on the abdominal wall when firing the tacker to

Tab. I. Characteristics of patients with primary and incisional hernias.

Hernia type	Primary (n = 84)	Incisional (n = 40)	p value
Age (years)	Mean: 51 ± 14.45 Median: 53 (range 28–77)	Mean: 58.5 ± 8.17 Median: 57 (range 49–74)	0.1392
BMI (kg/m²)	Mean: 29.07 ± 3.58 Median: 28.04 (range 24.39–35.43)	Mean: 29.65 ± 3.17 Median: 29.49 (range 25.15–37.46)	0.5261
Hernia location	Umbilical 76 Epigastric 8	Midline 40 Other 0	NA
EHS classification (stage) **I** **II** **III**	 Width < 2 cm 16 Width ≥ 2–4 cm 52 Width ≥ 4 cm 16	 Width < 4 cm 4 Width ≥ 4–10 cm 20 Width ≥ 10 cm 16	NA
Width of the defect (cm)	Mean: 2.69 ± 1.59 Median: 2 (range 1–8)	Mean: 8.15 ± 3.43 Median: 8.5 (range 1.5–13)	0.0004
Surface of the defect (cm²)	Mean: 6.97 ± 4.79 Median: 3.14 (range 0.79–40)	Mean: 35.68 ± 19.24 Median: 35.5 (range 1.77–78)	0.0005
Mesh overlap (cm)	Mean: 3.44 ± 0.79 Median: 3.5 (range 2–6)	Mean: 5.38 ± 1.38 Median: 5.25 (range 3.5–7.5)	0.0003
Mesh/defect ratio	Mean: 24.04 ± 15.01 Median: 20.25 (range 3.24–81)	Mean: 11.23 ± 9.06 Median: 8.45 (range 3.84–36)	0.0581
Follow–up time (month)	Mean: 32.62 ± 14.05 Median: 31 (range 14–67)	Mean: 32.3 ± 19.92 Median: 26 (range 12–57)	0.6118
Complication **No** **Yes**	 80 4	 36 4	0.5851

Abbreviation: NA, not applicable

ensure the proper right angle between the mesh and the tack, and to prevent intraoperative mesh migration and/or displacement. No drain was used in any of the patients.

Statistical Analysis

All statistical analyses were performed with STATA 16 statistical software. The significance level for all the analyses was set at 0.05. The results of group comparison tests were expressed as mean ± standard deviation (SD) as well as median and range. The results for continuous variables with a normal distribution were expressed as the mean and SD, whereas variables with a skewed distribution were expressed as the median and the range. Student's t test and the Mann-Whitney U test were used for comparisons between groups for variables with normal and non-normal distribution, respectively. The Chi-square test was used to compare categorical variables. The potential variables that may affect recurrence were first examined by univariate analysis. Multivariate analysis was performed with the independent variables that were significant or nearly significant in the univariate comparison tests.

RESULTS

Seventy-six patients (61.3%) were female and 48 (38.7%) were male. The mean age was 53.42 ± 13.11 years (median 56, range 28–77 years). Eighty-four patients (67.7%) had a primary ventral hernia (umbilical, epigastric), while 40 patients (32.3%) had an incisional hernia. In the primary hernia group, the mean age was 51 ± 14.45 years (median 53, range 28–77 years) while it was 58.5 ± 8.17years (median 57, range 49–74 years) in the incisional hernia group. The mean BMI in the groups was 29.07 ± 3.58 kg/m^2 (median 28.04, range 24.39–35.43) and 29.65 ± 3.17 kg/m^2 (median 29.49, range 25.15–37.46), respectively. According to the primary ventral hernia classification of EHS, the distribution of the patients was as follows: class I in 16 patients (19%), class II in 52 patients (61%) and class III in 16 patients (19%). In the incisional hernia group, there were four patients (10%) in class I, 20 patients (50%) in class II, and 16 patients (40%) in class III according to the EHS incisional hernia classification. The mean defect diameter in the primary hernia group was 2.69 ± 1.59 cm (median 2, range 1–8), whereas in the incisional hernia group, it was 8.15 ± 3.43 cm (median 8.5, range 1.5–13). In the primary hernia group, the mean defect surface area was 6.97 ± 4.79 cm^2 (median 3.14, range 0.79–40), as compared to 35.68 ± 19.24 cm^2 (median 35.5, range 1.77–78) in the incisional hernia group. The mean mesh overlap in the two groups was 3.44 ± 0.79 cm (median 3.5, range 2–6) and 5.38 ± 1.38 cm (median 5.25, range 3.5–7.5), respectively. The mean M/D ratio was 24.04 ± 15.01 (median 20.25, range 3.24–81) in the primary hernia group, and 11.23 ± 9.06 (median 8.45, range 3.84–36) in the incisional hernia group. The mean follow-up duration for the two groups was 32.62 ± 14.05 months (median: 31, range 14–67) and 32.3 ± 19.92 months (median: 26, range 12–57), respectively. In both groups, four patients developed postoperative seromas with an overall complication rate of 6.5%. The characteristics of patients with primary and secondary hernias are shown in Tab. I.

Twelve patients (9.7%) had recurrence. The recurrence rates in the incisional hernia and primary hernia groups were 10% and 9.52%, respectively. The average time from the first operation to recurrence was 13 months (median 16, range 4–19). Demographic data and patient characteristics are shown in Tab. II. According to the results of the univariate analysis, hernia type, BMI, size or the area of the defect and extent of mesh overlap were not among the significant factors in the development of recurrence ($p > 0.05$). However, there was a statistically significant difference

Tab. II. Characteristics of patients with or without recurrent hernia.

Variable	Hernia recurrence (n = 12)	No hernia recurrence (n = 112)	p value
Age (years)	Mean: 59.67 ± 6.51 Median: 60 (range 53–66)	Mean: 52.75 ± 13.53 Median: 54.5 (range 28–77)	0.3944
Sex ratio	4 male (33.33%) 8 female (66.67%)	44 male (39.28%) 68 female (60.72%)	0.8431
BMI (kg/m²)	Mean: 27.12 ± 1.73 Median: 27.12 (range 25.39–28.84)	Mean: 29.49 ± 3.49 Median: 29.39 (range 24.39–37.46)	0.2592
Hernia location	Primary 8 Incisional 4	Primary 76 Incisional 36	0.9671
EHS classification (stage) **I** **II** **III**	 Width < 2 cm 0 Width ≥ 2–4 cm 0 Width ≥ 4 cm 12	 Width < 4 cm 20 Width ≥ 4–10 cm 72 Width ≥ 10 cm 20	NA
Width of the defect (cm)	Mean: 7.33 ± 4.93 Median: 5 (range 4–13)	Mean: 4.14 ± 3.23 Median: 2.75 (range 1–12)	0.1061
Surface of the defect (cm²)	Mean: 36.73 ± 35.92 Median: 19.63 (range 12.56–78)	Mean: 14.03 ± 13.49 Median: 5.99 (range 0.79–45)	0.1063
Mesh overlap (cm)	Mean: 2.67 ± 0.76 Median: 2.5 (range 2–3.5)	Mean: 4.21 ± 1.32 Median: 3.75 (range 2.5–7.5)	0.0306
Mesh/defect ratio	Mean: 4.05 ± 0.93 Median: 3.84 (range 3.24–5.06)	Mean: 21.61 ± 19.38 Median: 12.73 (range 6.35–81)	0.0047
Follow–up (month)	Mean: 22 ± 3.60 Median: 23 (range 18–25)	Mean: 33.64 ± 16.25 Median: 31 (range 12–57)	0.1505
Complication **No** **Yes**	 12 0	 104 8	0.6378

Abbreviation: NA, not applicable

in terms of recurrence if the M/D ratio was equal to or less than 6 or over 6 (p = 0.012) (Tab. III.). The multivariate logistic regression analysis proved that the M/D ratio was the only predictive variant for recurrence (coefficient = 4.22, odds ratio [OR] 0.0146, 95% confidence interval [CI] 0.0002–1.3230; p = 0.066). In surgical practice, mesh overlap is still believed to be important for hernia recurrence. In our study, if the M/D ratio was equal to or less than 6 and the overlap was equal to or less than 4 cm, the recurrence rate was 75% (Tab. IV.).

DISCUSSION

Hernia repair is one of the rapidly evolving areas of laparoscopic surgery. Many retrospective and prospective studies have emphasized the superiority of the laparoscopic approach in terms of clinical outcomes in the treatment of ventral hernia [3, 4, 6, 12, 13]. These promising results have popularized laparoscopic hernia surgery to become a standard approach for some selected types of hernias. However, recurrence after hernia repair is still an important problem for both the patient and the surgeon. The high variability in recurrence rates described in the literature is generally due to short follow-up periods and/or inadequate patient standardization [7, 14, 15]. Some studies with longer follow-up periods have reported recurrence rates as high as 29% [14]. This means that the debate on factors causing recurrence is still ongoing.

Many parameters, including the defect dimensions, overlap, wound infections, stage according to the American Society of Anesthesiologists (ASA) classification, and mesh type have been studied for their possible effects on recurrence [9, 10, 12, 14, 15]. It is now obvious that the diameter of the defect plays an important role in recurrence. Several reports suggest that the risk of recurrence increases significantly if the defect diameter is over 5 cm in the LVHR and propose a maximum defect diameter of 10 cm as the upper limit for patient selection [12, 16]. Mesh overlap is also a widely accepted risk factor. LeBlanc, when defining bridging repair, found in his series of 200 cases that a 5 cm overlap was more effective than a 3 cm overlap in reducing recurrence [17]. In another study, the risk of recurrence was reported as 11.8% with an overlap of 2.5 cm, and a minimum overlap of 4 cm was suggested [18]. Surprisingly, in this study, the mesh overlap alone was not found to be a significant factor for recurrence.

One of the most important problems in the LVHR is improper mesh placement. Displacement during fixation causes uneven overlapping between the edges of the defect. One study found that the problem was mesh misalignment causing this uneven overlap in almost half of the patients, and suggested a minimum of 6 cm overlap as a solution [19].

Recent data suggest that a minimum overlap of 5 cm is necessary and that as the defect diameter increases, the extent of overlap becomes more important [20]. However, in a study showing that overlap was not the only predictor, recurrence rates as high as 22% were reported if the M/D ratio was equal to or less than 12 even though the overlap was 5 cm or more. If the overlap is less than 5 cm and the M/D ratio is below 12, recurrence is inevitable [14]. Similarly, the theory saying that "5 cm is enough for overlap" is not reliable because this limit is not fully consistent with the mathematical facts. As the defect becomes larger, it is the M/D ratio that seems to be the actual answer, rather than the overlap itself [21]. In accordance with these results, our study also revealed that the M/D ratio was the only independent parameter that predicted recurrence. The significance of the overlap alone seems to be somewhat

Tab. III. The effect of predictive factors on recurrence.

Variable	Number	Recurrent hernia	Percentage (%)	p value
Hernia type				
Primary Incisional	84 40	8 4	9.52 10	0.9666
BMI (kg/m²)				
≤ 30 > 30	80 44	12 0	15 0	0.535
Width of the defect (cm)				
≤ 4 > 4	80 44	4 8	5 18.18	0.281
Surface of the defect (cm²)				
≤ 20 > 20	84 40	8 4	9.52 10	0.967
Mesh overlap (MO) (cm)				
≤ 3 3 < MO ≤ 4 > 4	28 64 32	8 4 0	28.57 6.25 0	0.176
Mesh/defect ratio				
≤ 6 > 6	32 92	12 0	37.5 0	0.012

outdated. In the present study, the overlap was also analyzed together with the M/D ratio. When the overlap is less than or equal to 4 cm and the M/D ratio is less than or equal to 6 cm, the recurrence rate was 75%, which is unacceptable.

There is an ongoing debate against the laparoscopic bridging technique without defect closure for larger defects. Closing the defect during laparoscopic ventral hernia repair was initially performed in order to decrease seroma, to improve the functionality of the abdominal wall, and to decrease the bulging effect [10, 22, 23]. The laparoscopic technique of intracorporeal rectus aponeuroplasty has been demonstrated for medium-size defects under 10 cm in width but the long-term outcomes and complication rates need to be clarified as do the recurrence rates [24]. The M/D ratio will probably lead surgeons to use a larger size mesh and avoid the current failure of the intraperitoneal on-lay mesh technique in LVHR as a tension-free repair.

Our study has some limitations. The average size of the defect in the incisional hernia group was 8 cm, which is now generally accepted as a contraindication for laparoscopic repair. Also the patients with larger defects were those who underwent surgery in the early years of the study. Since then, our policy has changed markedly, especially after realizing the high recurrence rates in larger defects. Not all of the 124 patients underwent a physical examination and a CT evaluation to investigate a possible recurrence (which we do not think to be cost-effective), but all of the symptomatic patients (with increased pain, decreased abdominal core function, bulging in the abdominal wall, gastrointestinal symptoms or any other complaints) underwent these tests.

Tab. IV. Cumulative effect of mesh overlap and the mesh/defect (M/D) ratio on recurrence rates.

	M/D ratio	
	≤ 6	**> 6**
Mesh overlap (cm)		
≤ 4	RR: 12–16	RR: 0–76
> 4	RR: 0–16	RR: 0–16

Abbreviation: RR, recurrence rate

Asymptomatic recurrent cases, if present, may be overlooked in this series, yet it would spark a controversy if all asymptomatic individuals were to be screened for primary or secondary hernia in the absence of symptoms. Therefore, routine imaging follow-up of all patients with repaired hernias may be part of the management algorithm as our understanding increases with the number of cases.

CONCLUSION

It is possible to pre-operatively estimate the size of the mesh that will be fixed intraperitoneally to the anterior wall of the abdomen in the LVHR based on the M/D ratio. Using this ratio is a better method than using overlap alone. Understanding the concept of the M/D ratio and using it in clinical practice will likely allow surgeons to perform both laparoscopic and open ventral hernia surgery with lower recurrence rates.

REFERENCES

1. LeBlanc K.A., Booth W.V.: Laparoscopic repair of incisional abdominal hernias using expanded polytetrafluoroethylene: preliminary findings. Surg. Laparosc. Endosc, 1993; 3: 39–41.
2. Schlosser K.A., Arnold M.R., Otero J. et al.: Deciding on Optimal Approach for Ventral Hernia Repair: Laparoscopic or Open. J. Am. Coll. Surg., 2019; 228: 54–65. doi: 10.1016/j.jamcollsurg.2018.09.004.
3. Zhang Y., Zhou H., Chai Y. et al.: Laparoscopic versus open incisional and ventral hernia repair: a systematic review and meta-analysis. World J. Surg., 2014; 38: 2233–2240. doi: 10.1007/s00268-014-2578-z.
4. Misiakos E.P., Machairas A., Patapis P., Liakakos T.: Laparoscopic ventral hernia repair: pros and cons compared with open hernia repair. JSLS, 2008; 12: 117–125.
5. Ahonen-Siirtola M., Rautio T., Ward J. et al.: Complications in Laparoscopic Versus Open Incisional Ventral Hernia Repair. A Retrospective Comparative Study. World J. Surg., 2015; 39: 2872–2877. doi: 10.1007/s00268-015-3210-6.
6. Olmi S., Scaini A., Cesana G.C., Erba L., Croce E: Laparoscopic versus open incisional hernia repair: an open randomized controlled study. Surg. Endosc., 2007; 21: 555–559. doi: 10.1007/s00464-007-9229-5.
7. Awaiz A., Rahman F., Hossain M.B. et al: Meta-analysis and systematic review of laparoscopic versus open mesh repair for elective incisional hernia. Hernia, 2015; 19: 449–463. doi: 10.1007/s10029-015-1351-z.
8. Picazo-Yeste J., Moreno-Sanz C., Sedano-Vizcaíno C., Morandeira-Rivas A., Sánchez-De Pedro F.: Outcomes after laparoscopic ventral hernia repair: does the number of previous recurrences matter? A prospective study. Surg. Endosc., 2017; 31: 4514–4521. doi: 10.1007/s00464-017-5510-4.
9. Clapp M.L., Hicks S.C., Awad S.S., Liang M.K.: Trans-cutaneous Closure of Central Defects (TCCD) in laparoscopic ventral hernia repairs (LVHR). World J. Surg., 2013; 37: 42–51. doi: 10.1007/s00268-012-1810-y.
10. Wennergren J.E., Askenasy E.P., Greenberg J.A. et al: Laparoscopic ventral hernia repair with primary fascial closure versus bridged repair: a risk-adjusted comparative study. Surg. Endosc., 2016; 30: 3231–3238. doi: 10.1007/s00464-015-4644-5.
11. Muysoms F.E., Miserez M., Berrevoet F. et al: Classification of primary and incisional abdominal wall hernias. Hernia, 2009; 13: 407–414. doi: 10.1007/s10029-009-0518-x.
12. Nardi M Jr., Millo P., Brachet Contul R. et al: Laparoscopic ventral hernia repair with composite mesh: Analysis of risk factors for recurrence in 185 patients with 5 years follow-up. Int. J. Surg., 2017; 40: 38–44. doi: 10.1016/j.ijsu.2017.02.016.
13. Anadol A.Z., Akin M., Kurukahvecioğlu O., Tezel E., Ersoy E.: Comparison of laparoscopic primary and open primary repair of ventral hernias. Surg. Laparosc. Endosc. Percutan. Tech., 2011; 21: 301–305. doi: 10.1097/SLE.0b013e3182245d61.
14. Hauters P.., Desmet J., Gherardi D. et al.: Assessment of predictive factors for recurrence in laparoscopic ventral hernia repair using a bridging technique. Surg. Endosc., 2017; 31: 3656–3663. doi: 10.1007/s00464-016-5401-0.
15. Lasses Martínez B., Peña Soria M.J., Cabeza Gómez J.J. et al.: Surgical treatment of large incisional hernias with intraperitoneal composite mesh: a cohort study. Hernia, 2017; 21: 253–260. doi: 10.1007/s10029-016-1557-8.
16. Moreno-Egea A., Carrillo-Alcaraz A., Aguayo-Albasini J.L.: Is the outcome of laparoscopic incisional hernia repair affected by defect size? A prospective study. Am. J. Surg., 2012; 203: 87–94. doi: 10.1016/j.amjsurg.2010.11.017.
17. LeBlanc K.A., Whitaker J.M., Bellanger D.E., Rhynes V.K.: Laparoscopic incisional and ventral hernioplasty: lessons learned from 200 patients. Hernia., 2003; 7: 118–124. doi: 10.1007/s10029-003-0117-1.
18. Tsimoyiannis E.C., Tsimogiannis K.E., Pappas-Gogos G. et al.: Seroma and recurrence in laparoscopic ventral hernioplasty. JSLS., 2008; 12: 51–57.
19. Liang M.K., Clapp M.L., Garcia A., Subramanian A., Awad S.S.: Mesh shift following laparoscopic ventral hernia repair. J. Surg. Res., 2012; 177: 7–13. doi: 10.1016/j.jss.2012.03.048.
20. LeBlanc K.: Proper mesh overlap is a key determinant in hernia recurrence following laparoscopic ventral and incisional hernia repair. Hernia, 2016; 20: 85–99. doi: 10.1007/s10029-015-1399-9.
21. Tulloh B., de Beaux A.: Defects and donuts: the importance of the mesh: defect area ratio. Hernia 2016; 20: 893–895. doi: 10.1007/s10029-016-1524-4.
22. Booth J.H., Garvey P.B., Baumann D.P. et al: Primary fascial closure with mesh reinforcement is superior to bridged mesh repair for abdominal wall reconstruction. J. Am. Coll. Surg., 2013; 217: 999–1009. doi: 10.1016/j.jamcollsurg.2013.08.015.
23. Van Hoef S., Tollens T.: Primary non-complicated midline ventral hernia: is laparoscopic IPOM still a reasonable approach? Hernia, 2019; 23: 915–925. doi: 10.1007/s10029-019-02031-6.
24. Gómez-Menchero J., Guadalajara Jurado J.F., Suárez Grau J.M. et al: Laparoscopic intracorporeal rectus aponeuroplasty (LIRA technique): a step forward in minimally invasive abdominal wall reconstruction for ventral hernia repair (LVHR). Surg. Endosc., 2018; 32: 3502–3508. doi: 10.1007/s00464-018-6070-y.

Word count: 4252 Page count: 7 Tables: 4 Figures: 1 References: 24

DOI: 10.5604/01.3001.0015.0237 Table of content: https://ppch.pl/issue/14130

Copyright: Some right reserved: Fundacja Polski Przegląd Chirurgiczny. Published by Index Copernicus Sp. z o. o.

Competing interests: The authors declare that they have no competing interests.

The content of the journal „Polish Journal of Surgery" is circulated on the basis of the Open Access which means free and limitless access to scientific data.

This material is available under the Creative Commons – Attribution-NonCommercial 4.0 International (CC BY-NC 4.0). The full terms of this license are available on: https://creativecommons.org/licenses/by-nc/4.0/legalcodeode

Corresponding author: Ramazan Kozan MD; Department of General Surgery, Gazi University School of Medicine, Mevlana Blv. No: 47, 06560, Ankara, Turkey; Phone: +905327631697; E-mail: dr.kozan@hotmail.com, ramazankozan@gazi.edu.tr

Cite this article as: Kozan R., Anadol A.Z., Sare M.: A new criterion to predict recurrence after laparoscopic ventral hernia repair: mesh/defect area ratio; Pol Przegl Chir 2021; 93 (6): 1–7