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ORIGINAL ARTICLE

Hernia repair: a retrospective review of slit mesh (dp2 mesh) complications

Oghenevwoke Martin Onotevu[1] · Aqeel Roomy[1] · Mohammoud Albonajem[1] · Ariyaratnam Roshan[1] · Ramana Balasubramaniam[1]

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Abstract

Introduction This study reviews the complication rates associated with slit meshes used in groin hernia repair, using a slit polyester mesh (Parietex DP-2 mesh, Covidien) as the prototype for slit meshes. Though popular expert opinion is that a flat mesh is better suited for groin hernia repair while a slit mesh may have an increased propensity for causing complications such as pain and recurrence, there is paucity of data to support these claims.

Method The study was a retrospective observational study at a regional referral hospital in Victoria, Australia. We retrospectively compared complication rates among patients who had elective groin hernia repair at Goulburn Valley Health, Shepparton between 2018 and 2023. Patients were excluded from the study based on the following criteria: history of previous hernia repair with subsequent recurrence, documentation of obesity in clinical reports and unavailable formal operative or discharge notes.

Result A total of 960 patients were screened from the Goulburn Valley Health database for inguinal hernia repair procedures performed between 2018 and 2023. After applying the inclusion and exclusion criteria, 235 patients who underwent inguinal hernia repair with Parietex DP2 mesh were identified. Among these patients, 51 (21.70%) experienced complications within a two-year follow-up period, with some patients reporting multiple issues. Chronic pain occurring in 11 patients (4.68%). A recurrence of hernia within 2 years in 9 patients (3.83%), while 3 patients developed meshoma necessitating mesh explantation.

Conclusion The results highlight a notable incidence of complications associated with the use of DP2 mesh in inguinal hernia repair. Chronic pain, poor mesh integration and recurrence emerged as significant concerns, emphasizing the need for thorough postoperative monitoring and consideration of alternative mesh materials to potentially lower complication rates.

Keywords DP2 mesh · Slit mesh · Flat mesh · Complication rates · Meshoma · Cord lipoma · Ischemic orchitis · Chronic postoperative inguinal pain (CPIP)

Introduction

Hernia repair is one of the most frequently performed surgical procedures worldwide. Over the past few decades, mesh-based techniques have become the standard approach for inguinal hernia repair due to their ability to reduce recurrence rates compared to primary suture repair [1]. However, mesh use is associated with specific complications, including chronic pain, infection, mesh migration, and recurrence [1].

The Parietex DP2 mesh (Covidien, now part of Medtronic) is a three-dimensional, slit, polyester-based composite mesh designed for laparoscopic inguinal hernia repair [2]. It features a preformed anatomical shape and an oblique slit to wrap around the spermatic cord or round ligament. The double-layered polyester structure aims to enhance integration with host tissues, while its large-pore, lightweight design is intended to reduce foreign body reactions and chronic pain [2]. Despite these theoretical advantages, concerns have arisen regarding the long-term safety of slit meshes, particularly regarding recurrence risks, chronic

✉ Oghenevwoke Martin Onotevu
moghenevwoke@gmail.com

[1] Department of General Surgery, University of Melbourne, Goulburn Valley Health, Shepparton, Australia

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pain, and mesh-related complications, leading to its phase-out in many developed countries [3].

Mesh selection plays a crucial role in postoperative outcomes. Heavyweight meshes, made from dense polymers with small pores, provide high tensile strength but induce excessive fibrotic reactions, potentially increasing chronic pain and stiffness [4]. Conversely, lightweight meshes with larger pores and lower material density reduce inflammatory responses, enhance flexibility, and improve patient comfort [4]. Current European HerniaSurge guidelines recommend using lightweight, synthetic, large-pore meshes over heavyweight alternatives due to their superior long-term biocompatibility [5].

A key distinction between slit and non-slit meshes is the presence of an opening in slit meshes that allows placement around the spermatic cord. While some studies suggest no significant difference in recurrence rates or complications, others highlight an increased risk of recurrence with slit meshes due to inadequate slit closure, insufficient mesh dimensions, or large hernia sac diameter [6, 7]. The International Endohernia Society Guidelines acknowledge that recurrences can be linked to inappropriate mesh size, hernia sac characteristics, and the use of slit meshes [8].

Despite its withdrawal from several international markets, the DP2 mesh continues to be used in some Australian hospitals [9]. This study aims to evaluate the complication rates associated with its use in laparoscopic inguinal hernia repair at a regional referral hospital. By analysing postoperative outcomes, this research seeks to provide evidence-based insights to guide future clinical decision-making regarding mesh selection.

Methods

Using the hospital database, we identified 960 patients who underwent inguinal hernia repair at Goulburn Valley Health between 2018 and 2023, performed by six surgeons. Patient files were reviewed to determine the specific procedures conducted, categorized as open or laparoscopic, and as unilateral or bilateral repairs.

Ethical considerations

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki and was approved by the Goulburn Valley Health Ethics Committee. All participants provided informed written consent prior to their inclusion in the study. Data confidentiality was maintained by anonymizing patient identifiers and storing information in secure, password-protected systems accessible only to authorized personnel.

Participants were fully informed about the purpose, procedures, potential risks, and benefits of the study. Those experiencing complications were advised to seek follow-up care and were referred to specialists when necessary. The study excluded vulnerable populations, such as minors or individuals unable to provide consent, ensuring fairness in participant selection.

Disclosure

This study received no fundings. The authors declare no competing interests. The researchers were not influenced by any external parties, including manufacturers of the Parietex DP2 mesh, during the design, execution, or reporting of this study.

Inclusion and exclusion criteria

Patients were included in the study based on the following criteria:

Patients aged 18–65 who underwent Inguinal hernia repair Laparoscopic or open.

Patients who had repairs using the Precut and slit Parietex DP2 Mesh 17.2 cm x 13.4 cm size.

patients were excluded from the study based on the following criteria:

- History of previous hernia repair with subsequent recurrence.
- Documentation of obesity in clinical, operative and discharge reports.
- Intraoperative documentation of cord injuries.

Following this, all operation reports were screened for the use of Parietex DP2 mesh, yielding a final cohort of 235 patients.

Postoperative follow-up

We reviewed all postoperative appointments within the surgical and medical departments, as well as any emergency department presentations. In the surgical outpatient clinics, patients seen within two weeks postoperatively who reported swelling or pain were not classified as complications if the senior surgeon deemed these symptoms as part of the spectrum of normal recovery.

For a concern to be classified as a complication, it needed to be either confirmed through imaging or clearly documented clinical findings and necessitate management with medications or invasive interventions. Patients that were advised to return for follow-up and then reported complete resolution of symptoms with conservative management were excluded from the complication count. Presentations to the

emergency department related to the inguinal hernia repair were considered complications, regardless of the timeline.

Complication classification

Complications were categorized into four groups: pain, infection, collection, and recurrence within two years of hernia repair and others. Pain was further divided into acute and chronic, with chronic pain defined as lasting at least three (3) months. Pain was also probed to differentiate between a painful stabbing/throbbing sensation compared to a tugging/pulling sensation differentiating neuropathic from nociceptive pain.

For patients who had only one documented postoperative visit in the outpatient clinics, we individually contacted them to complete a validated inguinal hernia postoperative complication reporting questionnaire. This outreach also extended to patients with no recorded complications or recurrences. A total of 184 patients were contacted, with 78(42.39%) responding to the questionnaire. We categorized the responses into the following groups: pain, symptomatic issues in other areas, positive cough impulse, positive findings on self-examination with the Valsalva manoeuvre, and any surgeries performed to address complications in other centres.

Patients that answered the questionnaire with positive responses indicating complications of hernia repair were then advised to present to the outpatient clinics for further review by a senior hernia specialist. 11 patients, comprising 14.1% of the cohorts, were seen in clinic.

Results

A total of 960 patients who underwent inguinal hernia repair between 2018 and 2023 at Goulburn Valley Health were identified in the hospital database. After applying inclusion and exclusion criteria, 235 patients who underwent hernia repair using the Parietex DP2 mesh were included in the analysis, all were conducted laparoscopically.

Complication rates

Of the 235 patients, 51 (21.7%) experienced complications within a two-year follow-up period. These complications included multiple issues per patient in some cases. The breakdown of complications is as follows: Chronic Pain: Observed in 25 patients (10.68%) based on outpatient file reviews (11 patients) and questionnaire responses (14 patients) all requiring medical interventions. Recurrence: Hernia recurrence was documented in 9 patients (3.83%) within the two-year follow-up period. Pulling/Tugging Sensation: A reported symptom in 10 patients (4.26%),

Fig. 1 DP2-Covidien Parietex Mesh

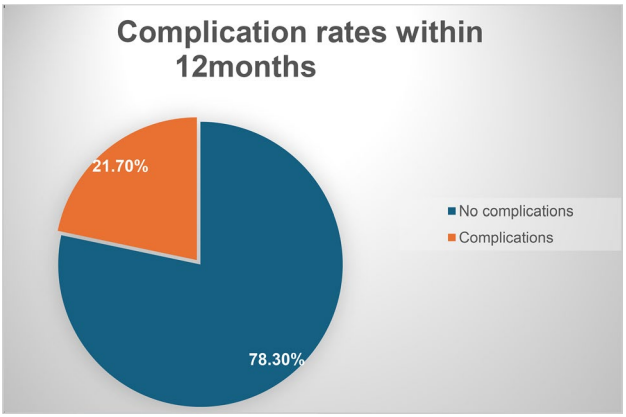

Fig. 2 Pie chart illustrating the total complication rate among patients undergoing inguinal hernia repair with DP2 mesh

comprising 6 identified during outpatient clinic reviews and 4 from questionnaire responses. Hematoma/Seroma: Identified in 12 patients (5.1%), requiring clinical intervention. Testicular Pain and Tenderness: Noted in 14 patients (6%). Meshoma:Occurred in 3 patients (1.2%), with two cases necessitating mesh explantation Image 1, Fig. 1, Fig. 2, Fig. 3, Fig. 4, Image 2).

Follow-up findings

Outpatient clinic reviews indicated additional complications: seventeen (17) patients reported groin/testicular pain. Six (6) patients experienced a persistent pulling or tugging sensation. Three (3) patients presented with palpable swellings due to meshoma.

From the 184 patients contacted for follow-up using a validated inguinal hernia postoperative complication questionnaire, seventy-eight (78) patients (42.39%) responded. The questionnaire responses included: Chronic Pain (>3 months): Eighteen (18) patients reported ongoing pain. Among these, four (4) described the pain as a grabbing sensation. Positive Cough Reflex: Observed in two (2) patients. Consultation for Recurrence Repair: two (2) patients sought surgery for recurrence at other facilities.

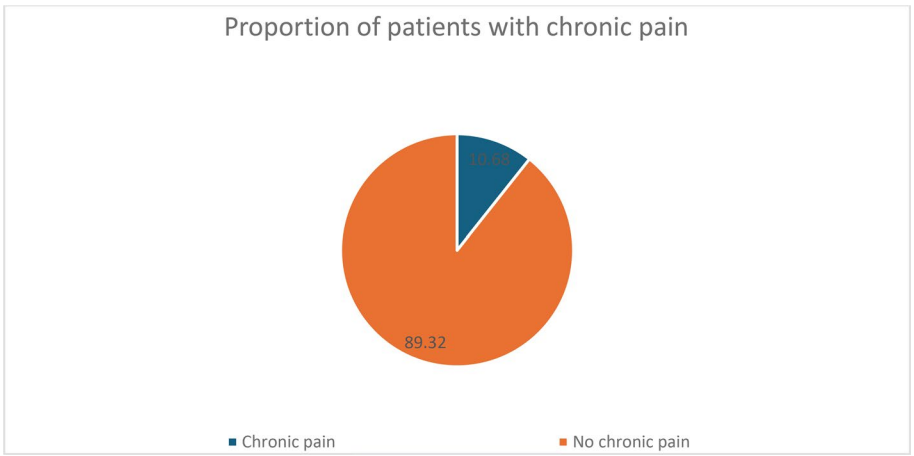

Fig. 3 Pie chart depicting the proportion of patients with chronic pain compared to those without

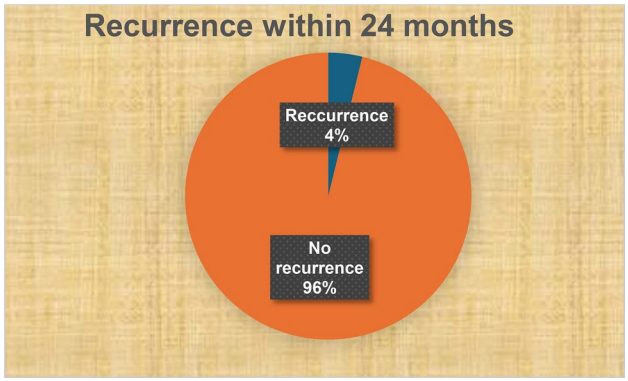

Fig. 4 Pie chart showing the percentage of patients with recurrence

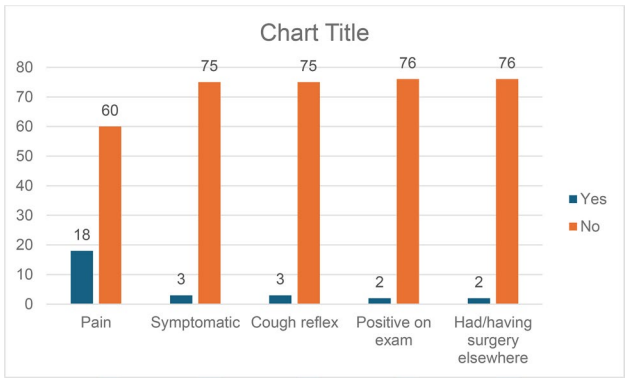

Fig. 5 Bar graph showing the response rates to the 5 questions posed on questionnaire

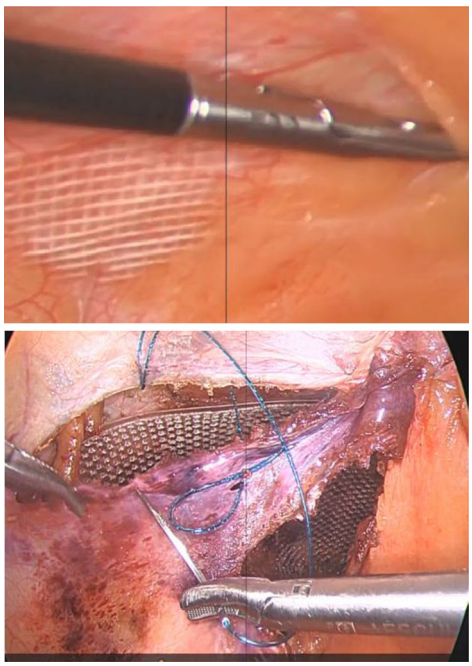

Fig. 6 Intraoperative image of a patient with DP2 mesh complication. **a** Pre-mesh explantation. **b** Post-mesh explantation and replacement

Complication summary

Chronic pain was the most frequently reported complication, affecting twenty-five (25) patients (10.68%). Recurrence rates were documented at 3.83%, and other symptoms such as pulling sensations and hematomas/seromas were less frequent but still clinically significant. A total of eleven (11) patients, identified through the questionnaire as having positive complications, were referred for specialist review. Among these, nine (9) reported ongoing pain, one (1) complained of a lump (later identified as a cord lipoma), and one (1) described a grabbing sensation (Tables 1, 2, 3).

Intention-to-treat analysis

A total of 184 patients were contacted for follow-up, with 78 responders (42.39%) and 106 non-responders (57.61%). This division of responders and non-responders raises important considerations regarding potential biases in the study.

Table 1 : *Complication Summary Table*

Complication	Number of cases	Percentages (%)
Chronic pain > (3 months)	25	10.68
Recurrence	9	3.83
Pulling/Tugging sensation	10	4.26
Hematoma/seroma	12	5.1
Testicular pain and tenderness	14	6
Meshoma/Cord Lipoma	3	1.2

Non-responder bias may have led to an inflation of the observed complication rates, as patients with fewer or no complications might have been less motivated to respond. Conversely, responder selection bias could have disproportionately included patients experiencing ongoing issues, further exaggerating the complication rates. Additionally, recall bias is another significant factor, as complication reporting relied on the accuracy of patient memory, especially for events occurring near the two-year mark.

A sensitivity analysis was conducted to explore these potential biases. If all non-responders experienced no complications, the overall complication rate would decrease significantly. For example, the chronic pain rate would drop from 10.68% to approximately 5.68% when accounting for the 106 patients with zero complications. Conversely, if the non-responders had the same complication rate as the responders, the observed rates would remain unchanged. This analysis highlights the importance of considering these biases when interpreting the results.

Statistical analysis

Key interpretations

Chronic Pain (10.68%) is the most frequently reported complication, with a 95% CI of 6.89% to 14.47%, suggesting it is a substantial issue.

1. Recurrence (3.83%) has a 95% CI of 1.38% to 6.28%, meaning the true recurrence rate likely falls within this range.
2. Meshoma (1.2%) is the least reported complication, and its confidence interval extends to 0.00%, indicating low but possible variability in the data.

Multivariate analysis

The logistic regression analysis showed the following:

Odds ratio for Bilateral repair: 0.457, 95% confidence interval: [0.245,0.854], p value: 0.014 (statistically significant).

Bilateral inguinal repair with the DP2 Mesh is associated with a significant lower likelihood of complications compared to unilateral repair (OR 0.457, P = 0.014) suggesting patients undergoing bilateral repair had a 54.3% lower odds of experiencing complications compared to those with unilateral repair however other factors such as surgical technique, age might play a role predicting complications.

Interpretation and clinical implications

The significantly higher complication rate associated with DP2 mesh suggests an increased risk for patients undergoing inguinal hernia repair with this mesh type. Chronic pain was the most frequently reported complication (10.68%), followed by recurrence (3.83%) and pulling/tugging sensations (4.26%). These findings emphasize the need for

Table 3 Distribution of complications by Type of repair

Type of Repair	Number of patients with complications	Percentages (%)
Bilateral Repair	16	31.37%
Unilateral Repair	35	68.63%
Total	51	100%

Table 2 Complications rates and 95% confidence intervals

Complication	Rate (%)	95% Confidence Interval
Chronic Pain	10.68%	(6.89%, 14.47%)
Recurrence	3.83%	(1.38%, 6.28%)
Pulling/Tugging Sensation	4.26%	(1.69%, 6.83%)
Hematoma/Seroma	5.1%	(2.41%, 7.79%)
Testicular Pain	6%	(3.15%, 8.85%)
Meshoma	1.2%	(0.00%, 2.56%)

reconsideration of DP2 mesh usage, particularly in settings where flat meshes are available as alternatives.

The confidence interval for the DP2 mesh complication rate provides a reliable estimate of its range, and the exclusion of the flat mesh complication rate from this interval strengthens the statistical validity of the observed difference. Clinically, this highlights the necessity for surgeons to weigh the risks associated with DP2 mesh against its potential benefits and consider flat meshes as safer alternatives.

Limitations of the analysis

While the findings are statistically significant, certain limitations must be noted: Confounding variables, such as surgical techniques and patient demographics, were not controlled for in this analysis.

That complication incidence rates cannot be definitively calculated due to the retrospective nature of this study hence the need for prospective trials or registry-based studies.

Patients with previous hernia repairs or obesity were excluded, potentially removing a subset of patients who might have had different complication rates.

Only patients with complete records were included, which may not fully represent all individuals undergoing hernia repair.

The study had a follow-up questionnaire, but only 42.39% of patients responded. Those experiencing complications might have been more motivated to respond, inflating complication rates.

Non-responders may have had fewer or no complications, leading to an overestimation of adverse outcomes.

Some complications were self-reported by patients via questionnaires, which introduces recall bias, as patients might misremember or underreport past symptoms.

Follow-up duration was limited to two years, meaning long-term complications beyond this period were not assessed.

Some complications may have been missed, especially if patients sought care outside the study hospital.

Only complications requiring medical intervention were counted, which might exclude minor but significant patient-reported symptoms.

Discussion

The DP2 mesh slit design may increase chronic pain due to tight or loose placement around the spermatic cord, contributing to ischemic orchitis and recurrence risks. Chronic pain's subjectivity necessitates cautious evaluation and comprehensive follow-ups.

The flat mesh eliminates the slit, reducing mechanical complications like tugging sensations. While there appears to be conflicting evidence about which mesh design might be most appropriate for groin hernia repair, recent evidence suggests flat meshes may provide better outcomes regarding recurrence and chronic pain reduction hence the phasing out of slit meshes in Europe and North America. In America, multiple reports were submitted to the FDA detailing complications associated with its use.

The continued use of DP2 mesh, despite its phasing out in many countries, raises concerns about healthcare disparities and the need for updated surgical materials in underserved regions. The DP2 mesh still in use in Australia despite falling out of favor in other developed countries might be attributed to lots of factors including; regulatory differences, Clinical preference and familiarity as surgeons who trained with the parietex DP2 mesh may prefer to continue using it based on their experience, technique familiarity and perceived patient outcomes, fewer immediately available alternatives that match the same clinical application, and the lack of strong negative data in Australia.

This study has shown a high complication rate (21.7%) among patients who underwent inguinal repair using the DP2 Mesh. Chronic pain was recorded in 10.68%, recurrence 3.83%, pulling/tugging 4.26%, hematoma/seroma requiring intervention 5.1%, testicular pain and tenderness 6% and 1.2% experienced meshoma/cord lipoma necessitating mesh explantation.

The retrospective nature of this study limits the ability to control for confounders, such as surgical technique variations. However, the findings support international recommendations advocating for the use of lightweight flat meshes in groin hernia repair [7].

Conclusion

The results highlight a notable incidence of complications associated with the use of the DP2 mesh in inguinal hernia repair. The complications associated with the DP2 Mesh is not unconnected to the slit in the mesh which is fitted around the spermatic cord during placement. While fitting too tightly predisposes to pain and in extreme cases ischemic orchitis, fitting too loosely can lead to recurrences. Chronic pain, poor mesh integration and recurrence emerged as significant concerns, emphasizing the need for thorough postoperative monitoring and consideration of alternative mesh materials to potentially lower complication rate. However, like much of the evidence relating to current hernia surgical practices, our study does not represent high level evidence. Clearly, this is a subject matter for a registry or quality collaborative project to reflect the findings closest to the truth. However, in the absence of any significant data, we believe our study does have the potential to influence practice in

Australia and other countries where slit meshes may still be in use.

Data availability The data that support the findings of this study are avaialble from the corresponding author upon reasonable request.

References

1. Kendell JS, Mike KL (2022) Hernia mesh: the good, the bad, and the ugly. Am J Surg 224:177–178
2. St John DH, Tan J, Chandraratna H (2019) Fibrin glue provides stronger mesh fixation than tacks: an in-vitro study. Surg Rehabilitation. https://doi.org/10.15761/SRJ.1000150
3. Chue KM, Kabir T, Wong WK et al (2024) Impact of slit compared with non-slit mesh in laparoscopic groin hernia repairs: a comprehensive propensity score analysis of a cohort of 611 hernias. J Surgery 176(5):1424–1432. https://doi.org/10.1016/j.surg.2024.07.043
4. Koch A, Bringman S, Myrelid P, Kald A (2008) Randomized clinical trial of groin hernia repair with titanium-coated lightweight mesh compared with standard polypropylene mesh. Br J Surg 10:1226–1231. https://doi.org/10.1002/bjs.6325
5. Bakker WJ, Aufenacker TJ, Boschman JS, Burgmans JPJ (2020) Lightweight mesh is recommended in open inguinal (Lichtenstein) hernia repair: a systematic review and meta-analysis. Surgery 167(3):581–589. https://doi.org/10.1016/j.surg.2019.08.021
6. Yildirim D, Donmez T, Ozcevik H, Cakir M, Demiryas S, Akturk OM (2018) Comparison of slit mesh versus non-slit mesh in laparoscopic extraperitoneal hernia repair. Video Surg 13(4):469–476. https://doi.org/10.5114/wiitm.2018.77258
7. Domniz N, Perry ZH, Lantsberg L et al (2011) Slit versus non-slit mesh placement in total extraperitoneal inguinal hernia repair. World J Surg 35(11):2382–2386. https://doi.org/10.1007/s00268-011-1251
8. Kokotovic D, Bisgaard T, Helgstrand F (2016) Long-term recurrence and complications associated with elective incisional hernia repair. JAMA 316(15):1575–1582. https://doi.org/10.1001/jama.2016.15217
9. Najm A, Niculescu AG, Gaspar BS, Grumezescu AM, Beuran M (2023) A review of abdominal meshes for hernia repair-current status and emerging solutions. Int J Surg 16(22):7124. https://doi.org/10.3390/ma16227124