SANAMED
2025; 20(3): 243–249
ISSN-1452-662X

DOI: DOI: 10.5937/sanamed0-61135
UDK: 618.5-089.888.61-06:616-007.43(532)"2023/2025"
ID: 183829513
Original article

RISK FACTOR STRATIFICATION AND EARLY DETECTION OF INCISIONAL HERNIAS AFTER CESAREAN AND OPEN GYNECOLOGIC PROCEDURES: A PROSPECTIVE OBSERVATIONAL STUDY

Memon Munir Muhammad,[1, 2] Salati Ahmad Sajad,[3] Saadia Zaheera[4]

[1] Qassim University Buraidah branch, College of Medicine, Department of Surgery, Kingdom of Saudi Arabia
[2] Bin Tayyab Medical Complex (BTMC), Hyderabad, Sindh, Pakistan
[3] Qassim University, Unayzah branch, College of medicine, Department of Surgery, Kingdom of Saudi Arabia
[4] Qassim University, Buraidah branch, College of Medicine, Department of Gynecology, Kingdom of Saudi Arabia

Primljen/Received: 28. 08. 2025. Prihvaćen/Accepted: 26. 10. 2025. Online First: 31. 10. 2025.

Abstract: **Background:** Incisional hernia is a major complication of abdominal surgery, leading to pain, functional impairment, and increased healthcare costs. This study aimed to identify and rank risk factors for incisional hernia in patients undergoing Cesarean section or open gynecologic surgery, and to evaluate strategies for early detection.

Methods: From January 2023 to June 2025, a prospective observational study enrolled 200 women, each followed for 12 months. Half of the women underwent Cesarean section (n = 100) and the other half underwent open gynecologic surgery (n = 100). Data were collected on patient demographics, body mass index, comorbidities, surgical details, and complications. The primary outcome was the incidence of incisional hernia within one year, assessed by clinical examinations at 6 weeks, 6 months, and 12 months.

Results: The overall incidence of incisional hernia was 8.0% (16/200), with 6.0% (6/100) after Cesarean section and 10.0% (10/100) after open gynecologic procedures. Multivariable analysis identified independent risk factors: higher body mass index (adjusted odds ratio 1.12 per unit, 95% confidence interval 1.05–1.19, $p < 0.001$), vertical incision (odds ratio 4.10, 95% CI 1.75–9.60, $p = 0.001$), postoperative wound infection (odds ratio 5.22, 95% CI 2.15–12.67, $p < 0.001$), and history of two or more prior Cesarean sections (odds ratio 3.85, 95% CI 1.42–10.45, $p = 0.008$). Continuous fascial closure was protective (odds ratio 0.42, 95% CI 0.20–0.88, $p = 0.022$). Early patient-reported symptoms preceding diagnosis included a palpable bulge (75%), persistent pain (62.5%), and discomfort during activity (50%).

Conclusion: Higher body mass index, vertical incisions, wound infection, and multiple prior Cesarean sections are significant risk factors for incisional hernia. Using transverse incisions and continuous fascial closure, when possible, together with vigilant wound care and patient education on self-examination for early symptoms, can help reduce risk and enable early detection in high-risk patients.

Keywords: Incisional hernia, Cesarean section, gynecologic surgery, risk factors, prospective study, obesity, surgical site infection.

INTRODUCTION

An incisional hernia (IH) is a common adverse outcome of abdominal surgery that can result in substantial morbidity (1) and increased medical expenses (2). Research indicates a strong correlation between the number of Cesarean sections (CSs) performed on a patient and the subsequent risk of incisional hernia (IH) (3). Reported incidence rates of IH after CS vary widely. Paulsen et al. (4), in a systematic analysis of five studies comprising 275,878 women with a previous CS, reported an occurrence of IH after CS between 0.0% and 5.6%, with follow-up periods ranging from six months to ten years.

Incisional hernia repair operations are often used as a proxy for the true incidence of IH, which likely underestimates the total number of clinically significant cases. In one cohort where transverse incisions were the primary approach, the overall probability of an IH necessitating surgical repair within ten years following CS was 2 per 1000 deliveries (5).

The incidence of IH following gynecological surgeries has been reported to range from 2% to 17%, with risk variables comparable to those observed in gastrointestinal surgery (6). Gynecological operations

have been recognized as an independent risk factor for IH (6,7). Studies indicate that the overall incidence of IH after off-midline and Pfannenstiel incisions is typically much lower than after midline laparotomy. Although Pfannenstiel incisions are often used for procedures such as CS, they may be inadequate for gynecological oncology procedures requiring wider surgical exposure (8).

Other established patient-related risk factors include obesity, diabetes, and advanced age, while surgical risk factors encompass vertical midline incisions, suture technique, postoperative surgical site infection (SSI), history of multiple CSs, and postoperative behaviors such as sedentary lifestyle.

Despite this knowledge, prospective data specifically stratifying risk factors and the natural history of IH in these common surgical populations remain limited. This study prospectively evaluated risk factors, symptomatology, and timing of IH after CS and open gynecologic surgery, with the goal of informing risk-stratified prevention and surveillance strategies.

PATIENTS AND METHODS

Research design and participants

A prospective observational cohort study was conducted from January 2023 to June 2025 at the Departments of General Surgery and Obstetrics & Gynecology at Bin Tayyab Medical Complex (BTMC), Hyderabad, Pakistan. Consecutive women scheduled for elective or emergency Cesarean section (CS; n = 100) or open gynecologic procedures (n = 100) via Pfannenstiel or midline incision were recruited. Exclusion criteria included pre-existing abdominal wall hernias, prior hernia repair surgery, inability to provide informed consent, or plans to relocate that would prevent follow-up. The study received ethical approval from the BTMC Institutional Review Board, and all participants provided written informed consent.

Data Collection

Baseline data collected preoperatively included:

• **Demographics:** Age, parity.

• **Anthropometrics:** Height and weight were measured to calculate Body Mass Index (BMI).

• **Medical History:** Comorbidities (hypertension, diabetes mellitus), smoking status, and history of prior abdominal surgeries, with specific notation of the number of previous Cesarean sections (CS).

• **Surgical Details:** Type of incision (Pfannenstiel vs. midline) and fascial closure technique (continuous vs. interrupted).

Patients were followed up at 6 weeks, 6 months, and 12 months through scheduled clinic visits. At each visit, a surgeon performed a physical examination to assess for an IH, diagnosed as a palpable defect or bulge at the surgical site. Patients were also interviewed using a structured questionnaire regarding symptoms, including persistent pain (rated on a visual analog scale), sensation of a bulge, discomfort during physical activity, or a feeling of pressure.

The occurrence of postoperative wound infection, defined according to CDC criteria and requiring antibiotic treatment or intervention, was recorded. Physical activity levels were self-reported and classified into three categories: low (< 30 minutes of moderate activity per week), moderate (30–150 minutes per week), and high (> 150 minutes per week).

Clinical Endpoint

The primary outcome was the incidence of a clinically detectable incisional hernia (IH) within 12 months post-surgery.

Secondary outcomes included:

1. Time from surgery to hernia detection.
2. Identification of independent risk factors for IH development.
3. Analysis of initial symptoms reported before diagnosis.

Statistical Analysis

All data were analyzed using SPSS version 27.0. Continuous data with normal distribution are presented as means ± standard deviations, while skewed continuous data are expressed as medians with interquartile ranges. Categorical variables are reported as frequencies and percentages.

Comparisons between groups were performed using the independent-samples t-test, Mann–Whitney U test, or Chi-square test, as appropriate. To identify potential risk factors, univariate logistic regression was first used ($p < 0.10$ threshold). Variables meeting this criterion were entered into a multivariable logistic regression model using a backward stepwise approach to determine independent predictors. Results are reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). A p-value < 0.05 was considered statistically significant.

RESULTS

Participant characteristics at enrollment

Table 1 summarizes the baseline characteristics of the 200 study participants. On average, participants were 34.2 years old (± 6.5 years) with a mean BMI of 28.5 kg/m² (± 4.2 kg/m²). In the Cesarean section (CS) group, the median number of prior deliveries was 1,

Table 1. *Descriptive statistics of the study population*

Characteristic	Overall (n = 200)	Cesarean Section (n = 100)	Open Gynecologic (n = 100)	p-value
Age (years), mean ± SD	34.2 ± 6.5	32.8 ± 5.9	35.6 ± 6.8	0.003
BMI (kg/m²), mean ± SD	28.5 ± 4.2	29.1 ± 4.5	27.9 ± 3.9	0.038
Parity, median [IQR]	2 [1, 3]	2 [1, 3]	–	–
≥ 2 Prior Cesareans, n (%)	45 (22.5)	45 (45.0)	–	–
Incision Type, n (%)				< 0.001
Pfannenstiel	100 (50.0)	85 (85.0)	15 (15.0)	
Midline	100 (50.0)	15 (15.0)	85 (85.0)	
Closure Technique, n (%)				1.000
Continuous	160 (80.0)	80 (80.0)	80 (80.0)	
Interrupted	40 (20.0)	20 (20.0)	20 (20.0)	
Comorbidities, n (%)				
Diabetes Mellitus	10 (5.0)	5 (5.0)	5 (5.0)	1.000
Hypertension	20 (10.0)	8 (8.0)	12 (12.0)	0.343
Postoperative Wound Infection, n (%)	25 (12.5)	10 (10.0)	15 (15.0)	0.278

with an interquartile range of 1 to 2, indicating that the middle 50% of values fell between 1 and 2.

The median time to hernia detection in our study was 5.5 months (interquartile range [IQR]: 3–9 months). Open gynecologic procedures included hysterectomy (65%), myomectomy (25%), and oophorectomy (10%). The use of midline incisions was significantly higher in the open surgery group, occurring in 70% of cases, whereas it was less common in the CS group (15%), where Pfannenstiel incisions predominated (85%). Continuous fascial closure was used in 80% of all procedures.

Incidence and Time to Detection

The overall incidence of incisional hernia at 12 months was 8.0% (16/200). The incidence was 6.0% (6/100) following Cesarean section (CS) and 10.0% (10/100) after open gynecologic procedures. The average time to hernia detection was 6 months, with most detections occurring between 4 and 8 months.

A Kaplan-Meier curve illustrating cumulative incidence over time is presented in Figure 1. In Figure 2, the median time to hernia detection after open gynecologic operations is shown at 5.6 months by a line within the box, which spans an interquartile range (IQR) of 4–8 months (Q1 = 4 months, Q3 = 8 months). Figure 2 clearly illustrates the spread and central tendency of the data. In contrast, the IQR for the CS group (1–2 months) is shown as a smaller, tighter box, representing a narrow spread of data.

Thus, Figure 1 shows the approximate hernia-free survival over 12 months for CS and open gynecologic surgery patients, whereas Figure 2 visualizes the distribution of time to hernia detection (IQR 4–8 months) for each group, including individual patient events.

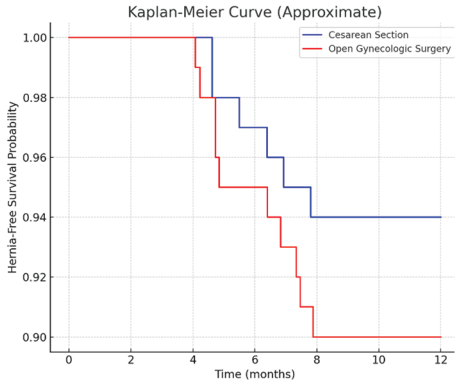

Figure 1. *Kaplan–Meier curve showing the cumulative incidence of incisional hernia over 12 months postoperatively, comparing Cesarean section and open gynecologic surgery patients. The x-axis represents time in months, and the y-axis represents the cumulative probability of hernia occurrence*

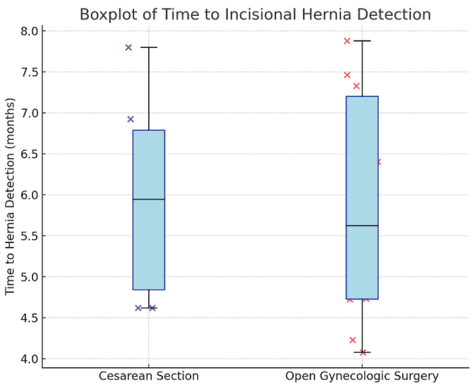

Figure 2. *Box-and-whisker plot showing the time to incisional hernia detection among patients diagnosed with IH (n = 16). The median is indicated by the line within the box, the interquartile range (IQR) by the box, and the whiskers represent the minimum and maximum values*

Risk Factor Analysis

Univariate analysis identified higher BMI, vertical incision, postoperative wound infection, and a history of two or more prior Cesarean sections as significant factors associated with IH development (Table 2).

DISCUSSION

This prospective observational study provides robust evidence for risk stratification of incisional hernias (IH) following common gynecological and obstetric surgeries. Our findings confirm and quantify several established risk factors while highlighting the cumulative risk posed by multiple prior Cesarean sections. The overall IH incidence of 8.0% aligns with the higher end of the range reported in contemporary literature for mixed surgical cohorts, reflecting our prospective design, which may capture hernias that retrospective studies miss (4, 6, 9).

Table 2. *An analysis of the unadjusted association between variables and the development of incisional hernia*

Variable	No Hernia (n = 184)	Hernia (n = 16)	O R (95% CI)	p-value
Age (years), mean ± SD	34.0 ± 6.5	36.1 ± 6.8	1.05 (0.98 - 1.13)	0.158
BMI (kg/m²), mean ± SD	28.2 ± 4.0	31.8 ± 4.5	1.22 (1.12 - 1.33)	< 0.001
Vertical Incision, n (%)	88 (47.8)	12 (75.0)	3.27 (1.08 - 9.87)	0.036
Wound Infection, n (%)	18 (9.8)	7 (43.8)	7.14 (2.45 - 20.80)	< 0.001
History of ≥ 2 Prior Cesareans, n (%)	38 (20.7)	7 (43.8)	3.00 (1.08 - 8.33)	0.035
Diabetes Mellitus, n (%)	8 (4.3)	2 (12.5)	3.13 (0.62 - 15.87)	0.169
Continuous Fascial Closure, n (%)	150 (81.5)	10 (62.5)	0.38 (0.14 - 1.03)	0.057

Table 3. *Statistical analysis of incisional hernia risk factors*

Variable	Adjusted OR	95% C I	p-value
BMI (per unit increase)	1.12	1.05 – 1.19	< 0.001
Vertical Incision	4.10	1.75 – 9.60	0.001
Postoperative Wound Infection	5.22	2.15 – 12.67	< 0.001
History of ≥ 2 Prior Cesareans	3.85	1.42 – 10.45	0.008
Continuous Fascial Closure	0.42	0.20 – 0.88	0.022

In the multivariable logistic regression model (Table 3), higher body mass index (per unit increase), vertical incision, postoperative wound infection, and a history of multiple (≥2) Cesarean sections remained significant independent risk factors. Continuous fascial closure was an independent protective factor.

Early Symptoms

Among the 16 patients diagnosed with an incisional hernia, the most commonly self-reported early symptoms before clinical confirmation were a palpable bulge or swelling (75%, 12/16), persistent ache or pain at the incision site (62.5%, 10/16), and discomfort during physical activity (50%, 8/16), as shown in Table 4.

Table 4. *Early symptoms reported before clinical diagnosis of incisional hernia (n = 16)*

Symptom	N	%
Palpable bulge or swelling	12	75.0
Persistent ache or pain at incision site	10	62.5
Discomfort during physical activity	8	50.0
Feeling of pressure or heaviness	6	37.5
Note: Patients could report more than one symptom.		

The observed difference in incidence between the Cesarean section (6.0%) and open gynecologic surgery (10.0%) groups is clinically significant and likely attributable to the substantially higher prevalence of midline incisions (70%) in the open gynecologic cohort compared to the CS group (15%), where the more robust Pfannenstiel incision predominated. These findings are consistent with the literature (10).

The strong association between higher Body Mass Index (BMI) and IH risk, with an adjusted odds ratio of 1.12 per unit, underscores the significant role of obesity in hernia development. Factors contributing to this risk include increased intra-abdominal pressure, reduced blood flow to the abdominal wall fascia from excess adipose tissue, and potentially poorer tissue quality and healing in obese patients (9). This finding emphasizes the importance of preoperative counseling and weight optimization, where feasible, as a key component of risk reduction strategies.

Our results strongly support the preferential use of transverse incisions, such as Pfannenstiel, over vertical midline incisions whenever surgically feasible. The adjusted odds ratio of 4.10 for a vertical incision highlights its biomechanical inferiority. Transverse incisions align with Langer's lines of skin tension, resulting in lower lateral tension on the fascial closure and promoting stronger healing (11). This is a modifiable surgical factor with substantial impact on long-term outcomes. Guitarte et al. (12) reported similar findings, identifying older age, hypertension, loop sutures, and cancer as risk factors for IH after vertical midline laparotomy.

Perhaps the most significant modifiable risk factor in our study was postoperative wound infection, which increased the odds of IH by over five-fold (OR 5.22). Surgical site infection (SSI) creates a local inflammatory environment that leads to collagenolysis, impaired fibroblast function, and ultimately fascial weakening (13,14). SSI rates for IH surgery range from 0.7% to 26.6% and are associated with local complications, prolonged treatment, and higher one-year recurrence, despite IH repair being classified as a clean surgical operation (15). These observations underscore the importance of strict adherence to SSI prevention bundles (14), including appropriate antibiotic prophylaxis, meticulous hemostasis, gentle tissue handling, maintenance of normothermia, and sterile technique (16). Vigilant postoperative wound care for early detection and management of infections is equally critical.

A novel and important finding of our study is the quantification of risk associated with multiple prior Cesarean sections. Patients with ≥ 2 previous CS had a nearly four-fold increased risk (OR 3.85). This emphasizes cumulative damage to the abdominal wall with each subsequent operation, as scar tissue retains only 70–80% of the tensile strength of native fascia (17, 18). These results highlight the need for meticulous surgical technique in repeat surgeries and inform patient discussions regarding cumulative risks of multiple abdominal procedures.

On a positive note, our study reinforces current best-practice guidelines for fascial closure (9,11). Continuous fascial closure with a slowly absorbable suture was protective (OR 0.42). This technique evenly distributes tension, creating a secure and biomechanically stable closure, unlike interrupted sutures that may create localized stress points and ischemia (16). This simple, evidence-based choice should be widely adopted to improve patient safety.

Beyond prevention, our findings on early symptomatology suggest clear opportunities for improving patient care. High frequencies of patient-reported early symptoms, specifically a palpable bulge (75%) and persistent pain (62.5%), indicate that patients often detect issues before clinical diagnosis. This supports implementing structured post-discharge education programs to teach high-risk patients how to perform careful self-examination and report "red flag" symptoms early (19). Such strategies could shorten the time to diagnosis and elective repair, reduce complications like obstruction or strangulation, and improve overall outcomes.

Limitations

The findings of this study may have limited generalizability to other populations or healthcare settings due to its single-center design. Physical activity level was based on self-report, which introduces the potential for recall and social desirability bias. While a 12-month follow-up is standard in IH research, it may miss hernias that manifest later; therefore, longer-term studies are needed to capture the true lifetime incidence. Finally, although our sample size was adequate for identifying major risk factors, it may be underpowered to detect the significance of rarer variables or more complex interactions.

CONCLUSION

This study successfully identified and categorized the main risk factors for incisional hernia after Cesarean and open gynecologic surgery. The predictors—obesity, vertical incisions, wound infections, and a history of multiple Cesareans—provide a clear profile for high-risk patients. These findings advocate for a multi-faceted approach encompassing:

1. Preoperative risk assessment and patient counseling,
2. The preferential use of transverse incisions and continuous fascial closure as standard technique,
3. Rigorous, protocol-driven SSI prevention, and
4. The implementation of post-discharge surveillance and patient education for high-risk individuals.

Future work should aim to validate these risk factors in larger, multi-center cohorts and to develop targeted interventions, such as prophylactic mesh augmentation or structured rehabilitation programs, to mitigate risk in these high-risk groups.

Abbreviations

IH – Incisional Hernia
CS – Cesarean Section
SSI – Surgical Site Infection
BMI – Body Mass Index
IQR – Interquartile Range
BTMC – Bin Tayyab Medical Complex

Acknowledgment: The authors thank the nursing staff and research coordinators at BTMC for their in-

valuable assistance with patient recruitment and data collection.

Financial Support: This research received no external funding or sponsorship.

Conflict of Interest Statement: The authors declare that there is no conflict of interest related to this paper.

Author Contribution & Responsibilities: The authors take full responsibility for the accuracy and integrity of the content, as well as the validity of institutional affiliations. The publisher remains neutral regarding jurisdictional claims in institutional affiliations. All authors have read and agreed to the published version of the manuscript. The project was conceptualized by Dr. Munir Menon and Dr. Zaheera Saadia. They were responsible for data collection, curation, and compilation of the original draft. Dr. Sajad Ahmad Salati reviewed and edited the Introduction, Discussion, and References sections. The project was supervised overall by Dr. Munir Menon.

Data Availability Statement: Requests to access the datasets should be directed to the corresponding author.

Note: Artificial intelligence was not utilized as a tool in this study.

Sažetak

STRATIFIKACIJA FAKTORA RIZIKA I RANA DETEKCIJA INCIZIONALNIH HERNIJA NAKON CARSKOG REZA I OTVORENIH GINEKOLOŠKIH PROCEDURA: PROSPEKTIVNA OPSERVACIONA STUDIJA

Memon Munir Muhammad,[1, 2] Salati Ahmad Sajad,[3] Saadia Zaheera[4]

[1] Univerzitet Qassim, podružnica Buraidah, Medicinski fakultet, Katedra za hirurgiju, Kraljevina Saudijska Arabija
[2] Medicinski kompleks Bin Tayyab (BTMC), Hyderabad, Sindh, Pakistan
[3] Univerzitet Qassim, podružnica Unayzah, Medicinski fakultet, Katedra za hirurgiju, Kraljevina Saudijska Arabija
[4] Univerzitet Qassim, podružnica Buraidah, Medicinski fakultet, Katedra za ginekologiju, Kraljevina Saudijska Arabija

Uvod: Incizionalna hernija predstavlja značajnu komplikaciju abdominalnih operacija, koja dovodi do bola, funkcionalnih ograničenja i povećanih troškova zdravstvene zaštite. Cilj ove studije bio je identifikovati i rangirati faktore rizika za incizionalnu herniju kod pacijentkinja koje su imale carski rez ili otvorenu ginekološku operaciju, kao i proceniti strategije za njihovu ranu detekciju.

Metode: Od januara 2023. do juna 2025. sprovedena je prospektivna opservaciona studija u kojoj je učestvovalo 200 žena, svaka praćena tokom 12 meseci. Polovina pacijentkinja je imala carski rez (n = 100), dok je druga polovina imala otvorene ginekološke operacije (n = 100). Prikupljeni su podaci o demografskim karakteristikama, indeksu telesne mase, komorbiditetima, detaljima operacije i postoperativnim komplikacijama. Primarni ishod bio je incidenca incizionalne hernije tokom jedne godine, procenjena kliničkim pregledima nakon 6 nedelja, 6 meseci i 12 meseci.

Rezultati: Ukupna incidenca incizionalne hernije iznosila je 8,0% (16/200), sa 6,0% (6/100) nakon carskog reza i 10,0% (10/100) nakon otvorenih ginekoloških procedura. Multivarijabilna analiza identifikovala je sledeće nezavisne faktore rizika: viši indeks telesne mase (adjusted odds ratio 1,12 po jedinici, 95% CI 1,05–1,19, p < 0,001), vertikalni rez (odds ratio 4,10, 95% CI 1,75–9,60, p=0,001), postoperativnu infekciju rane (odds ratio 5,22, 95% CI 2,15–12,67, p<0,001) i dva ili više prethodnih carskih rezova (odds ratio 3,85, 95% CI 1,42–10,45, p = 0,008). Šivenje fascije produžnim šavom predstavljalo je zaštitni faktor (odds ratio 0,42, 95% CI 0,20–0,88, p = 0,022). Najčešći rani simptomi koje su pacijentkinje prijavile pre postavljanja dijagnoze bili su palpabilno ispupčenje (75%), postojan bol (62,5%) i nelagodnost tokom fizičkih aktivnosti (50%).

Zaključak: Viši indeks telesne mase, vertikalni rezovi, infekcija rane i više prethodnih carskih rezova predstavljaju značajne faktore rizika za incizionalnu herniju. Upotreba transverzalnih rezova i šivenje fascije produžnim šavom, kada je moguće, zajedno sa pažljivom postoperativnom negom rane i edukacijom pacijentkinja o samopregledu radi ranog prepoznavanja simptoma, može doprineti smanjenju rizika i omogućiti ranije otkrivanje kod pacijentkinja sa visokim rizikom.

***Ključne reči**:* Incizionalna hernija, carski rez, ginekološke operacije, faktori rizika, prospektivna studija, gojaznost, infekcija hirurškog mesta.

REFERENCES

1. Söderbäck H, Gunnarsson U, Hellman P, Sandblom G. Incisional hernia after surgery for colorectal cancer: a population-based register study. Int J Colorectal Dis. 2018; 33(10): 1411-7. doi: 10.1007/s00384-018-3124-5.

2. Fischer JP, Basta MN, Mirzabeigi MN, Bauder AR, Fox JP, Drebin JA, et al. A risk model and cost analysis of incisional hernia after elective, abdominal surgery based upon 12,373 cases: The case for targeted prophylactic intervention. Ann Surg. 2016; 263(5): 1010–7. doi: 10.1097/SLA.0000000000001394.

3. Shand AW, Chen JS, Schnitzler M, Roberts CL. Incisional hernia repair after caesarean section: a population-based study. Aust NZJ Obstet Gynaecol. 2015; 55(2): 170-5. doi: 10.1111/ajo.12270.

4. Paulsen CB, Zetner D, Rosenberg J. Incisional hernia after cesarean section: A systematic review. Eur J Obstet Gynecol Reprod Biol. 2020; 244: 128-33. doi: 10.1016/j.ejogrb.2019.11.010.

5. Aabakke AJ, Krebs L, Ladelund S, Secher NJ. Incidence of incisional hernia after cesarean delivery: a register-based cohort study. PLoS One. 2014; 9(9): e108829. doi: 10.1371/journal.pone.0108829.

6. Bewö K, Österberg J, Löfgren M, Sandblom G. Incisional hernias following open gynecological surgery: a population-based study. Arch Gynecol Obstet. 2019; 299(5): 1313-9. doi: 10.1007/s00404-019-05069-0.

7. Franchi M, Ghezzi F, Buttarelli M, Tateo S, Balestreri D, Bolis P. Incisional hernia in gynecologic oncology patients: a 10-year study. Obstet Gynecol. 2001; 97(5 Pt 1): 696-700. doi: 10.1016/s0029-7844(01)01192-9.

8. Spear K, Davenport DL, Butler L, Plymale M, Roth JS. Comparison of incisional hernia rates between general and gynecological surgery procedures. Medicina (Kaunas). 2025; 61(3): 435. doi: 10.3390/medicina61030435.

9. Sanders DL, Pawlak MM, Simons MP, Aufenacker T, Balla A, Berger C, et al. Midline incisional hernia guidelines: the European Hernia Society. Br J Surg. 2023; 110(12): 1732-68. doi: 10.1093/bjs/znad284.

10. Kisielinski K, Conze J, Murken AH, Lenzen NN, Klinge U, Schumpelick V. The Pfannenstiel or so called "bikini cut": still effective more than 100 years after first description. Hernia. 2004; 8(3): 177–81. doi: 10.1007/s10029-004-0210-0.

11. Deerenberg EB, Henriksen NA, Antoniou GA, Antoniou SA, Bramer WM, Fischer JP, et al. Updated guideline for closure of abdominal wall incisions from the European and American Hernia Societies. Br J Surg. 2022; 109(12): 1239-50. doi: 10.1093/bjs/znac302.

12. Guitarte C, Grant J, Zhao H, Wang S, Ferriss JS, Hernandez E. Incisional hernia formation and associated risk factors on a gynecologic oncology service: an exploratory analysis. Arch Gynecol Obstet. 2016; 294(4): 805-11. doi: 10.1007/s00404-016-4100-3.

13. Thorup T, Tolstrup MB, Gögenur I. Reduced rate of incisional hernia after standardized fascial closure in emergency laparotomy. Hernia. 2019; 23(2): 341-6. doi: 10.1007/s10029-019-01893-0.

14. Berrevoet F. Prevention of incisional hernias after open abdomen treatment. Front Surg. 2018; 5: 11. doi: 10.3389/fsurg.2018.00011.

15. Juvany M, Hoyuela C, Trias M, Carvajal F, Ardid J, Martrat A. Impact of surgical site infections on elective incisional hernia surgery: a prospective study. Surg Infect. 2018; 19(3): 339-44. doi: 10.1089/sur.2017.233.

16. Dias Rasador AC, Mazzola Poli de Figueiredo S, Fernandez MG, Dias YJM, Martin RRH, da Silveira CAB, et al. Small bites versus large bites during fascial closure of midline laparotomies: a systematic review and meta-analysis. Langenbecks Arch Surg. 2024; 409(1): 104. doi: 10.1007/s00423-024-03293-0.

17. van Ramshorst GH, Nieuwenhuizen J, Hop WC, Arends P, Boom J, Jeekel J, et al. Abdominal wound dehiscence in adults: development and validation of a risk model. World J Surg. 2010; 34(1): 20-7. doi: 10.1007/s00268-009-0277-y.

18. Aylia FA, Khirie S, Steinberg D. Incisional hernia repair during cesarean section. Cureus. 2022; 14(4): e24121. doi: 10.7759/cureus.24121.

19. Sherer DM, Zinn H, Papavlassopulos A, Thompson M, Benton L, Filipovic A, et al. Early postpartum unilateral vulvar edema leading to diagnosis of a Pfannenstiel incisional hernia following cesarean delivery. Radiol Case Rep. 2024; 19(12): 6343-6. doi: 10.1016/j.radcr.2024.08.133.

Correspondence to/Autor za korespondenciju
Dr Muhammad Munir Memon,
Department of surgery, College of Medicine, Qassim University, Saudi Arabia.
email: m.ghafar@qu.edu.sa
Mob. Number 00966 542862377
Postal address
Building no. 8773, street.
Fahd ibn Sahl, Buraidah,
Qassim, KSA, 52379
ORCID Id
Muhammad Munir Memon 0000-0003-2501-3126
Salati Ahmad Sajad 0000-0003-2998-7542
Saadia Zaheera 0000-0001-5545-3902

How to cite this article: **Memon MM ,** Salati AS, Saadia Z. Risk factor stratification and early detection of incisional hernias after Cesarean and open gynecologic procedures: a prospective observational study. Sanamed. 2025; 20(3): 243-249. doi: 10.5937/sanamed0-61135.