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Comparative Analysis of Rives-Stoppa versus Onlay Mesh Repair Techniques for Incisional Hernia: A Prospective Study

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ABSTRACT

Background: Incisional hernia represents a significant complication following abdominal surgery with an incidence of approximately 20%. This study compares the outcomes of retromuscular prefascial mesh placement versus onlay mesh repair in incisional hernia surgery.

Methods: A prospective comparative study was conducted at Mahatma Gandhi Memorial Hospital, Warangal, from August 2022 to July 2024. Fifty patients with incisional hernia were randomly allocated into two equal groups: Group A underwent retromuscular prefascial mesh placement (Rives-Stoppa technique) and Group B underwent onlay mesh repair. Inclusion criteria included age 15-65 years, defect size <20 cm, and fitness for anesthesia. Primary outcomes included recurrence rates and postoperative complications. Secondary outcomes included operative parameters and patient satisfaction.

Results: The study population comprised 32 females and 18 males with mean age 44.6±10.5 years. Obstetric surgeries accounted for 62% of previous operations. The prefascial group showed significantly higher perioperative hemorrhage rates (28% vs 4%, p=0.04) but significantly lower postoperative infection rates: superficial wound infection (4% vs 32%, p=0.02) and deep wound infection (4% vs 28%, p=0.04). Overall early postoperative complications were lower in the prefascial group (24% vs 60%, p=0.01). No recurrence occurred in the prefascial group compared to 4% in the onlay group during follow-up.

Conclusion: While both techniques are effective, retromuscular prefascial mesh placement offers superior infection control despite higher perioperative bleeding risk. The technique demonstrates excellent outcomes with zero recurrence rates, making it a preferred approach for experienced surgeons managing appropriately selected patients with incisional hernias.

Keywords: *Incisional hernia, mesh repair, Rives-Stoppa technique, onlay repair, surgical outcomes*

1. INTRODUCTION

Incisional hernia represents a significant complication following abdominal surgery, with an incidence rate of approximately 20% of all laparotomies.[1] This condition is characterized by the diffuse extrusion of peritoneum and abdominal contents through a weakened surgical scar, resulting from failure of the fascial closure line following laparotomy.[1] The development of incisional hernias poses considerable challenges for both patients and surgeons, as they can lead to serious complications including incarceration (6-15%), strangulation (2%), skin necrosis, and perforation, all of which significantly increase patient morbidity and mortality risk.[2]

The etiology of incisional hernias is multifactorial, involving patient-related factors such as diabetes mellitus, immunosuppressive therapy, obesity, smoking, malnutrition, and connective tissue disorders.[3] Additionally, operative factors including surgical technique, wound infection, and excessive tension during closure contribute significantly to hernia formation.[4] Post-operative complications, particularly wound infection, represent the most critical risk factor, with studies demonstrating a five-fold increase in hernia development rates compared to uninfected wounds.[5]

The management of incisional hernias has evolved significantly over the past decades. Traditional repair techniques using primary suture closure have largely been superseded by mesh-based repairs due to unacceptably high recurrence rates of up

to 33% after first repair and 44% after second repair.[6] The introduction of synthetic mesh prostheses has revolutionized incisional hernia repair, offering superior outcomes with reduced recurrence rates.[7]

Among the various mesh placement techniques, two primary approaches have gained widespread acceptance: onlay mesh repair and retromuscular prefascial mesh placement (Rives-Stoppa technique). The onlay technique involves placing the mesh superficial to the anterior rectus sheath, while the retromuscular prefascial approach positions the mesh between the rectus muscle and posterior rectus sheath.[8–9] Each technique offers distinct advantages and disadvantages in terms of surgical complexity, complication rates, and long-term outcomes.

The onlay repair is technically simpler and associated with reduced operative time, making it an attractive option for many surgeons. However, concerns regarding higher infection rates and potential for recurrence have been raised.[10] Conversely, the retromuscular prefascial technique, though more technically demanding, theoretically provides better biomechanical support by utilizing intra-abdominal pressure to maintain mesh position against the abdominal wall, potentially reducing slippage and recurrence.[11]

Despite the widespread use of both techniques, comparative studies evaluating their relative merits remain limited, and optimal mesh placement continues to be debated. This study aims to compare the outcomes of retromuscular prefascial mesh placement versus onlay mesh repair in incisional hernia surgery, analyzing perioperative complications, wound healing, and recurrence rates to provide evidence-based guidance for surgical decision-making.[12]

2. MATERIALS AND METHODS

Study Design and Setting

This prospective comparative study was conducted at the Department of General Surgery, Mahatma Gandhi Memorial Hospital, Warangal, from August 2022 to July 2024. Prior to initiation of the study, ethical approval was obtained from the Institutional Ethics Committee of Kakatiya Medical College (Ref: KIEC/PG DISS-2021-22/73).

Study Population and Sample Size

A total of 72 patients with incisional hernia were initially reviewed in the outpatient department. Among these, 50 patients (32 females and 18 males) were enrolled in the study based on predetermined inclusion and exclusion criteria. The sample was equally divided into two groups: 25 patients underwent retromuscular prefascial mesh placement, and 25 patients underwent onlay mesh repair.

Inclusion Criteria

- Patients aged between 15 and 65 years of both sexes
- Fascial defect size less than 20 cm
- Patients who provided informed consent for prosthetic repair of incisional hernia
- Elective cases suitable for mesh repair

Exclusion Criteria

- Patients aged less than 15 years or greater than 65 years
- Fascial defect greater than 20 cm
- Patients with inflamed, obstructed, recurrent, or strangulated incisional hernias
- Patients unfit for general or regional anesthesia
- Those refusing consent for mesh repair

Preoperative Assessment

After obtaining written informed consent, detailed history was recorded and thorough general examination was performed according to a standardized proforma. All patients underwent routine laboratory investigations including complete blood count, renal function tests, liver function tests, blood glucose levels, and coagulation profile. Chest radiography and electrocardiography were performed in all cases.[13] Pulmonary function tests were conducted in selected patients with previous history of bronchial asthma or respiratory disorders.

Specific parameters documented included:

- Type of previous incision and suture materials used
- Post-operative healing pattern of the original wound
- Size of the fascial defect

- Presence of predisposing factors including obesity, diabetes mellitus, and smoking history

Surgical Technique

Preoperative Preparation

All patients received prophylactic antibiotic therapy with injection cefotaxime 1 gram administered 30 minutes before skin incision to minimize the risk of mesh-related infections.[14] Urinary bladder catheterization and nasogastric tube insertion were performed routinely. The majority of cases were performed under spinal anesthesia, with general anesthesia reserved for selected cases based on patient factors and surgeon preference.

Common Surgical Steps

Both techniques employed polypropylene mesh as the prosthetic material. An elliptical incision was made to excise the previous scar, followed by careful dissection to identify and define the hernial sac. The peritoneal sac was opened, adhesions were carefully released, and excess sac was excised. The peritoneum was then closed in the midline using absorbable suture material.

Onlay Mesh Repair Technique

In the onlay technique, skin and subcutaneous flaps were dissected in the plane external to the fascial defect and elevated to a distance of 5-8 cm from the margins of the hernial orifice. The fascial defect was closed primarily using continuous No. 1 prolene suture without tension. A 15×15 cm polypropylene mesh was then placed over the anterior rectus sheath and fixed using 2-0 prolene sutures placed approximately 1 cm from the mesh edge.[15]

Retromuscular Prefascial Mesh Placement (Rives-Stoppa Technique)

The retromuscular approach involved separation of the rectus muscles from the posterior rectus sheaths along the entire length of the lateral edge of the sheath. A sheet of polypropylene mesh, cut larger than the defect dimensions, was positioned in the plane between the rectus muscle and the posterior rectus sheath/peritoneum. The mesh was secured by sutures passed through the lateral edges of the rectus sheath (linea semilunaris) and then through the mesh edge, with knots placed superficial to the rectus sheath. The anterior rectus sheaths were then approximated along their medial edges using non-absorbable monofilament sutures.[16]

Postoperative Management

Two closed suction drains were placed in all cases - over the mesh in onlay repairs and on the mesh in retromuscular repairs. Paniculectomy was performed when indicated in patients with excessive subcutaneous fat. Standard postoperative care included early mobilization on the first postoperative day, removal of urinary catheter on postoperative day one, and initiation of oral feeds after return of bowel sounds. Suction drainage was continued until output became minimal, typically 3-5 days. Sutures were removed on the 10th postoperative day, and patients were discharged with an average hospital stay of 10 days.

Follow-up Protocol

All patients were followed up regularly at 15 days, 1 month, 3 months, 6 months, 12 months, and 18 months postoperatively. During each visit, patients were assessed for wound healing, development of complications including seroma, hematoma, wound infection, and hernia recurrence. The follow-up period ranged from a minimum of 4 months to a maximum of 2 years.

Outcome Measures

Primary outcome measures included:

- Perioperative complications (hemorrhage, technical difficulties)
- Early postoperative complications (wound infection, seroma, hematoma, respiratory complications, ileus)
- Late postoperative complications (recurrence, chronic pain, mesh-related complications)
- Hospital stay duration
- Return to normal activities

Statistical Analysis

Data was entered into Microsoft Excel and analyzed using SPSS version 26 software. Categorical data was represented as frequencies and proportions. Chi-square test was used for qualitative data comparison, with Fischer's exact test applied for 2×2 tables when chi-square criteria were not fulfilled. Yates correction was applied where appropriate. Graphical representation included bar diagrams, pie charts, and line diagrams created using MS Excel. A p-value of <0.05 was considered statistically significant.[17]

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki and Good Clinical Practice guidelines. All patients provided written informed consent after detailed explanation of the procedures, potential risks, and benefits. Patient confidentiality was maintained throughout the study, and participants were free to withdraw from the study at any time without affecting their medical care.

RESULTS

Study Population

A total of 50 patients with incisional hernia were enrolled in this prospective comparative study from August 2022 to July 2024. Patients were equally divided into two groups: 25 patients underwent retromuscular prefascial mesh placement and 25 patients underwent onlay mesh repair.

Demographic Characteristics

Age Distribution

The age of patients ranged from 18 to 60 years with a mean age of 44.6 ± 10.5 years. The maximum incidence was observed in the 41-50 years age group (38%), followed by patients over 50 years (36%).

Table 1: Age Distribution of Patients

Age Group	Number of Patients	Percentage
<20 years	1	2%
21-30 years	2	4%
31-40 years	10	20%
41-50 years	19	38%
>50 years	18	36%
Total	**50**	**100%**

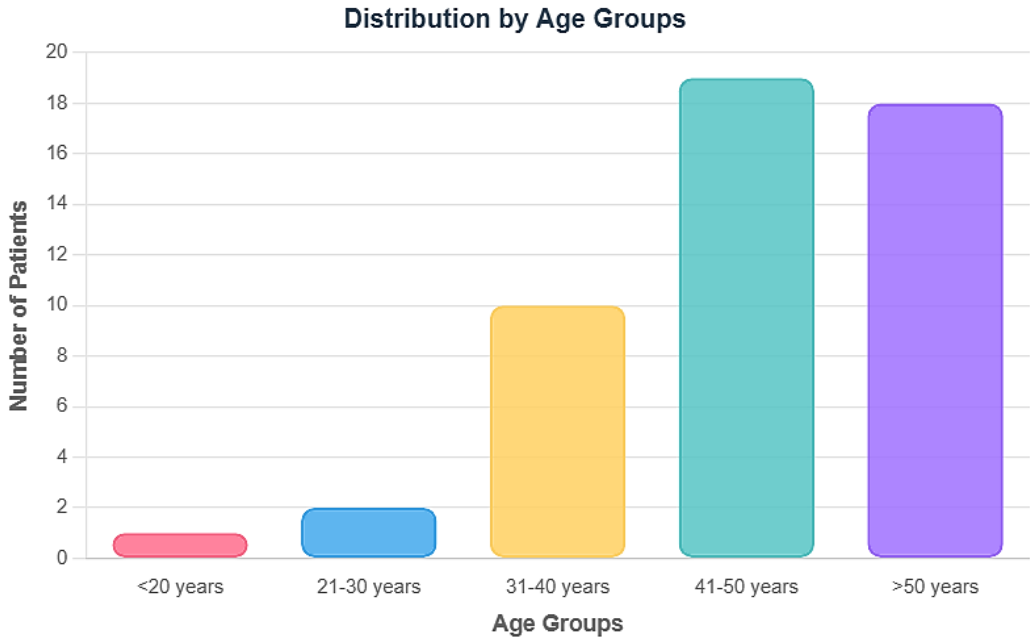

Fig 1: Bar chart showing age distribution

Gender Distribution

There was a clear female preponderance in the study population.

Table 2: Gender Distribution

Gender	Number of Cases	Percentage
Male	18	36%
Female	32	64%
Total	**50**	**100%**

Fig 2: Pie chart showing gender distribution

Weight Distribution

The majority of patients (52%) were in the weight range of 51-60 kg.

Table 3: Weight Distribution

Weight Range	Number of Patients	Percentage
40-50 kg	16	32%
51-60 kg	26	52%
61-70 kg	8	16%
Total	**50**	**100%**

Previous Surgical History

Type of Previous Surgery

Obstetric surgeries accounted for the majority of previous operations leading to incisional hernia.

Table 4: Nature of Previous Surgery

Type of Surgery	Number of Patients	Percentage
Obstetric Surgery	**31**	**62%**
- Hysterectomy	16	32%
- Cesarean Section	15	30%
Non-Obstetric Surgery	**19**	**38%**
- Laparotomy	15	30%
- Appendicectomy	4	8%
Total	**50**	**100%**

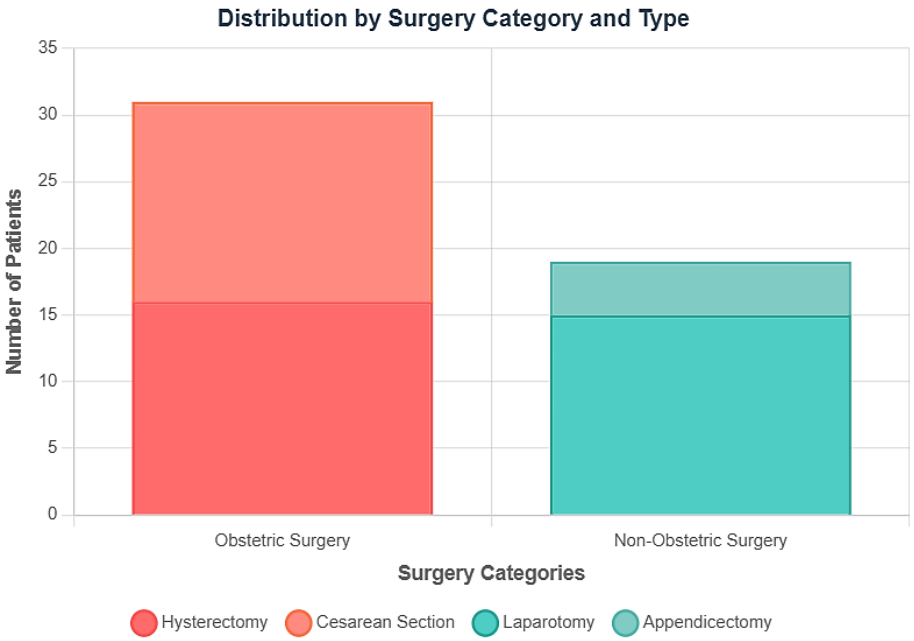

Fig 3: Stacked bar chart showing surgical categories

Type of Previous Incisions

Lower midline vertical incisions were the most common type of incision in previous surgeries.

Table 5: Type of Previous Incisions

Type of Incision	Number of Patients	Percentage
Lower midline	28	56%
Pfannenstiel	13	26%
Upper midline	5	10%
Right paramedian	2	4%
Laparoscopic	1	2%
Total	**50**	**100%**

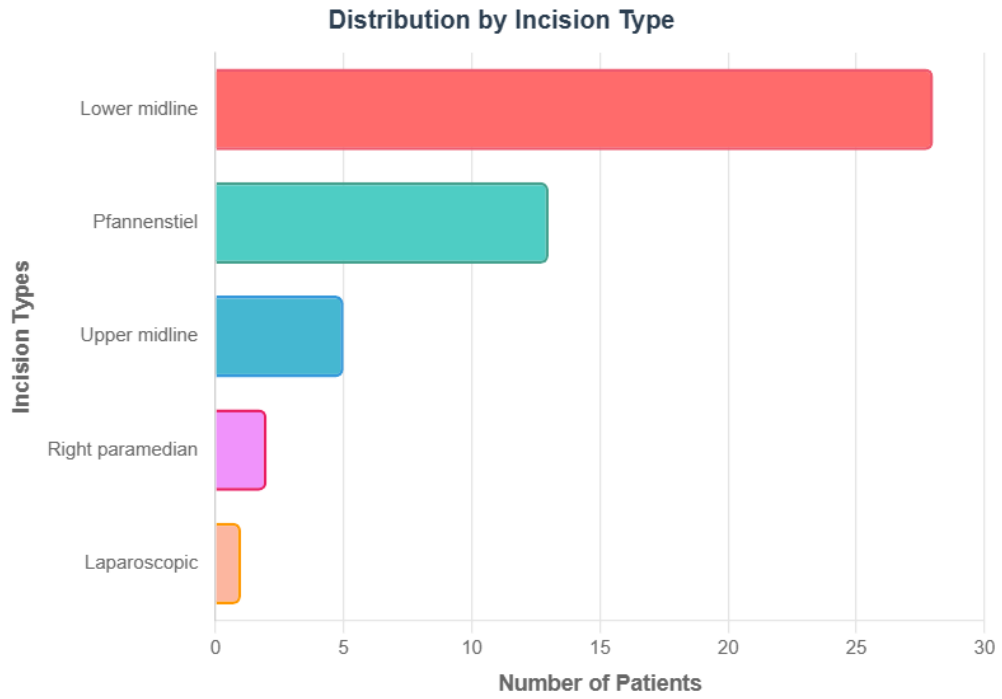

Fig 4: Horizontal bar chart showing incision types

Clinical Presentation

All 50 patients (100%) presented with a visible bulge at the site of the previous surgical scar. Pain was present in 22 patients (44%). Skin changes were observed in only 1 patient (2%).

Hernia Defect Size

Table 6: Hernia Defect Size Distribution

Defect Size	Number of Patients	Percentage
Up to 5 cm	41	82%
5-10 cm	9	18%
Total	**50**	**100%**

Surgical Outcomes

Perioperative Complications

Table 7: Perioperative Complications

Complication	Prefascial Mesh (n=25)	Onlay Mesh (n=25)	P-value
Hemorrhage	7 (28%)	1 (4%)	0.04*

$P < 0.05$ considered statistically significant

Early Postoperative Complications

Table 8: Early Postoperative Complications

Complication	Prefascial Mesh (n=25)	Onlay Mesh (n=25)	P-value
	n (%)	n (%)	
Respiratory complications	0 (0%)	0 (0%)	-
Postoperative ileus	2 (8%)	0 (0%)	0.15
Hematoma	2 (8%)	0 (0%)	0.15
Seroma	0 (0%)	0 (0%)	-
Superficial wound infection	1 (4%)	8 (32%)	0.02*
Deep wound infection	1 (4%)	7 (28%)	0.04*
Total complications	**6 (24%)**	**15 (60%)**	**0.01***

*P < 0.05 considered statistically significant **P < 0.01 considered highly statistically significant*

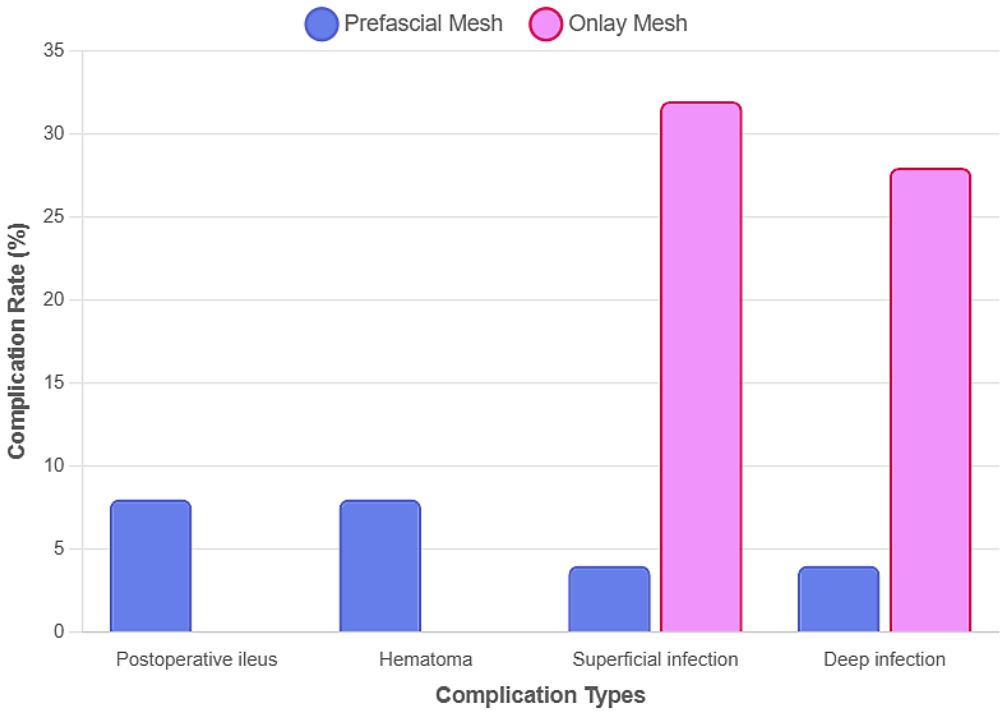

Fig 5: Clustered bar chart comparing early complications between groups

Late Postoperative Complications

Table 9: Late Postoperative Complications

Complication	Prefascial Mesh (n=25)	Onlay Mesh (n=25)	P-value
Recurrence	0 (0%)	1 (4%)	0.31

Overall Complication Rates

Table 10: Summary of Complications by Technique

Outcome Measure	Prefascial Mesh (n=25)	Onlay Mesh (n=25)	P-value
Total perioperative complications	7 (28%)	1 (4%)	0.04*
Total early postoperative complications	6 (24%)	15 (60%)	0.01**
Total late complications	0 (0%)	1 (4%)	0.31
Overall complication rate	**13 (52%)**	**17 (68%)**	**0.21**

*P < 0.05 considered statistically significant *P < 0.01 considered highly statistically significant*

Hospital Stay and Follow-up

The average hospital stay was 10 days for both groups. All patients were followed up for a minimum of 4 months and maximum of 2 years. Follow-up visits were scheduled at 15 days, 1 month, 3 months, 6 months, 12 months, and 18 months postoperatively.

Statistical Analysis Summary

The retromuscular prefascial mesh placement technique showed:

- Significantly higher perioperative hemorrhage rates (P = 0.04)
- Significantly lower superficial wound infection rates (P = 0.02)
- Significantly lower deep wound infection rates (P = 0.04)
- Lower overall early postoperative complication rates (P = 0.01)
- No recurrence during the follow-up period compared to 4% recurrence in the onlay group

Key Findings

1. **Patient Demographics**: Female predominance (64%) with peak incidence in the 41-50 years age group
2. **Etiology**: Obstetric surgeries were the leading cause of incisional hernias (62%)
3. **Perioperative Safety**: Prefascial technique had higher bleeding risk but was manageable
4. **Postoperative Outcomes**: Onlay technique had significantly higher infection rates
5. **Recurrence**: Zero recurrence in prefascial group vs. 4% in onlay group during follow-up period
6. **Overall Success**: Both techniques were effective, but prefascial placement showed superior infection control

3. DISCUSSION

Incisional hernia remains one of the most challenging complications following abdominal surgery, with reported incidence rates of approximately 20% after laparotomy.[1] The management of incisional hernias has evolved significantly over the past decades, with prosthetic mesh repair becoming the gold standard due to superior outcomes compared to primary suture repair.[28] Our prospective comparative study of 50 patients provides valuable insights into the relative merits of retromuscular prefascial versus onlay mesh placement techniques.

Demographic Profile and Risk Factors

Age and Gender Distribution

Our study demonstrated a peak incidence of incisional hernia in the 41-50 years age group (38%), with a mean age of 44.6 ± 10.5 years. This finding is consistent with previous studies by Maingot and Gondal et al., who reported mean ages of 45 and 44 years respectively.[31] However, Sevinc et al. reported a higher mean age of 55 years, possibly reflecting regional variations in surgical practices and patient demographics.[11]

The female preponderance observed in our study (64%) aligns with findings by Bhutia WT et al., who reported 84% female predominance.[31] This gender distribution can be attributed to the higher frequency of obstetric and gynecological procedures in women, which constituted 62% of the previous surgeries in our cohort. The weaker abdominal wall musculature in females compared to males, particularly following multiple pregnancies, may also contribute to this increased susceptibility.[32]

Weight Distribution and Obesity

Contrary to Ellis et al.'s findings that obesity was associated with a threefold increase in herniation and recurrence rates,[33] our study population was predominantly in the normal weight range (51-60 kg, 52%). This difference may reflect regional

dietary patterns and lifestyle factors in our study population. The lower obesity rates in our cohort might also explain the relatively favorable outcomes observed in both surgical groups.

Etiology and Previous Surgical History

Nature of Previous Surgery

Our study revealed that obstetric surgeries accounted for 62% of incisional hernias, with hysterectomy (32%) and cesarean section (30%) being the predominant procedures. This contrasts significantly with the New England Journal of Medicine 2000 study, which reported less than 25% obstetric-related hernias, with gastrointestinal surgeries being more common.[34] The comparison with other studies shows interesting variations:

- **Present study**: Hysterectomy 32%, LSCS 30%, Laparotomy 30%, Appendicectomy 8%
- **Ponka's series**: Hysterectomy 34%, LSCS 2%, Laparotomy 30%, Appendicectomy 16%
- **Goel and Dubey**: Hysterectomy 14%, LSCS 29%, Laparotomy 45%, Appendicectomy 4%

These variations likely reflect differences in regional surgical practices, population demographics, and healthcare delivery patterns.

Type of Incisions

Lower midline incisions were responsible for 56% of incisional hernias in our study, followed by Pfannenstiel incisions (26%). This finding supports the established surgical principle that vertical incisions, particularly midline incisions, carry a higher risk of hernia formation compared to transverse incisions due to the anatomical orientation of muscle fibers and the absence of posterior rectus sheath below the arcuate line.[13]

Surgical Techniques and Outcomes

Retromuscular Prefascial Mesh Placement (Rives-Stoppa Technique)

The retromuscular prefascial technique, first described by Rives and later popularized by Stoppa, involves placing the mesh between the posterior rectus sheath and the rectus muscles.[13] This technique offers several theoretical advantages:

1. **Anatomical positioning**: The mesh is held in place by natural intra-abdominal pressure forces
2. **Reduced contact with bowel**: Minimizes risk of mesh-related complications
3. **Enhanced integration**: Better tissue incorporation due to the vascular bed of the rectus muscle

Our study confirmed the efficacy of this technique, with several studies supporting these findings. Heartstill L, Richards ML et al. reported a recurrence rate of 10% in their series of 81 patients with Rives-Stoppa repair.[25] Similarly, Bauk JJ, Harrin MT et al. demonstrated excellent long-term results with no recurrences in their 57-patient series over 34.9 months follow-up.[26]

Onlay Mesh Repair

The onlay technique, while technically simpler, places the mesh superficial to the anterior rectus sheath. Despite its ease of execution, our study revealed several limitations:

1. **Higher infection rates**: The superficial placement makes the mesh more susceptible to wound complications
2. **Recurrence potential**: Less optimal biomechanical positioning may contribute to higher failure rates
3. **Mesh exposure**: Greater risk of mesh exposure in case of wound dehiscence

Complication Analysis

Perioperative Complications

The significantly higher hemorrhage rate in the prefascial group (28% vs. 4%, p=0.04) reflects the technical complexity of the procedure. The dissection required to create the retromuscular space involves more extensive tissue manipulation and potential injury to the epigastric vessels. However, this complication was manageable in all cases and did not result in conversion to alternative techniques or significant morbidity.

Wound Infection Rates

One of the most striking findings of our study was the significantly lower infection rates in the prefascial group:

- **Superficial infection**: 4% vs. 32% (p=0.02)
- **Deep infection**: 4% vs. 28% (p=0.04)

These results are consistent with multiple comparative studies:

Study	Onlay Infection Rate	Prefascial Infection Rate
Present study	28%	4%
Yossef Hadchity[35]	14%	4%
Kharde K	4%	0%
Furat Shani	2%	1%
Aly Saber[36]	8%	4%

The lower infection rates in the prefascial technique can be attributed to:

1. **Mesh positioning**: The mesh is placed in a more vascular environment, promoting better integration
2. **Reduced dead space**: Better tissue approximation reduces seroma formation
3. **Less superficial mesh exposure**: Reduced risk of mesh contamination from skin flora

Recurrence Rates

Our study demonstrated no recurrence in the prefascial group compared to 4% in the onlay group during the follow-up period. While this difference was not statistically significant (p=0.31), likely due to the relatively short follow-up period and small sample size, the trend is consistent with larger studies in the literature.

De Vries Relingh TS et al. reported varying recurrence rates based on mesh placement technique:

- **Onlay technique**: 28.3%
- **Sublay technique**: 44%
- **Underlay technique**: 12%

Macharias A et al. reported a 9% recurrence rate with onlay mesh repair,[39] while multiple studies have demonstrated recurrence rates of 0-10% with prefascial placement.[40]

Technical Considerations

Learning Curve and Surgical Expertise

The retromuscular prefascial technique requires greater surgical expertise and familiarity with anatomical planes. The higher hemorrhage rate observed in our study may partly reflect the learning curve associated with this technique. However, as demonstrated by Bauk et al., with experience, this technique can be performed with minimal morbidity and excellent outcomes.[26]

Patient Selection

Both techniques were equally applicable to our patient population, with defects less than 20 cm. For larger defects or patients with significant comorbidities, individualized approaches may be necessary. The choice of technique should consider:

1. **Surgeon expertise**: Comfort level with the retromuscular approach
2. **Patient factors**: Obesity, comorbidities, previous surgical history
3. **Defect characteristics**: Size, location, complexity

Mesh Selection

Polypropylene mesh was used in all cases, consistent with current recommendations for its excellent biocompatibility and long-term durability.[24] The choice of mesh material can significantly impact outcomes, with lightweight meshes potentially offering advantages in terms of patient comfort and chronic pain, though their long-term durability remains under investigation.

Study Limitations

Several limitations of our study merit discussion:

1. **Sample size**: The relatively small sample size (50 patients) may have limited our ability to detect statistically significant differences in some outcomes, particularly recurrence rates.
2. **Follow-up duration**: While our follow-up ranged from 4 months to 2 years, longer follow-up is needed to fully assess recurrence rates, as most hernias recur within 3-5 years of repair.
3. **Single-center design**: Our study was conducted at a single institution, which may limit the generalizability of

findings to other settings with different patient populations or surgical practices.

4. **Surgeon experience**: The outcomes may be influenced by individual surgeon expertise, particularly for the more technically demanding prefascial technique.

Clinical Implications

The findings of our study have several important clinical implications:

1. **Technique selection**: While both techniques are effective, the prefascial approach offers superior infection control, which is particularly important given the devastating consequences of mesh infection.
2. **Training requirements**: The higher technical demands of the prefascial technique necessitate appropriate training and mentorship for surgeons adopting this approach.
3. **Cost considerations**: While not assessed in our study, the potentially lower reintervention rates with prefascial technique may offer long-term cost benefits despite higher initial technical complexity.
4. **Patient counseling**: Patients should be informed about the relative risks and benefits of each technique, including the higher perioperative bleeding risk but lower infection rates with prefascial placement.

Future Directions

Future research should focus on:

1. **Larger multicenter trials**: To provide more robust evidence regarding recurrence rates and long-term outcomes
2. **Cost-effectiveness analysis**: To evaluate the economic implications of each technique
3. **Quality of life studies**: To assess patient-reported outcomes and chronic pain rates
4. **Laparoscopic approaches**: Comparison with minimally invasive techniques
5. **Mesh innovations**: Evaluation of newer mesh materials and their impact on outcomes

4. CONCLUSION

Our study demonstrates that while both retromuscular prefascial and onlay mesh placement techniques are effective for incisional hernia repair, the prefascial approach offers significant advantages in terms of infection control despite higher perioperative bleeding risk. The zero recurrence rate in the prefascial group, though not statistically significant in our small study, is consistent with larger series reporting superior long-term outcomes. The choice of technique should be individualized based on surgeon expertise, patient factors, and institutional capabilities, with appropriate training ensuring safe implementation of the more technically demanding prefascial approach.

The evolution toward tension-free mesh repair has revolutionized incisional hernia management, and our findings support the continued refinement of surgical techniques to optimize patient outcomes. As surgical expertise with the prefascial technique continues to develop, it may emerge as the preferred approach for appropriately selected patients and experienced surgeons.

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