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The closure debate: A prospective comparative study of mesh suture repair v/s Conventional mass closure operated at tertiary care centre

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Abstract

Background: Traditionally, a laparotomy wound is closed as mass closure, where the fascial layers are closed with single suture. The optimal approach to abdominal wound closure has yet to be determined. Ideally it should be technically straightforward, simple, cost-efficient, reduced risk of immediate and long term complication ensuring equally effective outcomes regardless of whether it is performed by a trainee or an experienced surgeon. Recently, a new closure technique known as the mesh-sutured method has gained popularity and has shown reduced complications than conventional mass closure method.

Aims and Objectives

- To compare effectiveness of mesh sutured repair vs. conventional mass closure of midline laparotomy
- To study feasibility and safety of mesh sutured repair.
- To compare the occurrence of wound infection, dehiscence and early incisional hernia in conventional mass closure and mesh sutured repair.

Setting and design: This study was performed in P.D.U. Government medical college and hospital, Rajkot (Gujarat) in patients undergoing midline laparotomy, either planned or emergency.

Materials and Methods: A total of 100 patients were enrolled in the study, with 50 undergoing conventional mass closure and the remaining 50 receiving closure using the mesh-sutured repair technique. Randomization was done by binary distribution to eliminate bias. Patients were monitored during the post-operative days for outcome of the procedure and complications such as wound infection, dehiscence and incisional hernia at regular interval.

Results: This study had shown significantly less rate of infection, dehiscence and incisional hernia in mesh sutured repair as compared to conventional mass closure.

Conclusion: This newer technique of mesh-sutured repair provides distinct advantages over the conventional mass closure method like lower incidence of wound infection and decreased rate of incisional hernia. However, the actual incidence of incisional hernia could

not be accurately determined due to short duration of study and limited sample size.

Keywords: Abdominal Wall, Emergency, Incisional Hernia, Laparotomy, Macroporous

Introduction

Midline laparotomy is one of the most commonly performed surgical procedures in patients treated at tertiary centres. In emergency situations, midline exploratory laparotomy plays a crucial role in diagnosing and managing various life-threatening abdominal conditions. The success of these procedures largely depends on precise surgical techniques and effective abdominal wall closure to promote healing and reduce complications[1]. Traditionally, abdominal mass closure involves using a continuous monofilament suture 1 number (polypropylene, polyamide) with a suture-to-wound length ratio of 4:1, placed 1 cm from the wound margin at 1 cm intervals[2]. This method is particularly vital in exploratory laparotomies during emergencies when the abdominal wall is under significant tension. In this conventional repair, sutures engage the entire sheath continuously without interruptions. As a result, if one suture becomes infected or loosens, the infection can spread to adjacent sutures, increasing the risk of dehiscence and wound infections[3]. Additionally, over time, the sutures may lose tension, weakening the repair's tensile strength and potentially leading to wound healing failure. Additionally, incisional hernias can develop over time due to repeated stress on the repair site. This continuous strain causes the sutures to gradually pull through the tissue, ultimately leading to repair failure.

To reduce complications and leverage the advantages of larger sutures while minimizing knot size, a mesh-sutured technique for abdominal wall closure was developed. In this method, strips from uncoated macroporous soft polypropylene mesh, known for its high tensile strength, and using them as sutures to approximate abdominal tissue with tied knots[1].

The mesh suture, composed of multiple polypropylene monofilaments, collapses at the knots, creating a lower profile and improving biocompatibility. Compared to traditional sutures, these mesh strips offer a suture-tissue interface approximately eight times larger, allowing for more even tension distribution across the abdominal wall[1,3]. This may help reduce the risk of wound dehiscence and incisional hernias. Additionally, tissue ingrowth into the mesh could promote collagen deposition and enhance the body's response at the repair site[4,5].

Materials and Methods

The study was conducted in the Department of Surgery at P.D.U. Government Medical College and Hospital, Rajkot, Gujarat. The research proposal was prepared and submitted to the Institutional Ethical Committee, which granted approval for the project. Total 100 patients were enrolled in the study, out of which 50 patients underwent conventional mass closure and other 50 patients underwent closure by mesh sutured repair. Binary randomization was done regarding the allocation of closure technique to ensure that there is no bias regarding the distribution. During the operation, a record was kept regarding the time required for closure and the type of suture material used.

In conventional repair, the rectus sheath is closed using Prolene™ -1 (Ethicon by Johnson & Johnson) sutures. After securing the anchor knot, the needle is passed through the musculo-aponeurotic layer without including the peritoneum, maintaining a 1 cm distance from both edges of the incision and spacing sutures at 1 cm intervals in a continuous manner until completion.

In mesh sutured repair, strips of mesh, 18–20 mm in width, are cut from a sheet of lightweight, macroporous, uncoated PROLENE Soft™ (Ethicon by Johnson & Johnson) mesh. These strips are cut parallel to the two fine filaments, aligning with the distance between the blue lines on the mesh sheet[1]. To create a precise surgical entry point, a sharp hemostat forceps is used to pierce the linea alba, 1 cm away from the incised margin on both sides. Cautery may be applied to the fascia to facilitate penetration of the rectus sheath at the entry site[1]. The mesh strip is then threaded through these openings. Also the mesh can be passed through rectus sheath by tying the free end of the suture to the mesh and rectus sheath is pierced with the help of the needle[1]. After this mesh suture is securely tied with a square knot and an additional two throws for reinforcement. Additional mesh strips are introduced through similar holes, spaced 1cm apart from each other, ensuring equal tension distribution to approximate the abdominal wall defect.

Patients were observed post-operatively for immediate post-operative complications like post-operative wound infection, stitch sinus formation, post-operative wound dehiscence and late post-operative complications like persistent wound pain and incisional hernia. They were followed up at interval of 1 week, 2 week, 1month, 3 month, 6 month and 1 year.

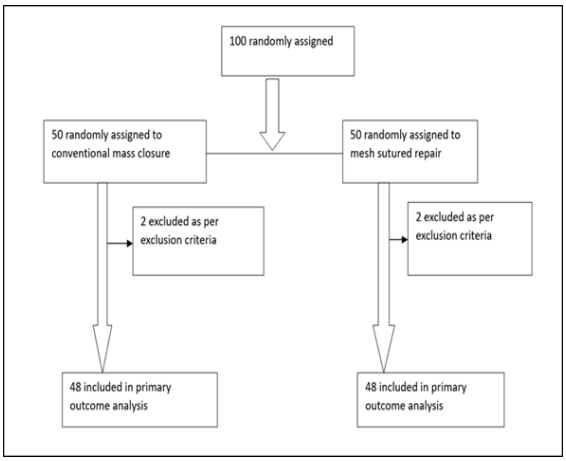

Figure 1: Triage Profile

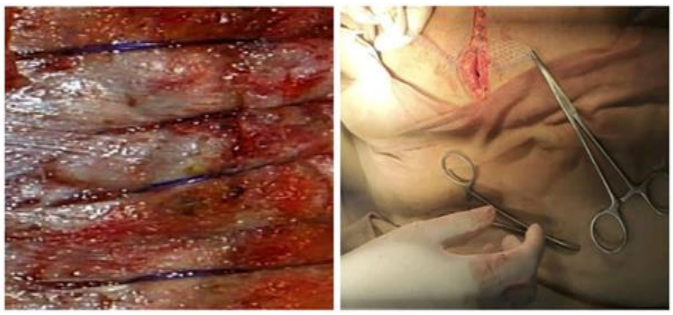

Figure 2: Figure on left shows conventional mass closure and on right shows mesh sutured repair

Figure 3: Soft prolene mesh used in mesh sutured repair

Inclusion criteria

- Patients aged >18 years.
- Patients undergoing midline exploratory laparotomy for either emergency or elective procedure.

Exclusion criteria

- Previous midline exploratory laparotomy and re-laparotomy.
- Other than midline incision.
- Patient who died within 10 days of post-operative period.

Result

Out of total subjects enrolled for study, the demographic profile of this study had shown mean age of patients who underwent midline laparotomy was 38 years in mesh sutured repair and 44 years in conventional mass closure. Among which 50% population was male and 50% female in mesh sutured repair whereas 72% of were male and

28% were female in conventional mass closure. The mean BMI among subjects was 25.1 in conventional mass closure and 24.5 in mesh sutured repair.

The average time for closure was 10 minutes higher in mesh sutured repair due to intricate technique of mesh sutured repair wherein each mesh strips are passed through the fascial edges and knot is tied at each strip of the mesh. 52% of total patients had mean duration of hospitalization >10 days in conventional mass closure due to higher rate of occurrence of wound infection and dehiscence whereas only 37% of total patients in mesh sutured repair had mean duration of hospitalization >10 days.

Overall, the occurrence of wound infection was 29% (14 out of 48) in mesh sutured repair as compared to 43% (21 out of 48) in conventional mass closure as better integrity of the wound overall reducing the rate of wound infection. Dehiscence occurred in 20% (10 out of 48) in conventional mass closure whereas no dehiscence occurred in subjects who underwent mesh sutured repair. Regarding the occurrence of incisional hernia, none of the subject developed incisional hernia in mesh sutured repair whereas 8% (4 out of 48) of subject developed incisional hernia who underwent conventional mass closure when followed for the duration of 1 year.

	Mass closure	Mesh sutured repair
Rate of wound infection	43%	29%
Dehiscence	20%	0%
Incisional hernia	8%	0%

Discussion

A surgeon's primary goal is to restore the structural integrity of incised or injured tissues as close to their normal state as possible. The role of sutures in achieving this cannot be overstated; however, the technique used for suturing is equally crucial in surgical outcomes[5]. Despite advancements in aseptic measures, surgical skills, and antibiotic use, wound complications still account for majority of all post-operative issues. Mesh-sutured repair shows promising results in reducing the incidence of wound infections and dehiscence compared to conventional mass closure for securing the abdominal wall in midline laparotomy patients.

The basis of this is explained as- the implantation of a mesh triggers a foreign-body reaction, essential for its integration into surrounding tissue. This response begins with an acute inflammatory phase, progressing through four stages. Proteins adsorb onto the mesh, forming a coagulum that attracts platelets, which release chemo-attractants[6]. These signals recruit various cells, such as PMNs, fibroblasts, and macrophages, through the process of chemotaxis, initiating the body's biological response to the implant. During the acute phase of inflammation, PMNs phagocytize microorganisms and contribute to the inflammatory response. If unresolved, the process transitions to chronic inflammation, where monocytes migrate to the wound and differentiate into macrophages, alongside plasma cells and lymphocytes, to eliminate foreign bodies and dead tissue[5]. In the final wound-healing stage, fibroblasts proliferate, synthesize collagen, and replace damaged tissue with scar tissue, aided by other cells involved in inflammation regulation and angiogenesis[6]. The implant’s macroporosity and higher suture-tissue interface area in mesh strips of approximately 8X than polypropylene suture results in its ability to distribute tension more evenly across the abdominal wall, potentially reducing the risk of wound dehiscence and incisional hernias. The tissue ingrowth into the mesh may enhance collagen deposition and the body's response at the repair site supports tissue ingrowth and scar formation, ultimately strengthening the repair over time.

The study conducted in 2017 by Zhang T et al. aimed to compare the mechanical performance of rotator cuffs repaired with mesh sutures versus traditional polydioxanone suture II (PDSII) and Fiber Wire sutures in a canine in vitro model. The results demonstrated that the tendon-bone interfaces repaired using mesh sutures provided significantly higher ultimate tensile force to failure compared with those repaired using classic sutures[7]. Study was done on rat laparotomy models for the incidence of incisional hernia by Souza JM in 2016 which showed none of the mesh sutures pulled through the surrounding tissue, whereas 65 percent of the conventional sutures exhibited complete pull-through[8]. The study done by Yurtkap Y et al. in 2020 where the linea alba of porcine abdominal wall was closed using small bites, large bite and Duramesh™ concluded that duramesh was more efficient in dividing suture tension across the incision when compared to large bites[9]. Lanier S et al. in 2016 conducted a retrospective review of patients undergoing ventral hernia repair with retrorectus placement of mid weight, uncoated polypropylene mesh and rectus sheath closure using mesh-sutured repair. The study found that mesh-reinforced repairs significantly reduced recurrence rates for ventral and incisional hernias[10].

Duramesh™ is the world's first suturable mesh, merging the benefits of mesh repair with the accuracy of suture placement designed to prevent suture pull-through by distributing forces across its mesh strands[11]. This duramesh as a part of mesh sutured repair can be ideal for various surgical procedures, including umbilical hernia repairs, hiatal hernia repairs, inguinal hernia repairs, open abdomen and acute dehiscence, parastomal hernia, closure of the rectus plication in abdomino plasty and abdominal wall reconstruction.

This technique has proven to be feasible in surgical practice, without significantly increasing wound infection rates, while also lowering the occurrence of post-operative incisional hernias. These findings suggest that mesh-sutured repair is a safe and effective alternative to traditional mass closure method. However, few disadvantage for mesh sutured repair were: 1) Attaching the introducing needle to the mesh strip can be awkward, however this have been overcomed by duramesh. 2) Increased repair site bulk and increased gliding resistance. 3) Increased occurrence of seroma and hematoma.

Conclusion

Mesh-sutured repair has shown promising results in reducing the incidence of wound infections and dehiscence compared to conventional mass closure for securing the abdominal wall in midline laparotomy patients. This technique has proven to be feasible in surgical practice, with no significant increase in wound infection rates and a lower occurrence of early post-operative incisional hernia, suggesting it is a safe alternative to traditional mass closure methods.

A larger sample size is necessary to determine the exact incidence of incisional hernia would be required for a more accurate assessment of its occurrence.

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