



## RESEARCH ARTICLE

## Comparative Study of Suture-Anchored Bi-Layer Mosquito Net Mesh with Standard Lichtenstein's Prolene Mesh Inguinal Hernioplasty

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### ABSTRACT

**Background:** Tension-free mesh hernioplasty is the standard of care for inguinal hernia repair, but the cost of commercial polypropylene mesh limits access in resource-poor settings. Sterilized mosquito-net mesh has been proposed as a low-cost alternative. Objective: To compare a self-fabricated, suture-anchored bi-layer mosquito-net mesh with standard Lichtenstein polypropylene mesh hernioplasty.

**Methods:** A prospective comparative study of 60 adult patients with primary unilateral inguinal hernia was conducted, with alternate allocation to mosquito-net mesh (Group A, n=30) or standard Lichtenstein mesh (Group B, n=30). Operating time, hospital stay, postoperative pain (VAS), wound healing, surgical site infection, seroma/hematoma, recurrence at 6 months, return to daily activity, and procedure cost were compared. Results: The groups were comparable at baseline for age, sex, symptom duration, hernia laterality, and anesthesia type. Operating time was significantly shorter with mosquito-net mesh ( $56.70 \pm 9.49$  vs.  $65.40 \pm 10.51$  minutes,  $p=0.001$ ), and cost was approximately 71% lower (Rs.  $2558.83 \pm 348.37$  vs. Rs.  $8758.43 \pm 896.42$ ,  $p<0.001$ ). No significant difference was found in postoperative pain at any time point, hospital stay, infection, seroma/hematoma, recurrence, or return to activity. A borderline, non-significant trend toward delayed wound healing was observed with mosquito-net mesh (23.3% vs. 3.3%,  $p=0.052$ ). Conclusion: Suture-anchored bi-layer mosquito-net mesh offers a safe, effective, and markedly cheaper alternative to standard polypropylene mesh for inguinal hernioplasty, with a shorter operating time and comparable complication and recurrence profile, though the wound-healing trend merits confirmation in larger trials.

**Keywords:** Inguinal hernia, mosquito net mesh, Lichtenstein repair, low-cost mesh, hernioplasty, cost-effectiveness

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### INTRODUCTION

Hernia is defined as the abnormal protrusion of a viscus, or part of a viscus, through the wall of the cavity that normally contains it. Inguinal hernia is the most common type, occurring when abdominal contents protrude through a weakness in the lower abdominal wall as a result of congenital predisposition, aging, raised intra-abdominal pressure, or connective-tissue weakness.

Edorado Bassini's late-nineteenth-century description of hernia repair, with its markedly reduced recurrence rate, is regarded as the foundation of modern herniorrhaphy [1]. Repair techniques have since evolved from pure-tissue repairs (Shouldice, Cooper ligament repair, Lichtenstein's original pure-tissue technique) through darn repairs and mixed tissue-prosthesis repairs to the pure prosthetic, tension-free approach popularized by Lichtenstein, in which the entire myopectineal defect is reinforced with a sheet of mesh rather than approximating tissues under tension. This concept, combined with the bilayer Prolene Hernia System (PHS) introduced in 1998, established mesh hernioplasty as the worldwide standard, with recurrence rates of 1–2%, low complication rates, and early return to normal activity [2].

Commercial polypropylene mesh, however, remains expensive relative to average incomes in low- and middle-income countries: a  $15 \times 7.5$  cm mesh costs approximately Rs. 1,200, a  $15 \times 15$  cm mesh approximately Rs. 3,000, and a  $30 \times 30$  cm mesh up to Rs. 14,000–15,000 in India. Good-quality mosquito net, by contrast, is manufactured from a similar copolymer of polypropylene and polyethylene, can be sterilized (including by ethylene oxide), and costs a fraction of a rupee per equivalent piece of cloth — for example, approximately 45 paise for a  $15 \times 7.5$  cm piece. This cost differential has motivated a body of work exploring sterilized mosquito-net mesh as a low-cost substitute for commercial mesh in hernia repair.

Several studies support the safety and efficacy of this approach. Ahmad et al. [3], in a systematic review and meta-analysis of nine studies (1085 patients), reported an overall complication rate of 9.3% for mosquito-net mesh hernioplasty, with no significant difference from commercial synthetic mesh. Jain et al. [4], in a prospective randomized double-blind trial of 170 patients in north-western India, found postoperative complication rates comparable between polyester mosquito-net mesh and polypropylene mesh,

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with significantly reduced cost in the mosquito-net group. Similar findings of comparable complication and recurrence rates with substantial cost savings (40–95% of standard mesh cost) have been reported by Shahi et al. [5], Wani et al. [6], Goswami [2], Clarke et al. (in Ghana) [7], and Darokar et al. [8]. Separately, studies of the bilayer Prolene Hernia System compared with the standard Lichtenstein onlay technique (Vironen et al. [9], Kingsnorth et al. [10], Awad et al. [11], Santosh et al. [12]) have reported shorter operating times and, in some series, lower complication and recurrence rates with the bilayer configuration.

Despite this literature, there is a paucity of published data — in India and worldwide — specifically evaluating a suture-anchored bi-layer mosquito-net mesh construct (combining the low cost of mosquito-net material with the bilayer PHS-type design) against standard Lichtenstein polypropylene mesh repair. This study was undertaken to address that gap, comparing wound healing, infection rate, postoperative pain, recurrence, and cost-efficiency between the two techniques.

## MATERIALS AND METHODS

This prospective comparative study was conducted in the Department of General Surgery, SGT Medical College, Hospital and Research Institute, Budhera, Gurugram, over an 18-month period following institutional ethics committee approval. Sixty patients aged 10 years or older, of either sex, with a primary inguinal hernia and able to give informed consent, were enrolled by convenience sampling and allocated alternately, in order of presentation, to Group A (self-fabricated suture-anchored bi-layer mosquito-net mesh, n=30) or Group B (standard Lichtenstein polypropylene mesh, n=30). Patients with recurrent or complicated (obstructed/strangulated) hernias, age under 10 years, or those not consenting were excluded. Alternate (non-random) allocation was used because of logistical constraints in mesh preparation and theatre scheduling, and is acknowledged as a limitation of this design.

All patients underwent standard preoperative work-up and were monitored postoperatively for temperature, pulse, pain, and complete blood count as indicated. Patients were followed up at 24 hours, 7 days, 1 month, and 6 months. The parameters compared between groups were wound healing, infection rate, postoperative pain (0–10 Visual Analogue Scale), recurrence, and cost efficiency, in addition to operating time, hospital stay, and return to daily activity. Data were entered in Microsoft Excel and analyzed in SPSS v28. Continuous variables were expressed as mean  $\pm$  standard deviation and compared using the independent-samples t-test; categorical variables were expressed as frequency (percentage) and compared using the Chi-square test or Fisher's Exact test where an expected cell count was below 5. A p-value  $< 0.05$  was considered statistically significant.

## RESULTS

Sixty patients were studied, 30 per group. The groups were comparable at baseline: mean age was  $45.43 \pm 14.99$  years in Group A and  $48.43 \pm 17.53$  years in Group B ( $p=0.479$ ); the cohort comprised 57 male and 3 female patients, with no significant difference in sex distribution between groups ( $p=1.000$ ). Duration of symptoms ( $10.67 \pm 7.09$  vs.  $12.37 \pm 7.14$  months,  $p=0.358$ ), hernia laterality (including 2 bilateral cases per group,  $p=0.849$ ), and type of anesthesia ( $p=0.492$ ) also did not differ significantly.

Operating time was significantly shorter with mosquito-net mesh ( $56.70 \pm 9.49$  minutes) than with Lichtenstein mesh ( $65.40 \pm 10.51$  minutes;  $p=0.001$ ). Hospital stay did not differ significantly ( $2.47 \pm 0.57$  vs.

Table 1

| Parameter                          | Group A (n=30)    | Group B (n=30)    | p-value |
|------------------------------------|-------------------|-------------------|---------|
| Age (years), mean $\pm$ SD         | 45.43 $\pm$ 14.99 | 48.43 $\pm$ 17.53 | 0.479   |
| Sex (M:F)                          | 28:2              | 29:1              | 1.000   |
| Duration of symptoms (months)      | 10.67 $\pm$ 7.09  | 12.37 $\pm$ 7.14  | 0.358   |
| Hernia side (Right:Left:Bilateral) | 18:10:2           | 20:8:2            | 0.849   |
| Anesthesia (Spinal:General)        | 30:0              | 28:2              | 0.492   |

Table 2

| Outcome                   | Group A (n=30)       | Group B (n=30)       | Test        | p-value |
|---------------------------|----------------------|----------------------|-------------|---------|
| Operating time (min)      | 56.70 $\pm$ 9.49     | 65.40 $\pm$ 10.51    | t = -3.364  | 0.001*  |
| Hospital stay (days)      | 2.47 $\pm$ 0.57      | 2.63 $\pm$ 0.72      | t = -0.995  | 0.324   |
| VAS pain, 24h             | 4.90 $\pm$ 1.58      | 5.13 $\pm$ 1.48      | t = -0.590  | 0.558   |
| VAS pain, 7d              | 2.40 $\pm$ 1.16      | 2.37 $\pm$ 1.13      | t = 0.113   | 0.911   |
| VAS pain, 1m              | 0.87 $\pm$ 0.86      | 0.73 $\pm$ 0.78      | t = 0.627   | 0.533   |
| Wound healing (delayed)   | 7 (23.3%)            | 1 (3.3%)             | Fisher      | 0.052   |
| Surgical site infection   | 3 (10.0%)            | 1 (3.3%)             | Fisher      | 0.612   |
| Seroma / hematoma         | 0 (0.0%)             | 4 (13.3%)            | Fisher      | 0.112   |
| Recurrence (6 mo)         | 1 (3.3%)             | 0 (0.0%)             | Fisher      | 1.000   |
| Return to activity (days) | 13.10 $\pm$ 4.11     | 13.80 $\pm$ 4.05     | t = -0.664  | 0.509   |
| Cost (INR)                | 2558.83 $\pm$ 348.37 | 8758.43 $\pm$ 896.42 | t = -35.308 | <0.001* |

\*Statistically significant ( $p < 0.05$ ).

2.63  $\pm$  0.72 days;  $p = 0.324$ ). Postoperative pain, assessed by VAS, showed no significant difference at 24 hours (4.90  $\pm$  1.58 vs. 5.13  $\pm$  1.48;  $p = 0.558$ ), 7 days (2.40  $\pm$  1.16 vs. 2.37  $\pm$  1.13;  $p = 0.911$ ), or 1 month (0.87  $\pm$  0.86 vs. 0.73  $\pm$  0.78;  $p = 0.533$ ). Return to daily activity was similar between groups (13.10  $\pm$  4.11 vs. 13.80  $\pm$  4.05 days;  $p = 0.509$ ).

Wound healing showed a borderline, non-significant trend toward more delayed healing with mosquito-net mesh (7/30, 23.3% vs. 1/30, 3.3%;  $p = 0.052$ ). Surgical site infection (10.0% vs. 3.3%,  $p = 0.612$ ), seroma/hematoma (0.0% vs. 13.3%,  $p = 0.112$ ), and recurrence at 6 months (3.3% vs. 0.0%,  $p = 1.000$ ) did not differ significantly between groups. Cost of the procedure was significantly lower with mosquito-net mesh (Rs. 2558.83  $\pm$  348.37 vs. Rs. 8758.43  $\pm$  896.42;  $p < 0.001$ ), a reduction of approximately 71%.

## DISCUSSION

This study found that a self-fabricated, suture-anchored bi-layer mosquito-net mesh achieved outcomes comparable to

standard Lichtenstein polypropylene mesh for postoperative pain, hospital stay, infection, recurrence, and return to activity, while offering a significantly shorter operating time and a markedly lower cost. These findings are broadly consistent with the wider literature on improvised low-cost mesh. Ahmad et al.'s [3] meta-analysis of 1085 patients found no significant difference in overall complication rates between mosquito-net and commercial mesh, and Jain et al.'s [4] randomized trial similarly found comparable postoperative complications with significant cost reduction using polyester mosquito-net mesh. Wani et al. [6] and Goswami [2] likewise concluded that indigenous mosquito-net mesh, having material properties similar to imported mesh, can be used safely for tension-free inguinal hernia repair, and Darokar et al. [8] reported a 40–50% cost benefit with ETO-sterilized mosquito-net mesh with complication rates similar to polypropylene mesh.

The significantly shorter operating time observed with mosquito-net mesh in this study parallels findings from

trials of the bilayer Prolene Hernia System design more generally: Vironen et al. [9] and Kingsnorth et al. [10] both reported significantly shorter operating times with a bilayer mesh construct compared with the standard Lichtenstein onlay patch. This suggests the operative-time advantage seen here may relate more to the bilayer, suture-anchored construction than to the mosquito-net material itself, and this distinction would be worth examining in future work that varies material and mesh geometry independently.

Pain scores did not differ significantly between groups at any follow-up point, in keeping with Goswami's [2] finding of no significant difference in postoperative pain severity between mosquito-net and polypropylene mesh, and with Santosh et al.'s [12] observation that pain differences between bilayer and onlay repairs, where present, were not statistically significant. The borderline trend toward delayed wound healing with mosquito-net mesh in the present study ( $p=0.052$ ) has not been consistently reported elsewhere and, given the modest sample size, should be interpreted cautiously; it may reflect a true but small effect, a chance finding, or handling factors specific to a self-fabricated mesh, and warrants confirmation in a larger series.

Cost remained the most robust and clinically significant finding, with mosquito-net mesh costing approximately 71% less than standard Lichtenstein mesh in this cohort. This is consistent with the substantial cost savings reported across the mosquito-net mesh literature, ranging from 40% (Darokar et al. [8]) to as much as 95% (Felix et al. [5]) of standard mesh cost, and reinforces the case for mosquito-net mesh as a viable option where commercial mesh affordability is a barrier to standard-of-care hernia repair.

This study has several limitations. Allocation was by alternate assignment rather than formal randomization, which may introduce selection bias. The sample size (30 per group) limits power to detect differences in low-frequency outcomes such as recurrence and infection, and follow-up was limited to 6 months, insufficient to capture late recurrences. The study was conducted at a single center, which may limit generalizability, and variables such as body mass index, hernia type (indirect/direct), and patient satisfaction score, though of interest, were not captured in the final dataset.

## CONCLUSION

In this prospective comparative study of 60 patients with primary unilateral inguinal hernia, suture-anchored bi-layer mosquito-net mesh hernioplasty was associated with a significantly shorter operating time and a substantially

and significantly lower cost (approximately 71% less) than standard Lichtenstein polypropylene mesh, with no significant difference in postoperative pain, hospital stay, infection, recurrence at 6 months, or return to daily activity. A non-significant trend toward more delayed wound healing with mosquito-net mesh warrants further evaluation in larger, adequately powered, ideally randomized trials with longer follow-up. These findings support suture-anchored bi-layer mosquito-net mesh as a safe, effective, and markedly more affordable alternative to standard polypropylene mesh for inguinal hernioplasty, particularly relevant in resource-limited settings.

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