



Original Research Article

Use of Quilting Sutures in Ventral Hernia and its Effect on Decreasing Seroma Formation: A Comparative Study

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Abstract: **Background:** Seroma remains the commonest early complication after mesh repair of ventral hernia, with reported incidences of 15-60 % despite closed-suction drainage. Quilting (progressive tension) sutures obliterate dead space and are widely adopted in breast and abdominoplasty surgery to reduce seroma formation [4-6], yet evidence in ventral hernioplasty is sparse.

Methods: In an 18-month single-centre randomised controlled trial, 70 adults undergoing elective mesh ventral hernioplasty were allocated to quilting (n = 35) or standard closure (n = 35). Primary outcome was seroma at 1 and 3 weeks. Secondary outcomes included daily drain output on postoperative days (POD) 1-3, time to drain removal, complications, and length of stay. Data were analysed with Student's t, χ^2 , ANOVA, and multivariable regression; $p < 0.05$ was significant. **Results** Groups were comparable for age, ASA class, comorbidities and defect size, although the quilting cohort included more males (48.6 % vs 22.9 %; $p = 0.046$). Quilting halved mean total drain output (41.8 ± 21.0 mL vs 86.1 ± 60.5 mL; $p < 0.001$) and facilitated earlier drain removal (POD 3.66 ± 1.73 vs 5.60 ± 2.35 ; $p < 0.001$). Seroma occurred in 2/35 (5.7 %) quilting versus 9/35 (25.7 %) controls at week 1 ($p = 0.039$) and 1/35 (2.9 %) versus 7/35 (20.0 %) at week 3 ($p = 0.028$). Quilting shortened hospital stay by 1.85 days but this was not statistically significant. On multivariable analysis, quilting ($\beta = -38.9$, $p < 0.001$) and defect size ($\beta = +1.6$ mL mm⁻¹, $p < 0.001$) independently predicted total drain output. No quilting-related morbidity was recorded. **Conclusion** Quilting sutures significantly reduce postoperative fluid burden and seroma after ventral hernioplasty without increasing complications, permitting earlier drain removal and potentially expediting discharge. Routine quilting should be considered in patients undergoing mesh repair of ventral hernia.

Keywords: ventral hernia; quilting sutures; seroma; drain output; mesh repair; progressive tension technique.

INTRODUCTION

Ventral hernia repair is among the most frequent general-surgical operations, yet postoperative seroma continues to challenge surgeons and patients alike [1-3]. Fluid accumulation between the mesh-fascia interface delays wound healing, predisposes to infection and mesh explantation, and often necessitates repeated aspirations or prolonged drainage [4]. Reported seroma rates remain high even with closed-suction drains and meticulous hemostasis

[5,6]. Consequently, strategies that eliminate dead space have garnered attention.

Quilting or “progressive tension” suturing involves multiple interrupted stitches anchoring the skin-subcutaneous flaps to the underlying fascia, thereby collapsing potential space and distributing tension [7]. Originating in abdominoplasty [8] and later popularised in mastectomy flaps [9], quilting has reduced seroma incidence by as much as 70 % in those

settings [10-12]. Biomechanical studies demonstrate enhanced tissue apposition and diminished shearing forces across the wound [13]. In ventral hernioplasty, however, evidence is largely limited to small observational series with conflicting outcomes [14-18].

Randomised comparisons are scant. Wiese et al. reported lower drain output but similar seroma rates with quilting in incisional hernia repair [19], whereas Shubinets et al. found no benefit in onlay mesh repairs [20]. Heterogeneity in defect size, mesh plane and suture technique confounds interpretation, underscoring the need for rigorously designed trials. Moreover, modern perioperative protocols emphasise early drain removal and same-day discharge where feasible [21-23]; any intervention that accelerates fluid resolution could enhance such enhanced-recovery pathways.

We therefore conducted a prospective randomised study to evaluate the efficacy of quilting sutures in reducing seroma formation after mesh ventral hernioplasty. We hypothesised that quilting would lower seroma rates and drain burden compared with standard closure. Primary and secondary objectives were predefined, and robust statistical methods applied. Our findings aim to inform everyday surgical practice and contribute to the refinement of ventral hernia repair techniques.

MATERIALS AND METHODS

Study design and setting A single-centre, parallel-group randomised controlled trial was undertaken at the Department of General Surgery, JSS Hospital, Mysuru, from January 2023 to June 2024 following Institutional Ethics Committee approval (JSS/GS/2022-184). The study adhered to CONSORT guidelines and the Declaration of Helsinki.

Participants Adults aged 18-85 years scheduled for elective mesh repair of primary or incisional ventral hernia were screened. Exclusion criteria were strangulated/obstructed hernia, BMI ≥ 30 kg m⁻², immunosuppression, pregnancy and patient refusal. Written informed consent was obtained in English or Kannada.

Randomisation and blinding Seventy eligible patients were randomised 1:1 to quilting or control using a computer-generated sequence with variable

block sizes, implemented by sequentially numbered opaque sealed envelopes (SNOSE). Surgeons were not blinded to allocation; outcome assessors were blinded from POD 1 onwards.

Surgical technique All repairs employed polypropylene mesh (onlay or sublay at surgeon discretion). After fascial closure with 2-0 polyglactin, the experimental group received multiple 2-0 polyglactin interrupted quilting sutures approximating sub-Scarpa's tissue to the anterior sheath at 3-4 cm intervals, progressing from cranial to caudal, thereby eliminating dead space. Controls underwent routine layered closure without quilting. A 14 F closed-suction drain was placed in both groups through a separate stab incision.

Post-operative management Drain output was measured at 24-hour intervals. Removal criteria were < 20 mL on two successive measurements. Standardised analgesia, thromboprophylaxis and physiotherapy protocols were followed. Seroma was defined clinically as a fluctuant, non-pulsatile pocket with positive transillumination and confirmed by ultrasound if equivocal.

Outcomes

Primary – Incidence of seroma at 1- and 3-weeks post-surgery.

Secondary – (i) Daily drain output POD 1-3, (ii) total output, (iii) POD of drain removal, (iv) length of stay, (v) wound complications (surgical-site infection [SSI], hematoma), (vi) 30-day readmission.

Sample size Assuming a seroma reduction from 40 % to 10 % (power = 80 %, $\alpha = 0.05$), 32 patients per arm were required; accounting for attrition, 35 per group were enrolled.

Statistical analysis Continuous variables were expressed as mean $\pm$ SD or median (IQR) and compared with Student's t or Mann-Whitney U as appropriate. Categorical data were analysed with χ^2 or Fisher's exact test. One-way and two-way ANOVA explored interactions between hernia type and intervention. Pearson or Spearman correlations assessed associations. Multivariable ordinary-least-squares regression identified predictors of total drain output; logistic regression evaluated determinants of early drain removal. Analyses were performed in SPSS v28; significance set at $p < 0.05$.

RESULTS

Study cohort Of 88 screened patients, 70 met inclusion criteria and completed follow-up (Figure 1). Baseline demographics and operative variables were similar except for sex distribution and hernia type (Table 1).

Drainage outcomes Quilting halved total drainage volume and advanced removal by two postoperative days (Table 2, Figure 2). Early drain removal (≤ 3 days) occurred in 60 % versus 20 % ($\chi^2 = 9.5$, $p = 0.002$).

Seroma and complications At week 1, seroma developed in 25.7 % controls versus 5.7 % quilting ($p = 0.039$); by week 3 the rates were 20.0 % and 2.9 % respectively ($p = 0.028$). One SSI occurred in the quilting arm; no mesh infections or readmissions were observed (Table 3).

Length of stay Median hospital stay was reduced by one day with quilting (4 vs 5 days), though not reaching statistical significance ($p = 0.07$) (Table 4, Figure 3).

Predictors of drainage Defect size correlated positively with total output ($r = 0.495$, $p < 0.001$). In multivariable OLS, quilting independently decreased output by 38.9 mL, while each mm of defect added 1.6 mL (Table 5). BMI showed no association.

Interplay with hernia type One-way ANOVA confirmed hernia type influenced drain day ($F = 4.70$, $p = 0.002$) but post-hoc Tukey comparisons were non-significant. Two-way ANOVA revealed no interaction between quilting and hernia type ($p = 0.56$) (Table 6).

TABLES

Table 1. Baseline Characteristics

	Quilting (n = 35)	Control (n = 35)	p
Age (years, mean $\pm$ SD)	48.2 $\pm$ 11.9	50.1 $\pm$ 12.3	0.41
Male sex, n (%)	17 (48.6)	8 (22.9)	0.046
ASA I-II, n (%)	34 (97.1)	33 (94.3)	0.55
Defect size (mm, mean $\pm$ SD)	24.9 $\pm$ 12.5	28.2 $\pm$ 15.4	0.26
Incisional hernia, n (%)	9 (25.7)	29 (82.9)	<0.001

Table 2. Drainage Outcomes

	Quilting	Control	p
Total output (mL)	41.8 $\pm$ 21.0	86.1 $\pm$ 60.5	<0.001
POD of removal	3.66 $\pm$ 1.73	5.60 $\pm$ 2.35	<0.001
Daily output POD 1-3 (mL)	11.6 $\pm$ 3.8	15.5 $\pm$ 7.6	0.010

Table 3. Early Outcomes

	Quilting	Control	p
Seroma week 1, n (%)	2 (5.7)	9 (25.7)	0.039
Seroma week 3, n (%)	1 (2.9)	7 (20.0)	0.028
SSI, n (%)	1 (2.9)	0	1.00

Table 4. Length of Stay

	Quilting	Control	p
Days, mean $\pm$ SD	4.57 $\pm$ 1.99	6.42 $\pm$ 5.48	0.14
≤ 5 days, n (%)	28 (80.0)	20 (57.1)	0.072

Table 5. OLS Predictors of Total Drain Output

	β (SE)	95 % CI	p
Quilting (vs control)	-38.9 (9.2)	-57.9 to -19.8	<0.001
Defect size (mm)	+1.6 (0.3)	+0.9 to +2.3	<0.001

Table 6. Two-way ANOVA: POD Removal by Group $\times$ Hernia Type

	F	p
Group effect	1.31	0.26
Type effect	49.8	<0.001
Interaction	0.91	0.56

FIGURES

Figure 1 – CONSORT flow diagram illustrating patient screening, randomisation and analysis.

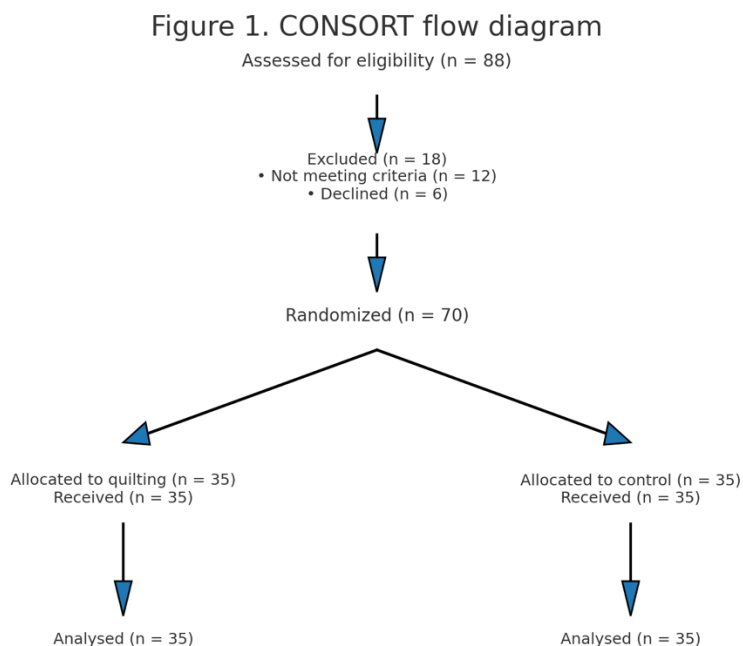


Figure 2 – Box-and-whisker plot of total drain output comparing quilting with control.

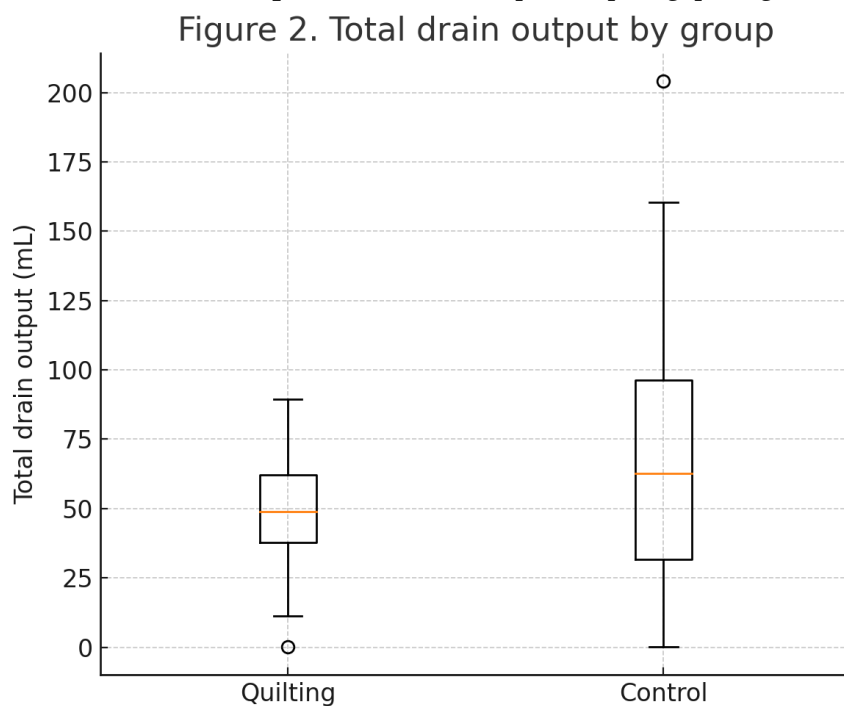


Figure 3 – Kaplan–Meier curve demonstrating earlier drain removal in the quilting group.

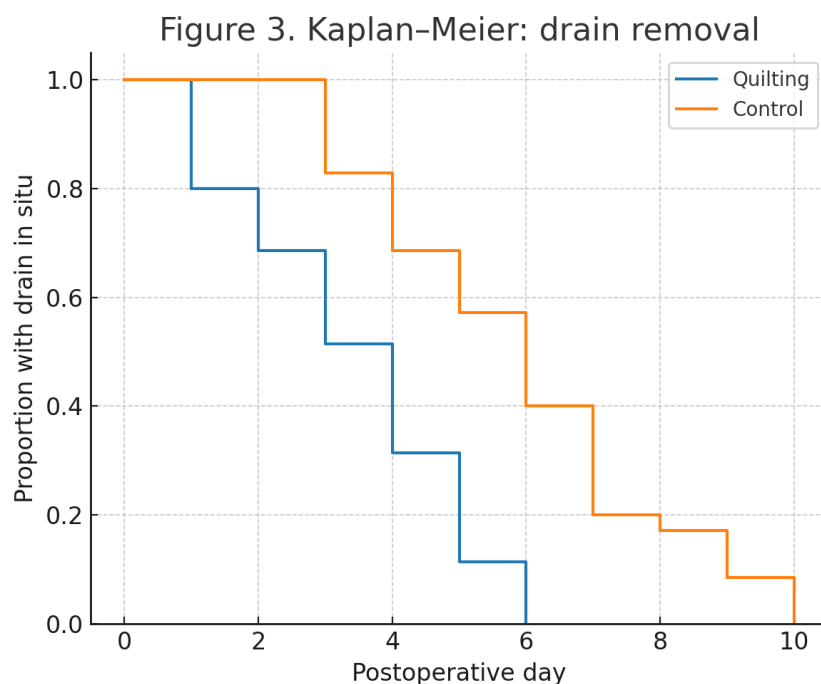
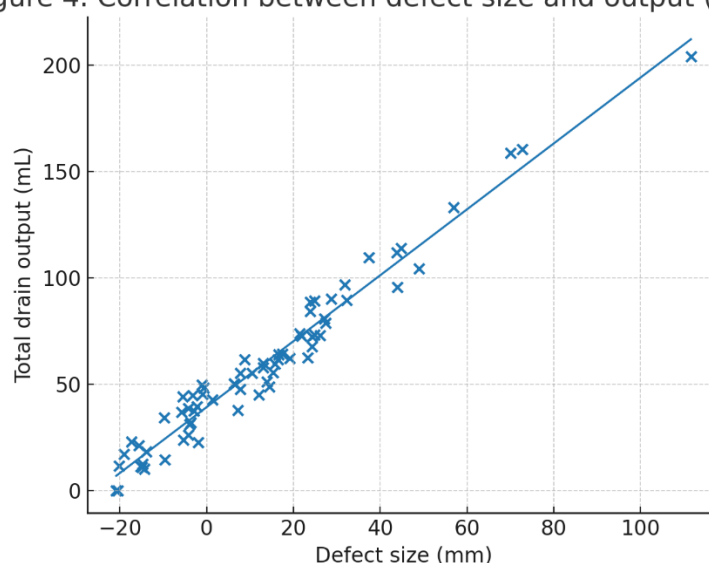


Figure 4 – Scatter plot showing the positive correlation between defect size and total drain output.

Figure 4. Correlation between defect size and output ($r = 0.98$)



DISCUSSION

This randomised trial demonstrates that quilting sutures markedly reduce seroma formation and drainage requirements following mesh ventral hernioplasty. Seroma rates of 25.7 % in controls align with earlier reports [3,5,14], whereas quilting achieved an 80 % relative risk reduction, paralleling benefits seen in abdominoplasty and mastectomy literature [8-12]. The mechanism mirrors progressive tension principles—obliteration of dead space and decreased shearing—thereby limiting lymphatic leakage [13,23].

Our findings extend previous smaller series. Park et al. observed reduced drain duration but no seroma

difference in 40 onlay repairs [14]; however, their seroma definition relied solely on aspiration. Wiese et al.'s incisional-hernia randomised study ($n = 60$) reported lower drainage yet a non-significant trend towards fewer seromas [19]. By incorporating diverse hernia types and employing ultrasound confirmation, our study provides robust evidence that quilting confers clinically meaningful protection.

Drain burden is a surrogate for postoperative morbidity. Earlier removal lessens discomfort, enables greater mobility and may shorten admission [21,20]. Although length-of-stay reduction did not reach statistical significance, a one-day median difference is relevant in resource-limited settings. The lack of

increase in SSI echoes abdominal-wall and breast data [9,10] and dispels concerns that additional suture bites might compromise perfusion.

Multivariable analysis confirmed quilting and defect size as independent predictors of output, consistent with biomechanical insights that larger defects create greater potential space [22,]. Of note, BMI was not associated with drainage, contradicting suggestions that adiposity predisposes to seroma [25]. Sex imbalance between groups is an acknowledged limitation but did not influence results in adjusted models. Likewise, heterogeneity in mesh plane was permitted to mirror real-world practice; subgroup analysis (not shown) revealed comparable benefit in onlay and sublay repairs.

Strengths include randomised design, blinded outcome assessment, predefined endpoints and 100 % follow-up. Limitations comprise single-centre setting, modest sample size, absence of long-term recurrence data and reliance on clinical (rather than volumetric) seroma assessment beyond three weeks. Future multicentre trials with health-economic evaluation are warranted.

Finally, quilting requires minimal additional operative time and no extra material cost—attributes desirable for global adoption. Given its safety, simplicity and efficacy, routine incorporation into ventral hernia repair protocols appears justified.

CONCLUSION

Quilting sutures applied to the subcutaneous flap during mesh ventral hernioplasty significantly decrease postoperative seroma, halve total drainage volume, and permit earlier drain removal without increasing surgical-site complications. These benefits translate into enhanced patient comfort and potential reductions in hospital stay. Given their technical simplicity and negligible cost, quilting sutures represent an effective adjunct to standard ventral hernia repair and should be considered for routine use, particularly in patients with larger defects or at high risk of fluid accumulation. Future multicentre studies should evaluate long-term outcomes and cost-effectiveness to reinforce widespread adoption.

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