The Search for an Ideal Method of Abdominal Fascial Closure
A Meta-Analysis

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Background and Objective
The ideal suture for abdominal fascial closure has yet to be determined. Surgical practice continues to rely largely on tradition rather than high-quality level I evidence. The authors conducted a systematic review and meta-analysis of randomized controlled trials to determine which suture material and technique reduces the odds of incisional hernia.

Methods
MEDLINE and Cochrane Library databases were searched for articles in English published from 1966 to 1998 using the keywords “suture,” “abdomen/surgery,” and “randomized controlled trials.” Randomized controlled trials, trials of adult patients, and trials with a Jadad Quality Score of more than 3, comparing suture materials, technique, or both, were included. Two independent reviewers critically appraised study quality and extracted data. The reviewers were masked to the study site, authors, journal, and date to minimize bias. The primary outcome was postoperative incisional hernia. Secondary outcomes included wound dehiscence, infection, wound pain, and suture sinus formation.

Results
The occurrence of incisional hernia was significantly lower when nonabsorbable sutures were used. Suture technique favored nonabsorbable continuous closure. Suture sinuses and wound pain were significantly lower when absorbable sutures were used. There were no differences in the incidence of wound dehiscence or wound infection with respect to suture material or method of closure. Subgroup analyses of individual sutures showed no significant difference in incisional hernia rates between polydioxanone and polypropylene. Polyglactin showed an increased wound failure rate.

Conclusions
Abdominal fascial closure with a continuous nonabsorbable suture had a significantly lower rate of incisional hernia. The ideal suture is nonabsorbable, and the ideal technique is continuous.
METHODS

Literature Search

Computer searches of MEDLINE for the years 1966 to 1998 and the Cochrane Library (1998, vol. IV) database were performed using the keywords “abdominal surgery,” “sutures,” and “randomized clinical trials.” A manual search of the bibliographies of the identified papers was carried out to identify any additional trials. Finally, expert academic surgeons in Ontario, Canada, were asked whether they knew about any important unpublished data.

Inclusion and Exclusion Criteria

All randomized clinical trials comparing at least two different suture materials or techniques for abdominal fascial closure were included. Trials using vertical midline, paramedian, oblique, or transverse incisions were included. Other criteria included patients older than 15 years and a Jadad Quality Score of more than 3. Gynecologic surgery trials and trials of children younger than 15 years were excluded. Trials comparing two sutures of the same category (i.e., absorbable vs. absorbable) and with the same technique were excluded because relevant comparisons could not be applied to our clinical question.

Data Extraction

Two reviewers masked to journal, authors, and publication dates performed independent data extraction. Study quality was assessed using the Jadad Quality Scale. Discrepancies were resolved by discussion and consensus.

Analyses

The primary outcome was postoperative incisional hernia. Definitions of incisional hernia, wound dehiscence, wound infection, wound pain, and suture sinuses were accepted as reported. Based on a priori criteria, the primary comparison was nonabsorbable versus absorbable sutures and continuous versus interrupted techniques. Further comparisons included continuous nonabsorbable versus continuous absorbable and interrupted nonabsorbable versus interrupted absorbable. Studies were assessed for homogeneity both qualitatively and quantitatively. Statistical homogeneity of the study data was confirmed using the chi-square test of heterogeneity. All analyses were conducted using Review Manager 3.1 (Software Update, the Cochrane Collaboration, Oxford, UK).

The Mantel-Haenszel fixed-effects method was used to summarize dichotomous outcomes of pooled studies. The odds ratio (OR) was used as the summary statistic, with 95% confidence intervals (CI). Absolute risk reduction (ARR), relative risk reduction (RRR), and number needed to treat (NNT) were also calculated. Sensitivity analyses were performed by serially omitting each trial and omitting trials with follow-up periods of less than 1 year. Comparisons of trials using only midline incisions were also carried out. A reanalysis using the random-effects model was also performed to assess the robustness of the results.

Subgroup analyses of individual suture types (i.e., polydioxanone [PDS] vs. polypropylene [Prolene]) were also conducted.

RESULTS

Thirty-two studies that evaluated suture material or technique for abdominal fascial closure were identified. Nineteen trials were excluded for the following reasons: poor quality, gynecologic surgery only, pediatric trial, nonrandomized trials, and comparison exclusions (i.e., studies assessing absorbable vs. absorbable sutures). Study characteristics are displayed in Table 1. No unpublished data were identified. Data extraction revealed no interobserver variation, with 100% agreement between the two reviewers for all outcomes.

Nonabsorbable Versus Absorbable

The clinical homogeneity of included trials was confirmed, with the possible exception of one trial that compared polydioxanone and polypropylene in morbidly obese patients. The test for heterogeneity was not significant (chi-square = 21.16, P > .05), indicating that the studies were homogenous and statistical combination was appropriate. The pooled OR for all outcomes comparing nonabsorbable versus absorbable sutures (13 studies) are summarized in Figure 1. An OR less than 1 favors nonabsorbable and an OR more than 1 favors absorbable. For the primary outcome, incisional hernia, the OR was 0.68 (95% CI 0.52–0.87; Fig. 2). This means that the odds of incisional hernia were significantly lower in the nonabsorbable group, by 32%. The calculated cumulative incidence of incisional hernias across all studies was 5%.

The OR of wound infection in the nonabsorbable group versus the absorbable group was 0.90 (95% CI 0.73–1.12) and the OR of wound dehiscence was 1.25 (95% CI 0.78–2.01). Neither was statistically significant. Suture sinuses and wound pain were significantly more frequent in the nonabsorbable group (OR 2.18, 95% CI 1.48–3.22, and OR 2.05, 95% CI 1.52–2.77, respectively).

Continuous Versus Interrupted

In the six trials comparing continuous versus interrupted technique (irrespective of suture type), the OR for incisional hernia was significant, favoring continuous closure (OR 0.73, 95% CI 0.55–0.99; Fig. 3). There was no statistical
difference in the rate of wound infection or wound dehis-
cence.

Continuous Nonabsorbable Versus Continuous Absorbable

In the nine trials comparing continuous nonabsorbable versus continuous absorbable suture technique (Fig. 4), incisional hernias were significantly less common in the continuous nonabsorbable group (OR 0.61, 95% CI 0.46–0.80; Table 2).

Interrupted Nonabsorbable Versus Interrupted Absorbable

There was no significant difference in incisional hernia rates between these two trials.

Sensitivity Analyses

A reanalysis of only the trials using vertical midline incisions (omitting trials using paramedian, transverse incisions) found that the rate of incisional hernia was still significantly lower in the nonabsorbable group (OR 0.64, 95% CI 0.48–0.86). Further sensitivity analyses included...
reanalyzing the data using the random-effects model, including poor-quality trials, including gynecologic trials, excluding small trials, excluding the obesity trial, and omitting all trials with less than 1 year of follow-up. These analyses did not substantially change the summary statistic.

Subgroup Analyses

The subgroup analyses are summarized in Table 3. Polydioxanone (PDS) compared with polypropylene (Prolene) did not have an increased risk of incisional hernia (OR 1.53, CI 0.50–4.72). In contrast, use of polyglactin (Vicryl) compared with nonabsorbable sutures resulted in an increased rate of wound failure. Nylon compared with polyglycolic acid (Dexon) demonstrated a lower rate of incisional hernia (OR 0.30, 95% CI 0.13–0.68). There was no statistical difference between polyglycolic acid (Dexon) and polypropylene (Prolene).

DISCUSSION

Incisional hernias contribute significantly to the complication rate and once repaired have a high recurrence rate. Wound dehiscence, infection, pain, and suture sinus formation are also important contributors to postoperative complications.

A meta-analysis, when it includes a series of satisfactory trials and when it is rigorously performed, provides high-quality level I evidence. The recent meta-analysis by Weiland et al failed to meet most of the methodologic requirements supported by a recent consensus. The search strategy was less than explicit, nonrandomized trials, and poor-quality studies were included in their analyses, decreasing the validity of their results. The quality of the randomized controlled trials included in their analysis was not assessed. Interpretation of their results was difficult because individual study characteristics were not described. There was an
absence of clinically useful outcome measures; OR, NNT, and RRR figures were not reported. The method of combining probability values used in their report has two important drawbacks: it does not weigh the studies according to their uncertainties or sample sizes, and it does not give estimates of the magnitude of the effects. For these reasons, combining probability values is seldom used as a metaanalytic tool.42

Poor-quality surgical trials appear to be common.43 A recent meta-analysis of drainage of colorectal anastomoses also reported overall poor quality of the surgical trials included in their analyses.44 The Jadad Quality Scale8 is the only validated instrument available to assess the quality of randomized controlled trials. Incorporation of poor-quality trials into a meta-analysis has been shown to increase the estimate of benefit by 34% and may produce discordant results.45 In our review, 10 trials (31%) were excluded for poor quality (Jadad score <3) to assess adequately any benefit of intervention.

In our review, qualitative and quantitative homogeneity was confirmed and statistical combination was appropriate. Multiple sensitivity analyses confirmed the robustness of our summary statistic. Inclusion or exclusion of the morbidly obese trial39 did not alter the results. Gynecologic trials20,21 were omitted to focus results to a general surgical practice, and inclusion of these trials did not appreciably change the summary statistic.

The pooled OR for incisional hernia in the nonabsorbable versus absorbable suture groups, the primary outcome for this study, was 0.68 (95% CI 0.52–0.87). The fact that the point estimate was less than 1 favored the nonabsorbable group (Fig. 2), a statistically significant result. Clearly, the evidence supports a significant benefit in using nonabsorbable suture. With an RRR of 32%, using a nonabsorbable suture lowers the risk of incisional hernia formation by 32%. A more clinically useful measure is NNT: the NNT was 50, which means only 50 patients need to undergo nonabsorbable fascial closure to prevent one incisional hernia.

For continuous nonabsorbable versus continuous absorbable, the RRR was even greater (36%), and the NNT was 40 patients. These results are also biologically plausible: nonabsorbable sutures retain tensile strength for the duration of

![Figure 3](image-url) Pooled estimates of continuous versus interrupted suture technique. Squares indicate point estimates of odds ratios, and horizontal bars represent 95% confidence intervals. Values less than 1 favor the continuous group and values more than 1 favor the interrupted group.

![Figure 4](image-url) Pooled estimates of incisional hernia comparing continuous nonabsorbable versus continuous absorbable closure. Squares indicate point estimates of odds ratios, with the size of the square representing the weight of each study. Horizontal bars signify 95% confidence intervals. The summary odds ratio is represented by the diamond; values to the left of the vertical bar favor the continuous nonabsorbable group and values to the right favor continuous absorbable.
fascial healing.\(^4\) Continuous suture technique also has the added benefit of being easier and less time-consuming.\(^3\)

A potential benefit of meta-analysis is the ability to perform subgroup analyses.\(^46,47\) Our subgroup analyses demonstrated that polydioxanone (PDS), unlike all other absorbable sutures, did not have an increased risk of incisional hernia. Polyglactin (Vicryl) appeared to have a significant risk of incisional hernia when compared with non-absorbable sutures.

Our meta-analysis is limited by the absence of unpublished literature and possibly other sources of heterogeneity. Unpublished studies are more likely to have “negative results”; therefore, a meta-analysis of only published studies may have some publication bias. A survey of experts in Ontario yielded no unpublished data. Extraction bias was minimized by masking reviewers to publication date, authors, and journal. Other sources of heterogeneity include patient factors (malignancy, steroid use, pulmonary disease, obesity, age), local factors (emergency surgery, degree of contamination, antibiotic prophylaxis), and technical factors (surgical experience, type of incision). These factors may theoretically have been unequally distributed between treatment groups or between studies. Type of incision may be instrumental in incisional hernia formation. A prospective study described lower incisional hernia rates in paramedian incisions versus midline incisions.\(^28\) Studies of transverse incisions have been inconclusive.\(^47–50\) The randomized trials included in this study did not stratify based on type of incision. For example, no direct comparisons of midline versus transverse incisions were done. The question of the role of incision type in the development of incisional hernias is therefore impossible to answer by this meta-analysis.

The follow-up of patients for individual studies was highly variable: only seven (54%) studies followed patients for 1 year or more. This may explain why our cumulative incidence of incisional hernia across studies was only 5%. This incisional hernia rate at 1 year does not reflect the true incidence of this outcome. Mudge and Hughes\(^1\) followed up a cohort of patients prospectively for 10 years and noted that 35% of all incisional hernias occurred after 3 years.

This meta-analysis serves to synthesize some of the in-

Table 3. SUBGROUP ANALYSIS OF INDIVIDUAL SUTURE TYPES

<table>
<thead>
<tr>
<th>Suture Type</th>
<th>No. of Studies (n)</th>
<th>Favors</th>
<th>Odds Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyglycolic acid (Dexon) vs. nylon</td>
<td>3</td>
<td>Nylon</td>
<td>0.30 (0.13–0.68)</td>
</tr>
<tr>
<td>Polydioxanone (PDS) vs. polypropylene (Prolene)</td>
<td>2</td>
<td>No difference</td>
<td>1.53 (0.50–4.72)</td>
</tr>
<tr>
<td>Polyglycolic acid (Dexon) vs. polypropylene (Prolene)</td>
<td>4</td>
<td>No difference</td>
<td>0.78 (0.43–1.42)</td>
</tr>
<tr>
<td>Polyglactin (Vicryl) vs. nonabsorbable</td>
<td>3</td>
<td>Nonabsorbable</td>
<td>0.67 (0.41–0.77)</td>
</tr>
</tbody>
</table>

formation on the effect of suture choice on wound failure. It is hypothesis-generating in that, given the high number of poor-quality trials, short follow-up, and variable patient factors, a large definitive trial of nonabsorbable continuous closure versus the current surgical practice with a longer follow-up period is warranted. Because incisional hernia is an infrequent outcome, very large sample sizes are required to determine a difference between suture materials (nonabsorbable vs. absorbable) or technique (continuous vs. interrupted). If we assume an incisional hernia rate of 10% in a control group and we would like to reduce this rate to 8% (20% RRR) in the intervention group with 80% power and a significance level of 5%, we would require 3,206 patients in each treatment arm in a traditional randomized controlled trial. Such a trial seems improbable and supports doing this meta-analysis of current trials.

In conclusion, we report high-quality level I evidence that the ideal suture in reducing incisional hernia rates is a nonabsorbable suture material and a continuous technique.

References

43. Solomon MJ, McLeod RS. Clinical studies in surgical journals; have we improved? Dis Colon Rectum 1993; 36:43–44.