



Systematic review with meta-analysis of transverse vs. vertical midline extraction incisional hernia risk following laparoscopic colorectal resections

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Background: The aim of this article is to explore the risk of incisional hernia (IH) occurrence at the site of specimen extraction following laparoscopic colorectal resection (LCR), highlighting the comparison between transverse incision versus midline vertical abdominal incision.

Methods: Analysis was conducted according to PRISMA guidelines. Systematic search of medical databases, EMBASE, MEDLINE, PubMed and Cochrane Library were performed to find all types of comparative studies reporting the incidence of IH at the specimen extraction site of transverse or vertical midline incision following LCR. The analysis of the pooled data was done using the RevMan statistical software.

Results: Twenty-five comparative studies (including 2 randomised controlled trials) on 10,362 patients fulfilled the inclusion criteria. There were 4,944 patients in the transverse incision group and 5,418 patients in the vertical midline incision group. In the random effects model analysis, the use of transverse incision for specimen extraction following LCR reduced the risk of IH development (odds ratio =0.30, 95% CI: 0.19–0.49, Z=4.88, P=0.00001). However, there was significant heterogeneity (Tau²=0.97; Chi²=109.98, df=24, P=0.00004; I²=78%) among included studies. The limitation of the study is due to lack of RCTs, this study includes both prospective and retrospective studies along with 2 RCTs which makes the meta-analysis potentially biased in source of evidence.

Conclusions: Transverse incision used for specimen extraction following LCR seems to reduce the risk of postoperative IH incidence compared to vertical midline abdominal incisions.

Keywords: Extraction site hernia; incisional hernia (IH); laparoscopic colorectal resection (LCR); transverse incision; vertical incision

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Introduction

In recent years, laparoscopic surgery is considered standard for most of the colorectal pathology including malignancy. Even in laparoscopic approach, a mini laparotomy is

often done for specimen extraction (1,2). Having an incidence of 3% to 20% (3), incisional hernia is considered a common complication. European Hernia Society Guidelines define incisional hernia as any abdominal wall

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gap with or without a bulge in the area of a postoperative scar perceptible or palpable by clinical examination or imaging (4). Almost half of the incidences are picked up within the first year following surgery although they can occur afterwards (5). More than one third of incisional hernia patients complain of pain, discomfort, bowel obstruction, restricted mobility and overall delayed recovery (6). There is evidence that suggests these patients reporting low score for physical and social functioning and overall general health perception (7) About 17% patients present with strangulated/incarcerated hernia requiring emergency surgery (8). In the United States, approximately 360,000 incisional hernia repairs are done per year with a total estimated cost of 3.2 billion USD per year (9). There is existing evidence and recommendations on the use of transverse and off-midline approach for mini laparotomy showing a reduced incidence of incisional hernia (10,11). Some high-quality trials have also showed the effectiveness of enhanced closure techniques, such as small bites and prophylactic mesh (12,13). Aim of the present study is to perform a systematic review and meta-analysis to compare the incidence of incisional hernia at the extraction site with a primary emphasis on the location of the incision, comparing between transverse incision and midline vertical incision. We present the following article in accordance with PRISMA reporting checklist (available at <https://tgh.amegroups.com/article/view/10.21037/tgh-22-75/rc>).

Highlight box

Key findings

- Transverse incision for specimen extraction following laparoscopic colorectal resection seems to have of incisional hernia compared to midline incision.

What is known and what is new?

- Incisional hernia is evidenced to be one of the most common complications following laparoscopic colorectal resections; hence several actions has been adapted to reduce the incidence naming, using off-midline approach, small bites and prophylactic mesh. An off-midline approach has been shown to be effective in reducing the risk of incisional hernia in many comparative trials. The finding of current meta-analysis of 25 comparative studies (including two RCTs) on a sample size of 10,362 is consistent with the outcomes of previously published meta-analysis.

What is the implication, and what should change now?

- Furthermore, studies need to be done to compare the different type of closing materials (sutures/mesh) and techniques in order to find the best method of reducing incisional hernia incidence.

Methods

Data sources and literature search technique

Literature search was thoroughly carried out from electronic databases like MEDLINE, EMBASE, PubMed and Cochrane Library using the MeSH search terms. Boolean operators (AND, OR, NOT) were used for extended search result. The titles were carefully looked at for study selection. Moreover, references from curated articles were examined to find additional relevant trials

Trial selection

The primary inclusion criteria for the meta-analysis were the comparison of the risk of incisional hernia at the specimen extraction site following laparoscopic colorectal resection, emphasising mainly on transverse incision versus midline vertical abdominal incision.

Data collection and management

Reported data were collected from the included trials by independent reviewers on a standard data extraction form. The collected dataset was matched and found to be in satisfactory inter-reviewer agreement. The extracted data consisted of list of the authors, title of the published study, journal of publication, country and year of the publication, testing sample size (with gender differentiation if applicable), the number of patients in each group based on the incision type and site, treatment protocol for each intervention, and duration of follow up. Following data extraction, the reviewers went through discussing their respective results and a consensus of mutual agreement was reached in likely discrepancies.

Statistical analysis

Statistical analysis was performed using RevMan 5.3 (Review manager 5.3, The Nordic Cochrane Centre, Copenhagen, Denmark). The risk ratio (RR) and a confidence interval (CI) of 95% were used for binary data and random-effects model (14,15) was used for both binary and continuous variables. Heterogeneity was calculated by inspecting the forest plots and by computing the chi² test, with significance set at $P < 0.05$ as well as using I² test with a maximum value of 30 per cent identifying low heterogeneity (16). The Mantel-Haenszel method was used for the calculation of RR under the random effect model (17) analysis. In a sensitivity

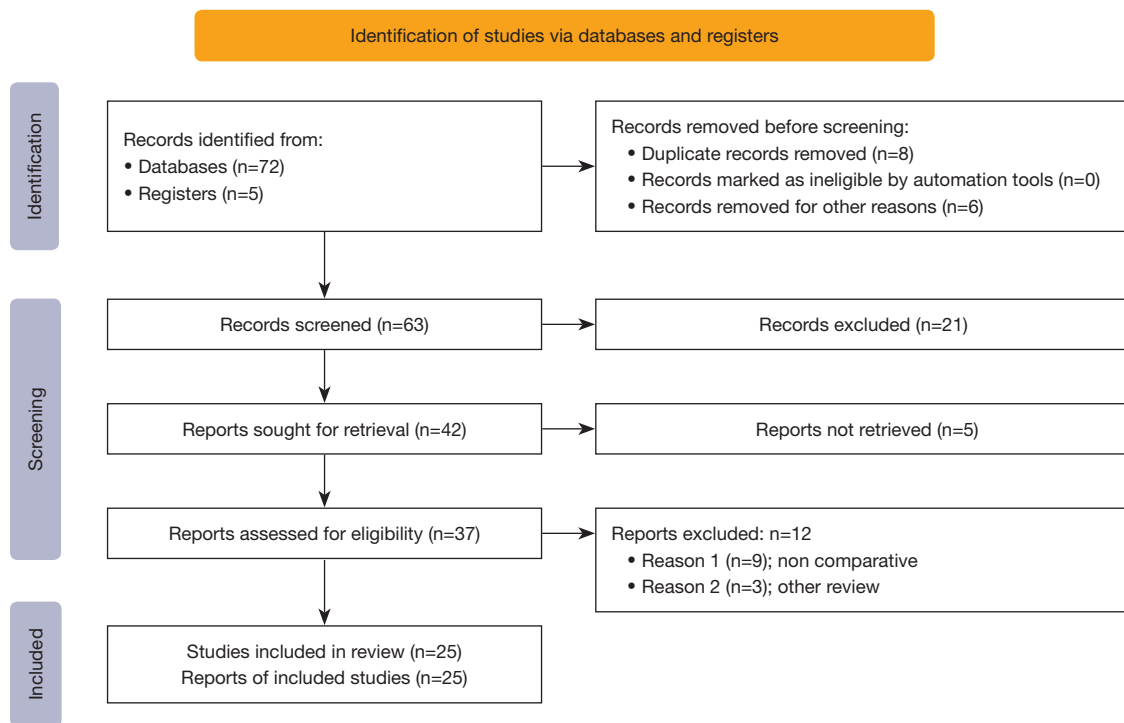


Figure 1 PRISMA flowchart showing literature search outcomes.

analysis, 0.5 was added to each cell frequency for trials in which no event occurred in either the treatment or control group, according to the method recommended by Deeks *et al.* (18). If the standard deviation was not available, then the risk of bias was calculated according to the guidelines provide by the Cochrane Collaboration (14). This process assumed that both groups had the same variance, which may not have been true, and variance was either estimated from the range or from the p-value. The estimate of the difference between both techniques was pooled, depending upon the effect weights in results determined by each trial estimate variance. A forest plot was used for the graphical display of the results. The square around the estimate stood for the accuracy of the estimation (sample size), and the horizontal line represented the 95% CI. The methodological quality of the included trials was initially assessed using the published guidelines of Jadad *et al.*, Chalmers *et al.* and Rangel *et al.* (19-21).

Endpoint

Post-operative occurrence of extraction site incisional hernia comparing vertical midline and transverse incision was assessed as the primary endpoint in this meta-analysis.

Results

The initial database search generated 63 studies after removing 14 duplicate studies. After initial title and abstract assessment 21 studies were excluded. Forty-two studies were sought for retrieval, 5 were not found. Finally 37 studies were assessed for inclusion and 25 were found to be appropriate according to the inclusion criteria (Figure 1).

Characteristics and demographics of included studies

Eighteen retrospective trials (22-39), five prospective studies (40-44) and two RCTs (45,46) on 10,362 patients were included to conduct this meta-analysis based upon the principles provide by the Cochrane Collaboration. The PRISMA flow chart for trial selection is given in Figure 1. The included trials were conducted in USA (22,23,27,30,35,36,41,44,46), Italy (24), Spain (25,40), Korea (26,31,34,43), Japan (28,37), Canada (32,33,45), Israel (29,42), Australia (38) and UK (38,39). The number of patients who were involved varies between the trials ranging between 33 (44) to 2,704 (26). All the trials were conducted between 2000 (23) and 2019 (26). Four studies (27,29,30,33) reported a range of 10–19 months as the duration of

Table 1 Characteristics of included trials

| Title | Year | Country | Study design | Total patient | IH | Age (years) | Male: female | Follow up (months) | Duration |
|---|------|------------------|---------------|---------------|--------|-------------------------|---------------|-------------------------|-----------|
| Aquina (22) (vertical; transverse) | 2015 | USA | Retrospective | 193 | 8; 3 | 66.4 | 1.16:1 | 56.4 | 2003–2010 |
| Benlice (23) (vertical; transverse) | 2016 | USA | Retrospective | 2,148 | 35; 11 | 57.5±16.6; 46.7±16.9 | 7:10.5; 2.4:1 | 72.5±41.8; 60.8±28.6 | 2000–2011 |
| Campagnacci (24) (vertical; transverse) | 2015 | Italy | Retrospective | 748 | 45; 3 | 64.9; 66 | Not included | 48 | 2004–2012 |
| Cano-Valderrama (25) (vertical; transverse) | 2020 | Spain | Retrospective | 225 | 34; 5 | 68.7 | 1.1:1 | 28.8 | 2014–2016 |
| Choi (26) (vertical; transverse) | 2022 | Korea | Retrospective | 2,704 | 52; 21 | 68.5±9.6 | 1:1.1 | 41 | 2006–2019 |
| DeSouza (27) (vertical; transverse) | 2011 | USA | Retrospective | 512 | 65; 0 | 62.68; 61.32 | 1:1.3; 1:1.1 | 18.49; 17.53 | 2004–2007 |
| Fukuoka (28) (vertical; transverse) | 2021 | Japan | Retrospective | 423 | 36; 0 | 72 | 1:1.1; 1 | 48.4 | 2012–2014 |
| Greeland (29) (vertical; transverse) | 2021 | Israel | Retrospective | 138 | 42; 12 | 71.40±8.87 | 1:1.7 | 15.3 | 2011–2016 |
| Harr (30) (vertical; transverse) | 2016 | USA | Retrospective | 259 | 14; 1 | 61.5±13.8; 57.5±12.4 | 1.09:1; 1:1.7 | 17.25±15.21 | 2009–2014 |
| Lee (31) (vertical; transverse) | 2012 | Canada | Retrospective | 99 | 20; 1 | 63; 65.8 | 13:8; 3:4 | 28.3; 44.1 | 2003–2009 |
| LaChapelle (32) (vertical; transverse) | 2020 | USA | Retrospective | 423 | 1; 0 | 43.8; 38.9 | 1.5:1; 1:1.2 | 21.9; 22.2 | 2008–2016 |
| Llaguna (33) (vertical; transverse) | 2010 | USA | Retrospective | 218 | 26; 4 | 64.2±13.3 | 12:5 | 24.2±10.6 | 2002–2007 |
| Morita (34) (vertical; transverse) | 2015 | Japan | Retrospective | 206 | 1; 6 | 65.0±10.4; 64.5±10.3 | 29:18; 15:8 | 24 | 2008–2011 |
| Navaratnam (35) (vertical; transverse) | 2015 | UK; Australia | Retrospective | 224 | 5; 13 | 68.8; 65.4 | 72:67; 41:44 | 24 | 2005–2009 |
| Pereira (36) (vertical; transverse) | 2019 | Spain | Retrospective | 182 | 23; 16 | 70.4; 68.8 | 1.5:1; 1.35:1 | 13 | 2015–2016 |
| Samia (37) (vertical; transverse) | 2013 | USA | Retrospective | 480 | 27; 5 | 65.1±13.5 | 19:13 | 45.9±15.6 | 2005–2012 |
| Shapiro (38) (vertical; transverse) | 2016 | Israel | Retrospective | 191 | 17; 0 | 72 | 1:1.2 | 33.7 | 2006–2014 |
| Sadava (39) (vertical; transverse) | 2016 | USA | Retrospective | 33 | 4; 4 | 60 | 2:1 | 20 | 2001–2014 |
| Ku (40) (vertical; transverse) | 2020 | Korea | Prospective | 189 | 22; 23 | 64.3±11.2; 64.9±10.7 | 1.6:1; 2:1 | 31 | 2010–2017 |
| Lim (41) (vertical; transverse) | 2013 | Korea | Prospective | 147 | 2; 0 | 63; 66 | 61:31; 37:18 | 20.0±5.4 | 2010 |
| Parés (42) (vertical; transverse) | 2016 | UK | Prospective | 292 | 16; 4 | 75.15±6.9 | 2:3 | 42 | 2006–2013 |
| Shin (43) (vertical; transverse) | 2016 | Korea | Prospective | 114 | 1; 2 | 65.0 | 37:20; 39:18 | 31 | 2010–2014 |
| Singh (44) (vertical; transverse) | 2008 | Canada | Prospective | 166 | 13; 0 | 64.0±13.4 | 7:8 | 20.2±14.4 | 2002–2006 |
| Lee (45) (vertical; transverse) | 2018 | Canada | RCT | 141 | 6; 1 | 66.4±12.1; 66.6±12.4 | 1.08:1; 1.2:1 | 12 | 2011–2016 |
| Tan (46) (vertical; transverse) | 2015 | USA | RCT | 40 | 1; 0 | 57; 61.5 | 1:1; 13:7 | 30 | 2010–2011 |

IH, incisional hernia; RCT, randomized controlled trial.

follow-up. Nine studies (25,32,34,35,36,37,38,44,45) fall in the range of 20–29 months, 30–39 months in four studies (31,42,43,46), 40–49 months in six studies (24,26,28,32,39,41) were reported as the duration of follow-up. In the remaining trials (22,23), the follow-up period was more than 50 months, the highest reported being

72 months (23). The mean age of patient included in the trial was ranging from 38.9 (35) to 75.15 (39). There was no discrimination for study selection in terms of gender, age, number of recruited patients and language of the published study. Main characteristics of the included studies are given in *Table 1* and the treatment protocol adopted in each of the

Table 2 Treatment protocol used in the included trials

| Title | Midline vertical incision closure technique | Transverse incision closure technique |
|----------------------|---|---|
| Aquina (22) | NR | NR |
| Benlice (23) | Mass closure running; 0- polydioxanone | Full thickness; running; 1 polyglactin |
| Campagnacci (24) | Interrupted; 2-0 glycolide/lactide co-polymer | Interrupted; 2-0 glycolide/lactide co-polymer |
| Cano-Valderrama (25) | Running; polyglactin 910 or polydioxanone | Running; polyglactin 910 or polydioxanone |
| Choi (26) | NR | NR |
| DeSouza (27) | Continuous polydioxanone | Continuous polydioxanone |
| Fukuoka (28) | Interrupted 1 vicryl for fascia and 4-0 PDS for skin (subcuticular) | Interrupted 1 vicryl for fascia and 4-0 PDS for skin(subcuticular) |
| Gremland (29) | Loop polydioxanone suture, nylon "0" in 1 layer, or interrupted absorbable verticalcryl "0" sutures | Loop polydioxanone suture, nylon "0" in 1 layer, or interrupted absorbable verticalcryl "0" sutures |
| Harr (30) | Running, 0- polydioxanone | Running, 0- polydioxanone |
| Lee (31) | Single layer continuous. 1 polydioxanone | Two layers continuous 1 polydioxanone |
| LaChapelle (32) | NR | NR |
| Llaguna (33) | #1 polydioxanone (PDS) for fascia and skin clips | #1 polydioxanone (PDS) for fascia and skin clips |
| Morita (34) | Single layer, absorbable | Single layer, oblique muscle suture |
| Navaratnam (35) | NR | NR |
| Pereira (36) | Interrupted 1-0 polyglactin | Continuous 3/0 polyglactin |
| Samia (37) | NR | NR |
| Shapiro (38) | NR | NR |
| Sadava (39) | No. 1 polyglactin | No. 1 polyglactin |
| Ku (40) | Single layer, interrupted polyglactin | Single layer, interrupted polyglactin |
| Lim (41) | Single layer; 1 polyglactin | Two layers; 1 polyglactin |
| Parés (42) | Single layer, Continuous, 1-polydioxanone | Two layers; continuous, 1 polydioxanone |
| Shin (43) | NR | NR |
| Singh (44) | Single layer, 1 Verticalcryl | Two layers ,1 verticalcryl |
| Lee (45) | Continuous 1–0 polydioxanone | Two layers; continuous 1–0 polydioxanone |
| Tan (46) | Looped 1 polydioxanone | Looped 1 polydioxanone |

NR, not reported.

study is given in *Table 2*.

Methodological quality of included studies

The methodological quality of included trials is summarized in *Table 3*. The Mantel-Haenszel random effects model was used to compute robustness and susceptibility to any outlier among these trials. The randomization in randomized trials was done using computer generated random numbers, and the concealment was done using sealed envelopes

(33,46). However, the blinding was not adopted in either randomized trial. The quality of the 23 comparative studies (retrospective & prospective) were analysed by using the Scottish Intercollegiate Guidelines Network and Dudgeon *et al.* (21), and eight studies were found to have good quality (26,29,31,32,34,35,39,43), and the rest were of fair quality.

Outcome of the primary variable

In the analysis, the use of transverse incision for specimen

Table 3 Quality of included randomised controlled trials

| Study | Randomization technique | Concealment | Blinding | Intention to treat analysis | Ethical approval |
|----------|-----------------------------------|-----------------------------|-------------|-----------------------------|------------------|
| Lee (45) | Computer generated random numbers | Sequential sealed envelopes | Not blinded | Not reported | Reported |
| Tan (46) | Computer generated | Sealed envelope | Not blinded | Not reported | Reported |

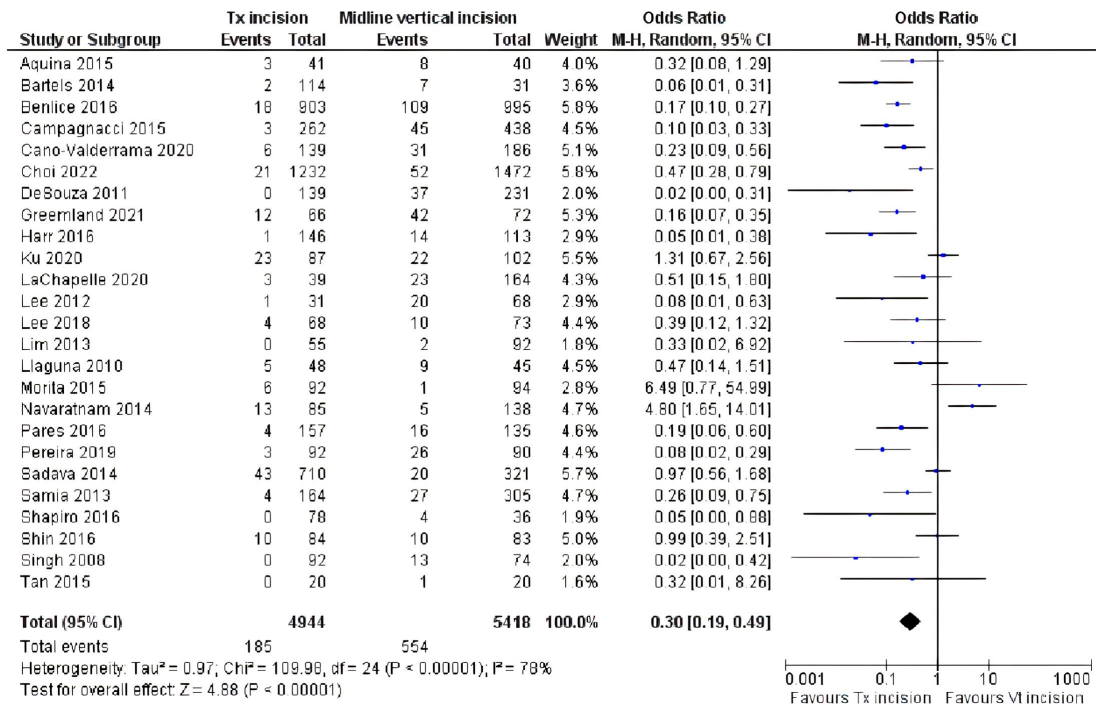


Figure 2 Forest plot showing the incisional hernia following transverse versus vertical midline incision for specimen extraction after laparoscopic colorectal resections. The outcome is presented as odds ratio with 95% confidence interval.

extraction is found to have less the risk of IH development (odds ratio =0.30, 95% CI: 0.19–0.49, Z=4.88, P=0.00001). However, there was significant heterogeneity (Tau²=0.97; χ^2 =109.98, df=24, P=0.00004; I²=78%) among included studies (Figure 2).

Discussion

Incisional hernia is evidenced to be one of the most common complications following laparoscopic colorectal resections; hence several actions has been adapted to reduce the incidence naming, using off-midline approach, small bites and prophylactic mesh. An off-midline approach has been shown to be effective in reducing the risk of incisional hernia in many comparative trials. The outcome of this study comparing 25 trials on a sample size of 10,362 is

consistent with the outcome of previously published meta-analysis (47). The previous meta-analysis analysed fewer number of trials with fewer number of patients (47). To the best of our knowledge this is the only meta-analysis on the highest number [10,362] of patients reporting the effectiveness of using off-midline incision especially transverse to reduce the risk of extraction site incisional hernia. Also, all the comparative studies included are of fair to good quality well according to the criteria of quality assessment. Thus, it provides a relatively stronger evidence to consider routine use of transverse incision in patients undergoing laparoscopic colorectal resections. There are a number of limitations in this study. Due to lack of RCTs, this study includes both prospective and retrospective studies along with 2 RCTs which makes the meta-analysis potentially biased in source of evidence. A number of

multicentre larger RCTs are required to support this study before making regular recommendations of using transverse incision. Furthermore, studies need to be done to compare the different type of closing materials (sutures/mesh) and techniques in order to find the best method of reducing incisional hernia incidence at specimen extraction site following laparoscopic colorectal resection.

Conclusions

Transverse incision used for specimen extraction seems to reduce the risk of postoperative IH incidence compared to vertical midline abdominal incisions based on our meta-analysis.

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Footnote

Reporting Checklist: The authors have completed the PRISMA reporting checklist. Available at <https://tgh.amegroups.com/article/view/10.21037/tgh-22-75/rc>

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://tgh.amegroups.com/article/view/10.21037/tgh-22-75/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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