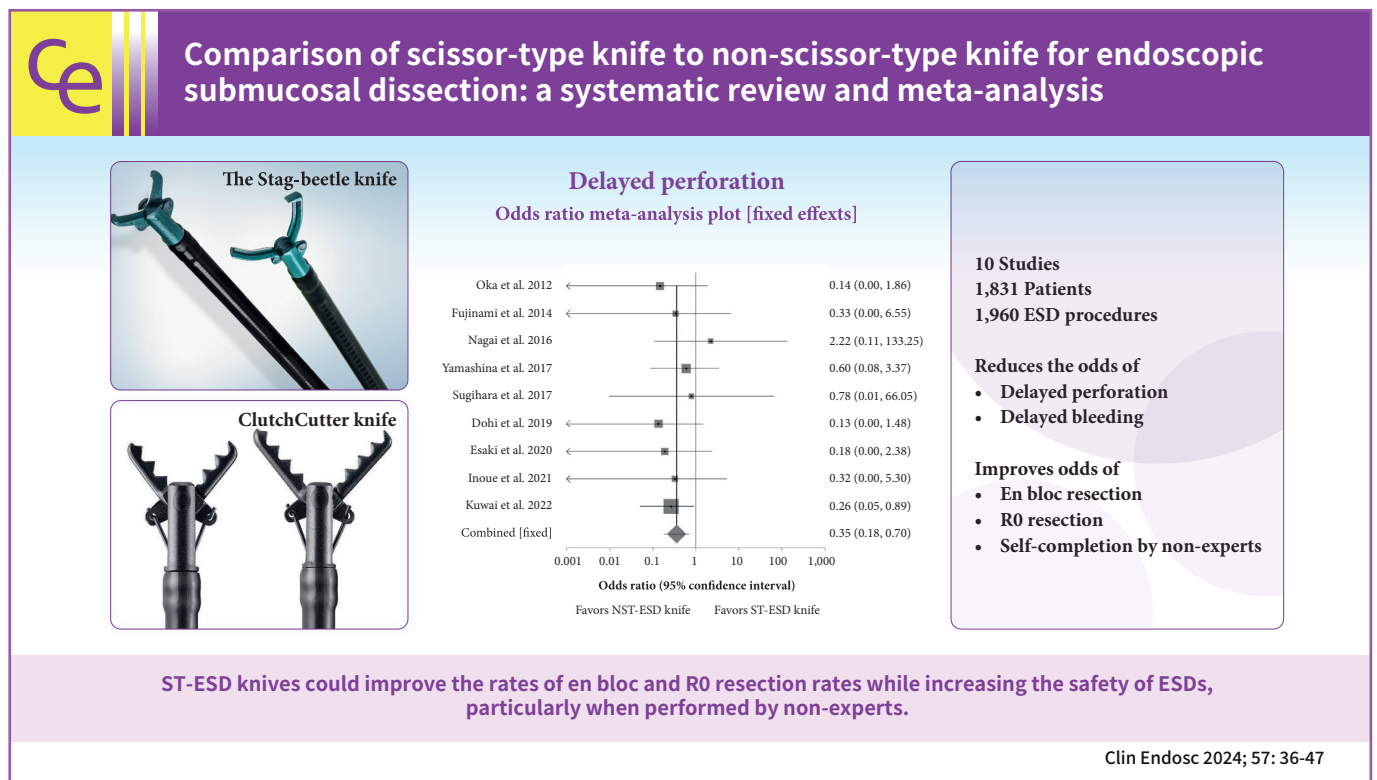


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# Comparison of scissor-type knife to non-scissor-type knife for endoscopic submucosal dissection: a systematic review and meta-analysis

Harishankar Gopakumar<sup>1</sup>, Ishaan Vohra<sup>1</sup>, Srinivas Reddy Puli<sup>1</sup>, Neil R Sharma<sup>2</sup>

<sup>1</sup>Department of Gastroenterology and Hepatology, University of Illinois College of Medicine at Peoria, Peoria, IL; <sup>2</sup>Interventional Oncology & Surgical Endoscopy (IOSE) Division, GI Oncology Tumor Site Team, Parkview Cancer Institute, Fort Wayne, IN, USA



Received: May 7, 2023 Revised: June 13, 2023 Accepted: June 16, 2023

**Correspondence:** Harishankar Gopakumar  
 Department of Gastroenterology and Hepatology, University of Illinois  
 College of Medicine at Peoria, 530 NE Glen Oak Ave, Peoria, 61637 IL, USA  
**E-mail:** hgopakumarmd@gmail.com

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**Background/Aims:** Scissor-type endoscopic submucosal dissection (ST-ESD) knives can reduce the adverse events associated with ESDs. This study aimed to compare ST-ESD and non-scissor-type (NST)-ESD knives.

**Methods:** We identified ten studies that compared the performance characteristics and safety profiles of ST-ESD and NST-ESD knives. Fixed- and random-effects models were used to calculate the pooled proportions. Heterogeneity was assessed using the  $I^2$  test.

**Results:** On comparing ST-ESD knives to NST-ESD knives, the weighted odds of *en bloc* resection was 1.61 (95% confidence interval [CI], 0.90–2.90;  $p=0.14$ ), R0 resection was 1.10 (95% CI, 0.71–1.71;  $p=0.73$ ), delayed bleeding was 0.40 (95% CI, 0.17–0.90;  $p=0.03$ ), perforation was 0.35 (95% CI, 0.18–0.70;  $p<0.01$ ) and ESD self-completion by non-experts was 1.89 (95% CI, 1.20–2.95;  $p<0.01$ ). There was no heterogeneity, with an  $I^2$  score of 0% (95% CI, 0%–54.40%).

**Conclusions:** The findings of reduced odds of perforation, a trend toward reduced delayed bleeding, and an improvement in the rates of *en bloc* and R0 resection with ST-ESD knives compared to NST-ESD knives support the use of ST-ESD knives when non-experts perform ESDs or as an adjunct tool for challenging ESD procedures.

**Keywords:** ClutchCutter knife; Endoscopic submucosal dissection; Scissor-type knife; Stag-beetle knife

## INTRODUCTION

Endoscopic submucosal dissection (ESD) for early cancers and large gastrointestinal luminal lesions is well-established in European and Asian countries.<sup>1,2</sup> ESD is currently indicated for most superficial esophageal squamous cell tumors, Barrett's esophagus-associated lesions, and superficial gastric lesions.<sup>2</sup> ESD is also recommended for *en bloc* resection of colorectal lesions with features suggestive of limited submucosal invasion (demarcated, depressed areas with irregular surface patterns, or large protruding or bulky components, particularly if the lesions are larger than 20 mm) or for lesions that otherwise cannot be entirely removed by snare-based techniques.<sup>2</sup> ESD has also been used for the resection of duodenal and small bowel lesions, but is recommended only for selected cases in expert centers.<sup>2</sup> ESD enables the endoscopist to achieve *en bloc* resection regardless of lesion size with complete (R0) resection, thus allowing for comprehensive pathological staging of the tumor.<sup>3,4</sup> In contrast to Asian countries and Europe, ESD in the United States of America (USA) is primarily confined to major academic high-volume centers, where it is performed by therapeutic endoscopists, and the adoption of ESD has been gradual for various reasons.<sup>4,5</sup> These include a steep learning curve, longer procedure time, limited training opportunities, and an increased risk of severe complications, such as bleeding and perforation, compared with snare-based resection techniques. With the establishment of its efficacy over the past two decades, increased training exposure, and technological advancements, ESD is gaining acceptance among gastroenterologists in the West, particularly in the USA.<sup>6</sup>

However, ESD is a technically challenging endoscopic pro-

cedure with a risk of severe adverse events.<sup>7</sup> ESD is a multistep process, involving various tools, and consists of the following steps: (1) the boundary of the lesion is marked using an electro-surgical knife; (2) a lifting solution is injected into the submucosal plane, raising the lesion; (3) a circumferential or semi-circumferential mucosal incision is performed around the lesion; and (4) the lesion is meticulously dissected along the submucosal plane using electro-surgical knives, separating it from the underlying muscle layer, and resected.<sup>6</sup> Intraprocedural bleeding is common when performing ESDs and is usually managed in real-time using electrocoagulation. This may be performed with an electro-surgical knife using a soft coagulation setting or may necessitate the use of other tools, such as a hemostatic grasper. Hence, dissection and hemostatic devices play crucial roles in achieving positive ESD outcomes. Several electro-surgical knives are available today, most of which are needle-type (IT knife, hook knife, triangle tip knife, dual knife, flex knife, hybrid knife, etc.).<sup>7</sup> Precise endoscopic tip control to keep pace with the dissection rate is critical to avoid unintended cutting, which can lead to adverse events such as perforation or bleeding. This can prove challenging depending on natural movements (peristalsis, respiration, heartbeat), approach angle, and the endoscopist's skill.<sup>8–10</sup> Moreover, ESD has evolved from a procedure that was initially limited to gastric lesions to other, more challenging, and complex areas of the gastrointestinal tract, such as the duodenum and right colon. In 2007, a new scissor-type ESD (ST-ESD) knife was developed in Japan to overcome the limitations of needle-type knives.<sup>8,9</sup> ST-ESD knives are unique in their ability to grasp and pull the target tissue away from the deeper muscle layer before electro-surgical cutting or coagulation.<sup>8</sup> ST-ESD knives also have an external electrically insulated coating with

sharply jagged, non-insulated inner cutting jaws.<sup>8,9</sup> This allows the precise delivery of electro-surgical current to the grasped tissue while sparing adjacent regions. Endoscopists can also use this grasping feature of the ST-ESD knife to control bleeding as it can perform the functions of hemostatic forceps using a soft coagulation setting.<sup>9</sup> These qualities of the ST-ESD knife have been shown to reduce adverse events such as severe postprocedural bleeding and perforations, specifically when non-experts perform ESDs. The Stag-beetle (SB) knife shown in **Figure 1** (Sumitomo Bakelite) and the ClutchCutter (CC) knife shown in **Figure 2** (Fujifilm Medical) are the two types of ST-ESD knives currently available.<sup>8,9</sup> Studies have compared the efficacy and safety of ST-ESD knives with non-scissor-type ESD (NST-ESD)

knives with conflicting findings. For example, in an earlier study, Akahoshi et al.<sup>9</sup> reported that using ST-ESD knives was time-consuming compared to NST-ESD knives. However, studies by Hayashi et al.,<sup>11</sup> Dohi et al.,<sup>12</sup> Esaki et al.,<sup>13</sup> and Inoue et al.<sup>14</sup> found that the use of an ST-ESD knife was associated with a significantly lower total procedure time when performed by less experienced endoscopists. Studies by Oka et al.,<sup>10</sup> Fujinami et al.,<sup>15</sup> and Kuwai et al.<sup>16</sup> found significant improvements in *en bloc* and R0 resection rates with a reduction in perforation and bleeding rates, while other studies noted no statistically significant difference in these parameters.<sup>11-14,17-19</sup>

Given this variability in findings from prior studies,<sup>10-19</sup> we decided to perform a systematic review and meta-analysis of all currently available studies that compared the efficacy and safety of ST-ESD and NST-ESD knives.



**Fig. 1.** The Stag-beetle knife (Sumitomo Bakelite).



**Fig. 2.** ClutchCutter knife (Fujifilm Medical).

## METHODS

### Search methodology

A literature search was performed using the electronic databases Medline through PubMed, Ovid, Cochrane Library (Cochrane Central Register of Controlled Trials and Cochrane Database of Meta-Analysis), Embase, and the Database of Abstracts of Reviews of Effects according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines from January 2005 to October 2022 to identify studies comparing the performance of ST-ESD knives to NST-ESD knives. The keywords used were “endoscopic submucosal dissection”, “ESD”, “ESD knife”, “grasping-type ESD knife”, “scissor-type ESD knife”, “ClutchCutter”, “SB knife”, and “insulated tip knife”. The references of the reviewed articles were scanned for additional studies. The retrieved studies were carefully examined to exclude potential duplicates or overlapping data.

### Study eligibility

Published studies were eligible if they compared scissor-type knives to conventional needle- or blade-type electro-surgical knives for ESDs. Articles were excluded if they were not published in English. Studies on animal models, editorials, abstracts with incomplete data, and comments were excluded. Ten articles matched the study criteria, and two authors independently reviewed the full-text articles (HG and IV). Differences were resolved by mutual agreement or review by a third author (SRP). Interobserver agreement was evaluated using Cohen’s  $\kappa$ .

### Data extraction and quality assessment

The following data were independently abstracted by two authors (HG and IV) into a standardized form: study characteristics (primary author, period of study, year of publication, and country of the population studied), study design, baseline characteristics of the study population (number of patients enrolled and participant demographics), intervention details (number of ESD procedures, location, indication), outcomes (*en bloc* resection, R0 resection, duration of procedures, and speed of procedure), adverse events (perforations and delayed bleeding), and operator experience.

### Outcomes evaluated

The primary outcomes evaluated were *en bloc* resection rates, R0 resection rates, and total procedure time. The adverse events compared were the perforation and delayed bleeding rates.

### Statistical analysis

This meta-analysis was performed by calculating the weighted pooled effects. Individual study proportions were transformed into quantities using the Freeman-Turkey variant of the arcsine square root-transformed proportion. The pooled proportion was calculated as the back-transform of the weighted mean of the transformed proportions, using inverse arcsine variance weights for the fixed-effects model (Mantel-Haenszel method) and the random-effects model (DerSimonian-Laird method). The heterogeneity of the studies was evaluated using Cochran's Q test based on inverse variance weights and by calculating  $I^2$  statistics.  $I^2$  values of 0% to 39% were considered non-significant heterogeneity, 40% to 75% moderate heterogeneity, and 76% to 100% considerable heterogeneity. A  $p$ -value  $>0.10$  was used to reject the null hypothesis that the studies were heterogeneous. The findings of this meta-analysis were reported using a fixed-effects model as there was no statistically significant heterogeneity. Forest plots were drawn to show the point estimates for each study relative to a summary of the pooled estimates. The width of the point estimates in the forest plots indicates the weight assigned to that study. The odds ratio was used to represent dichotomous outcomes with a 95% confidence interval (CI), where a  $p$ -value of  $<0.05$  was considered statistically significant. The effects of publication and selection biases on the summary estimates were tested using the Egger and Begg-Mazumdar bias indicators. Funnel plots were constructed to assess the potential publication bias using standard errors and diagnostic odds ratios. The quality of the included studies was

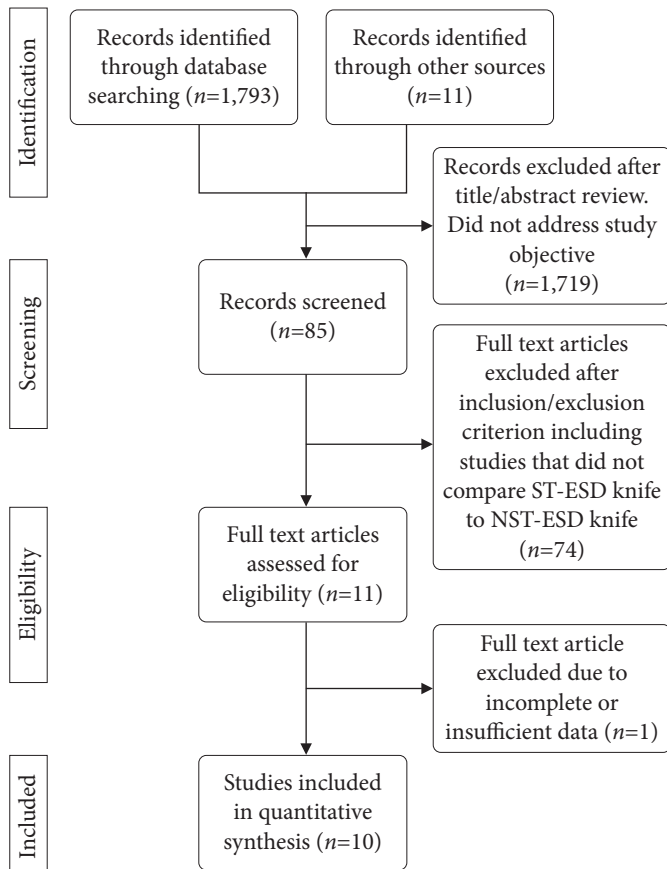
evaluated using the Newcastle-Ottawa scale for nonrandomized studies and the Jadad scale for randomized controlled trials. Microsoft Excel 2019 was used to perform the statistical analysis.

## RESULTS

The initial search identified 1,793 studies, of which 85 were relevant. Data were extracted and analyzed from ten studies that met the inclusion criteria. These studies included 1,831 patients who underwent 1,960 ESD procedures. In studies that used propensity-matched analysis, data reported from the propensity-matched cohorts were used for the final analysis. The PRISMA outline describing the details of the review process are shown in Figure 3. All the included studies are available as full-text articles. The studies included in this meta-analysis and their characteristics are summarized in Table 1.<sup>10-19</sup> The quality of the studies was good, as evaluated using the Newcastle-Ottawa and Jadad scales shown in Tables 2, 3,<sup>10-19</sup> respectively. All pooled estimates were calculated using a fixed-effects model, because there was no significant heterogeneity. The agreement between reviewers was 1.0, as measured by Cohen's  $\kappa$ .

The total sample size was 1,960 ESD procedures. ST-ESD knives were used in 768 ESD procedures, whereas NST-ESD knives alone were used in the other 1,192 ESDs. The mean patient age was  $70.01 \pm 1.73$  years in the ST-ESD group and  $69.78 \pm 1.65$  years in the NST-ESD group. The overall pooled lesion size in the ST-ESD group was  $28.46 \pm 7.93$  mm and  $29.92 \pm 6.20$  mm in the NST-ESD group. Pooled lesion size for colorectal lesions was  $31.84 \pm 4.94$  mm in the ST-ESD group and  $32.00 \pm 2.96$  mm in the NST-ESD group. Table 4 summarizes the findings. CC knife was the ST-ESD knife used in five studies, SB knife (SB and SB knife Jr [SB Jr], MD-47703; Sumitomo Bakelite) was used in four studies, and Kuwai et al.<sup>16</sup> used both the ClutchCutter and SB knife. Three of the ten studies were prospective randomized controlled trials, whereas the others were retrospective studies.

Analysis showed that the weighted odds of *en bloc* resection with an ST-ESD knife compared to an NST-ESD knife was 1.61 (95% CI, 0.90–2.90;  $p=0.14$ ), while the weighted odds of an R0 resection with an ST-ESD knife compared to an NST-ESD knife was 1.10 (95% CI, 0.71–1.71;  $p=0.73$ ). There was no heterogeneity, with an  $I^2$  scores of 0% (95% CI, 0%–56.30%) and 0% (95% CI, 0%–58.50%) for *en bloc* and R0 resections, respectively. Figure 4 shows a forest plot comparing the odds of *en bloc*



**Fig. 3.** Study flow diagram according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.

resection, and [Figure 5](#) shows the odds of R0 resection between ST-ESD and NST-ESD knives.<sup>10,12-19</sup> The weighted odds of *en bloc* and R0 resections based on the anatomic location of the ESD were also analyzed. This showed that the weighted odds of *en bloc* resection for colorectal lesions with an ST-ESD knife compared to an NST-ESD knife was 1.95 (95% CI, 0.99–3.81;  $p=0.06$ ), and for gastric lesions was 0.21 (95% CI, 0.02–2.00;  $p=0.31$ ). Analysis of adverse events showed that the weighted odds of delayed bleeding with an ST-ESD knife compared to an NST-ESD knife was 0.40 (95% CI, 0.17–0.90;  $p=0.03$ ), while the weighted odds of delayed perforation was 0.35 (95% CI, 0.18–0.70;  $p<0.01$ ). The forest plot showing the individual study estimates and the pooled estimate for delayed perforation is shown in [Figure 6](#).<sup>10,12-19</sup> There was no heterogeneity, with an  $I^2$  score of 0% (95% CI, 0%–54.40%). The Begg-Mazumdar bias indicator yielded a Kendall's tau b value of 0 ( $p=0.91$ ), suggesting no pub-

lication bias. [Figure 7](#) shows the funnel plot assessing publication bias for the odds of perforation when comparing ST-ESD to NST-ESD knives. The weighted odds of self-completion of ESD by non-experts was 1.89 (95% CI, 1.20–2.95;  $p<0.01$ ) when using an ST-ESD knife compared to an NST-ESD knife. A forest plot showing the odds of self-completion is shown in [Figure 8](#). The pooled overall ESD procedure completion time was 63.03 minutes (95% CI, 60.77–65.29) in the ST-ESD knife group and 65.19 minutes (95% CI, 63.31–67.06) in the NST-ESD knife group. On evaluation based on location, the procedure completion time was 64.89 minutes (95% CI, 62.15–67.63) in the ST-ESD knife group compared to 65.95 minutes (95% CI, 63.86–68.05) in the NST-ESD group for colorectal ESDs.

## DISCUSSION

The main finding of this meta-analysis was that the performance of ST-ESD knives was comparable to that of conventional NST-ESD knives, with similar rates of *en bloc* and R0 resections. However, there was a statistically significant reduction in the odds of perforation with the ST-ESD knife compared with the NST-ESD knife. A trend favoring the ST-ESD knife for mitigating delayed bleeding was also observed.

Increased risk for significant complications, including perforation and bleeding, has been a major deterrent to ESD adoption in the USA, as discussed by Schlachterman et al.<sup>5</sup> in their survey on ESD training in the USA. Previous studies using NST-ESD knives have reported varying perforation rates of 4.3% to 8.2% following gastric ESDs,<sup>20,21</sup> approximately 4% following esophageal ESDs,<sup>22</sup> and approximately 5% following colonic ESDs.<sup>23-25</sup> Duodenal ESDs carry the highest risk of perforation, with a wide variability in reported rates.<sup>26</sup> Our analysis showed that the odds of perforation were significantly lower with ST-ESD knives than with NST-ESD knives. Electrosurgical incision using a conventional needle-type knife is achieved by the controlled lateral movement of the cutting edge of the needle, which requires a high level of precision and skill from the endoscopist. This mechanism differs from that of familiar endoscopic tools, which primarily involve open and closed tip motions (e.g., biopsy forceps, clips, and snares).<sup>27</sup> Scissor-type ESD knives work like other familiar endoscopic tools using a similar grasp-and-cut approach. The target tissue is also pulled away from the underlying tissue before electrosurgical dissection. Both these mechanisms, in addition to the electrically insulated outer coating of ST-ESD knives, mitigate the risk of injury

**Table 1.** Basic characteristics of studies included in this meta-analysis

Study	Study design (location)	Patients, lesions (n)	Male (n)	Location of lesion	ST-ESD knife	No. of operators
Oka et al. (2012) <sup>10</sup>	Single-center retrospective (Japan)	39, 39	NA	Colon	SB Jr	1 Expert <sup>a)</sup>
Fujinami et al. (2014) <sup>15</sup>	Single-center retrospective (Japan)	15, 17	15	Esophagus	SB	1 Expert <sup>a)</sup>
Nagai et al. (2016) <sup>17</sup>	Single-center prospective RCT (Japan)	56, 56	49	Stomach	CC	3 Non-experts <sup>b)</sup>
Yamashina et al. (2017) <sup>18</sup>	Single-center prospective RCT (Japan)	39, 39	24	Colon and rectum	SB Jr	2 Non-experts <sup>b)</sup>
Sugihara et al. (2017) <sup>19</sup>	Single-center prospective RCT (Japan)	20, 20	8	Colon and rectum	SB Jr	2 Non-experts <sup>b)</sup>
Hayashi et al. (2018) <sup>11</sup>	Single-center retrospective (Japan)	44, 44	8	Stomach	CC	4 Experts and 5 non-experts
Dohi et al. (2019) <sup>12</sup>	Single-center retrospective (Japan)	61, 61	42	Stomach	CC	1 Expert and 8 non-experts <sup>a)</sup>
Esaki et al. (2020) <sup>13</sup>	Multi-center prospective (Japan)	36, 36	29	Esophagus	CC	5 Experts and 10 non-experts <sup>b)</sup>
Inoue et al. (2021) <sup>14</sup>	Single-center retrospective (Japan)	49, 49	27	Colon	CC	2 Experts and 5 non-experts <sup>a)</sup>
Kuwai et al. (2022) <sup>16</sup>	Multi-center retrospective (Japan)	386, 407	235	Colon	SB Jr and CC	49 Operators, varying levels of experience

ST-ESD, scissor-type endoscopic submucosal dissection; SB, Stag-beetle knife (Sumitomo Bakelite); SB Jr, Stag-beetle knife Jr (Sumitomo Bakelite); CC, ClutchCutter (Fujifilm Medical); RCT, randomized controlled trial.

<sup>a)</sup>No standard definition for expert or non-expert. This was assigned based on what each study considered its operators to be. <sup>b)</sup>ESDs were performed primarily by non-expert trainees with an expert supervisor available for assistance when needed.

**Table 2.** Modified Newcastle-Ottawa scale assessing the quality of included non-randomized studies

Study	Representativeness of the exposed cohort	Selection of non-exposed cohort	Ascertainment of exposure	Outcome of interest not present at start of study	Comparability	Assessment of outcome	Was follow up long enough for outcome to occur	Adequacy of follow-up	Quality score	Quality
Oka et al. (2012) <sup>10</sup>	O	O	O	O	O	O	O	O	8	High
Fujinami et al. (2014) <sup>15</sup>	O	O	O	O	O	O	O	O	8	High
Hayashi et al. (2018) <sup>11</sup>	O	O	O	O	O	O	O	O	8	High
Dohi et al. (2019) <sup>12</sup>	O	O	O	O	O	O	O	O	8	High
Esaki et al. (2020) <sup>13</sup>	O	O	O	O	O	O	O	O	8	High
Inoue et al. (2021) <sup>14</sup>	O	O	O	O	O	O	O	O	8	High
Kuwai et al. (2022) <sup>16</sup>	O	O	O	O	O	O	O	O	8	High

O indicates that the criterion in the corresponding column was satisfied by the study.

**Table 3.** Jadad quality assessment tool for randomized control trials included in this meta-analysis

	Nagai et al. (2016) <sup>17</sup>	Yamashina et al. (2017) <sup>18</sup>	Sugihara et al. (2017) <sup>19</sup>
Described as randomized <sup>a)</sup>	1	1	1
Described as double-blinded <sup>a)</sup>	0	0	0
Description of withdrawals <sup>a)</sup>	1	1	1
Randomization method described and appropriate <sup>b)</sup>	1	1	1
Double blinding method described and appropriate <sup>b)</sup>	0	0	0
Total score	3	3	3

A total score of three or more indicates good quality trials.

<sup>a)</sup>A study receives a score of 1 for YES and 0 for NO. <sup>b)</sup>A study receives a score of 0 if no description is given, 1 if the method is described and appropriate, and -1 if the method is described but inappropriate.

**Table 4.** Basic findings of ST-ESD and NST-ESD groups

	ST-ESD knife	NST-ESD knife
No. of ESDs	768	1192
Mean patient age (yr)	70.01±1.73	69.78±1.65
Mean lesion size (mm)	28.46±7.93	29.92±6.20
Pooled mean total procedure time (min)	63.03 (60.77–65.29)	65.19 (63.31–67.06)

Values are presented as mean±standard deviation or odds ratio (95% confidence interval).

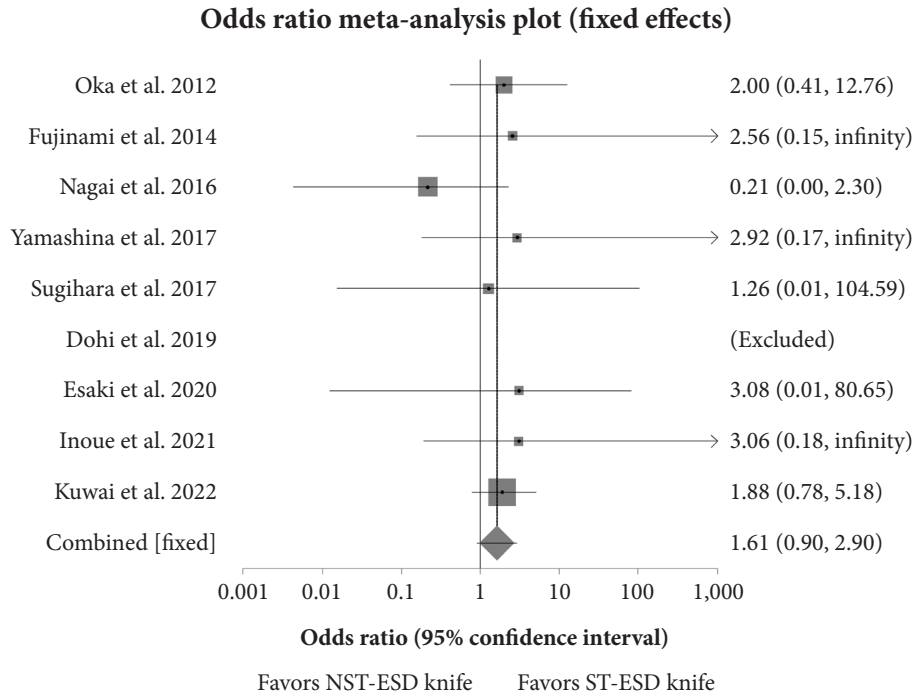
ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.

to the deeper muscle layer.<sup>8,9,27</sup> These factors could explain the lower perforation rates observed with ST-ESD knives, particularly in the hands of less experienced endoscopists. The odds of delayed bleeding were similar between ST-ESD and NST-ESD knives but showed a trend that favored ST-ESD knives. Owing to its ability to grasp tissue, an ST-ESD knife can also be used as coagulation forceps with soft coagulation settings. This could reduce the need for frequent exchange of tools when a vessel is encountered during the submucosal dissection step and reduce the overall risk of bleeding. None of the studies reported any adverse events that could be attributed to using an ST-ESD knife, aside from the standard adverse events seen in any ESD, regardless of the type of electro-surgical knife used. In addition to the type of endoscopic tool and operator inexperience, the risk of perforation and delayed bleeding also depends on factors such as tumor size, location, fibrosis, and procedure duration.<sup>21</sup> Hence, an ST-ESD knife could be the preferred electro-surgical knife for lesions in high-risk locations, or could be used as an adjunct to conventional NST-ESD knives for challenging ESDs, as reported by Yamashina et al.<sup>18</sup>

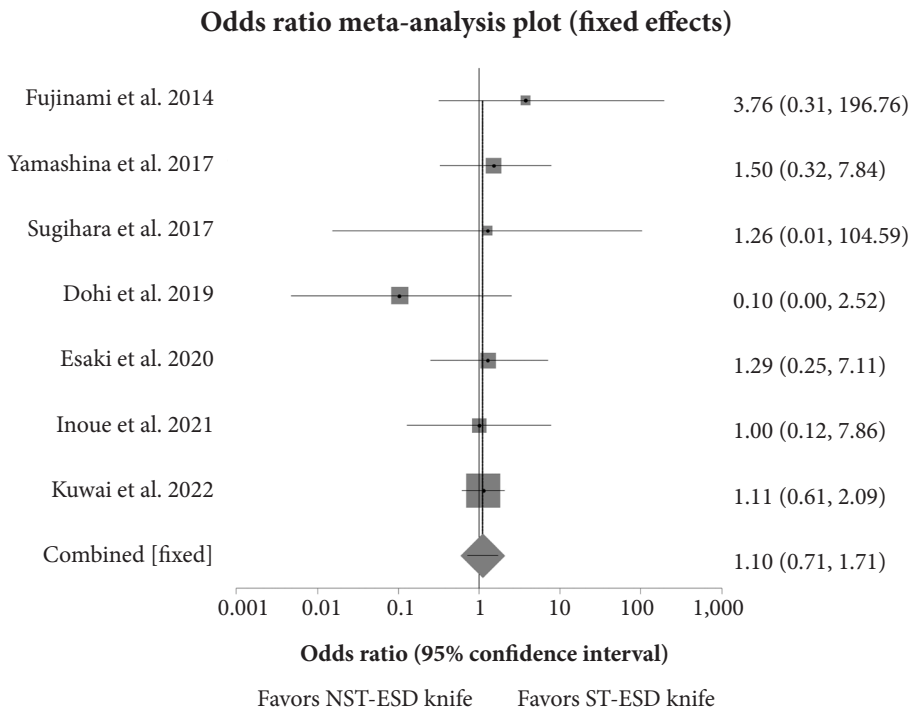
The main advantage of ESD over snare-based resection techniques is the higher rate of *en bloc* and R0 resections, par-

ticularly for lesions >20 mm.<sup>20</sup> Our study showed that the odds of *en bloc* and R0 resections were comparable between the ST-ESD and NST-ESD knives, with a trend observed to favor the ST-ESD knife, although the difference was not statistically significant. Our analysis also showed that the odds of achieving an *en bloc* resection for colorectal lesions with an ST-ESD knife compared to an NST-ESD knife was 1.95, while that for gastric lesions was 0.21. Colorectal ESD is considered more difficult than gastric ESD because the colorectal wall is thinner than that of the stomach.<sup>28</sup> Depending on the location of the lesion, there can be additional challenges in performing colorectal ESD, such as the maneuverability of the endoscope in the colon (especially the right colon), physiological flexion, peristalsis, and respiratory movements.<sup>28</sup> The improved odds of *en bloc* resection of colorectal lesions with ST-ESD knives may be due to these reasons, although the difference may not be prominent for gastric lesions. One criticism of the ST-ESD knife was that its use could increase the total procedure time. However, this meta-analysis of the pooled data did not show any significant difference in the total procedure time between ST-ESD and NST-ESD knives. The ST-ESD knife was used for all steps involving an electro-surgical knife in four of the included studies,<sup>13,14,16,17</sup> and only one study reported using a NST knife to perform the mucosal incision step.<sup>19</sup> This shows that an ST-ESD knife can be used as a standalone ESD knife or as an adjunct.

The findings of this study also suggest that the trainees' odds of self-completion of an ESD procedure are higher with ST-ESD knives than with non-ST-ESD knives. Dohi et al. found no significant difference in R0 resection between ST-ESD and NST-ESD knives in gastric ESDs when experts performed the procedure. However, there was a significant improvement in both self-completion rates and mean procedure time when non-experts performed ESD using ST-ESD knives.<sup>12</sup> Yamashina et al.<sup>18</sup> also observed an improvement in the self-completion



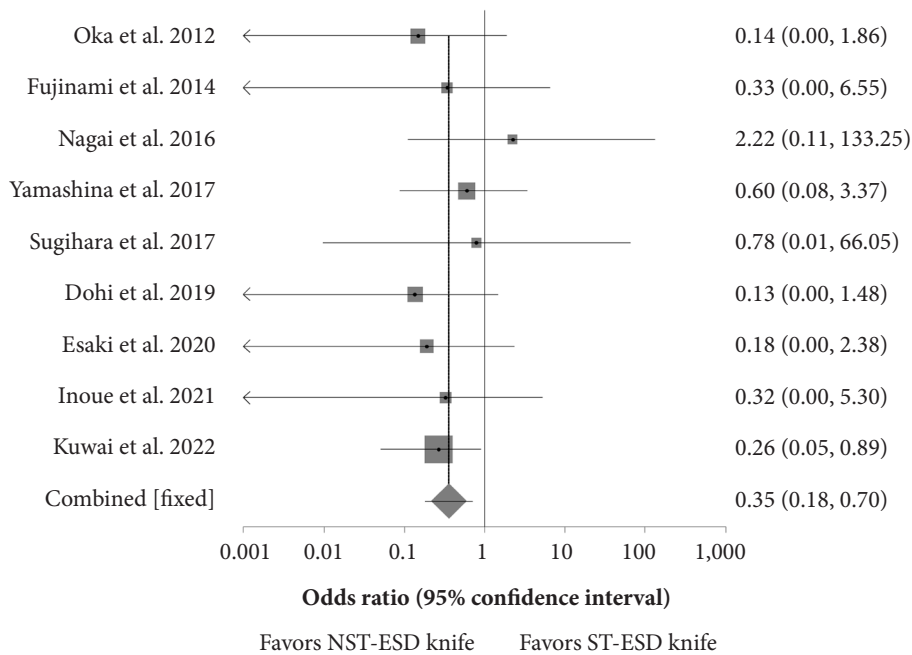
**Fig. 4.** Forest plot comparing the odds of *en bloc* resection between the ST-ESD and NST-ESD knives. ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.



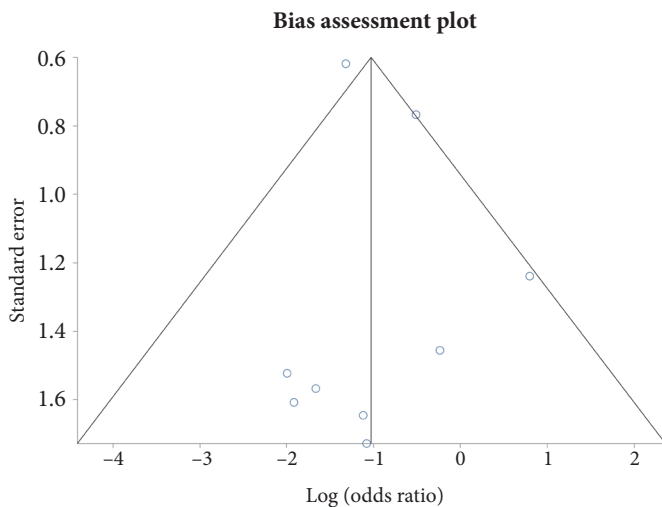
**Fig. 5.** Forest plot comparing the odds of R0 resection between the ST-ESD and NST-ESD knives. ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.



Odds ratio meta-analysis plot (fixed effects)



**Fig. 6.** Forest plot comparing the odds of delayed perforation between the ST-ESD and NST-ESD knives. ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.



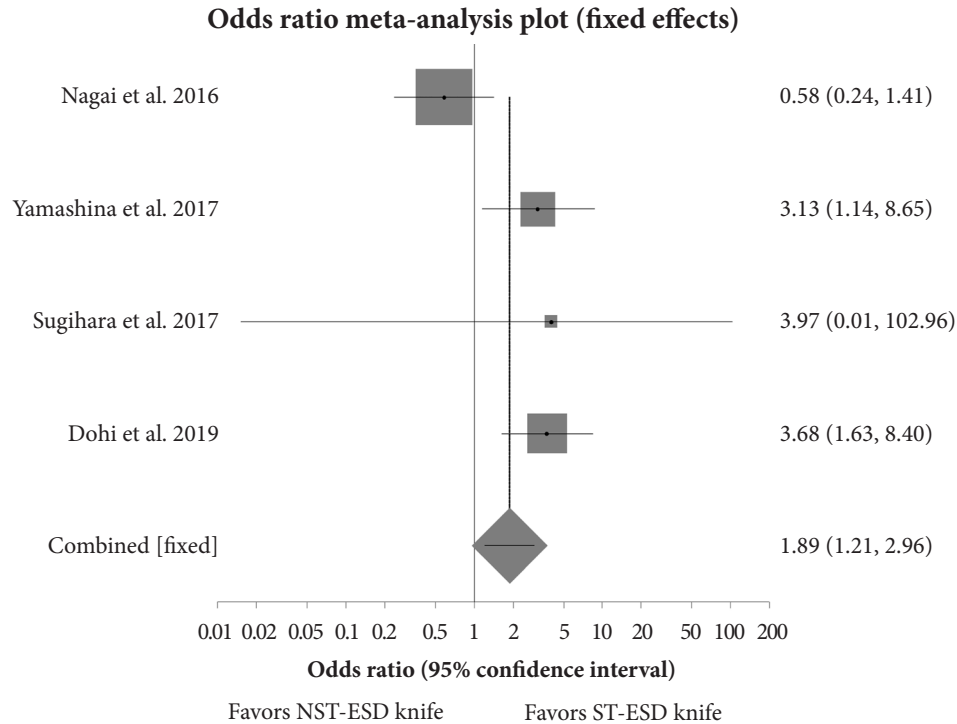
**Fig. 7.** Funnel plot showing no publication bias.

rate when trainees performed ESDs using scissor-type knives. Head-to-head comparisons of these two types of ESD knives in trainees are scarce, because most available studies are based on expert experience. Further studies are required to confirm these

findings. This has significant implications, particularly for ESD training programmes.

Accumulating evidence over the past two decades has proven that ESD is effective in achieving high *en bloc* and curative resection of lesions that are not amenable to conventional snare-based endoscopic resection techniques.<sup>20</sup> Many factors, including a perceived higher rate of complications than EMR, a steep learning curve, and the slow release of ESD tools, have hampered the widespread adoption of ESD in the USA. ESDs have conventionally been performed using needle-type electro-surgical knives. The ST-ESD knife has been used in Japan over the past decade, and studies have evaluated its unique features and usefulness. This meta-analysis of studies comparing these two types of ESD knives further demonstrates that the performance of ST-ESD knives is comparable to that of conventional NST-ESD knives, with the potential to mitigate some of the complications associated with ESD. With the recent enthusiasm and increasing accessibility to ESD training, the findings of this study could help guide appropriate tool selection for ESD, particularly for beginners.

To the best of our knowledge, this is the first comprehensive meta-analysis comparing scissor-type and non-scissor-type



**Fig. 8.** Forest plot comparing the odds of self-completion of ESD when performed by non-experts using ST-ESD vs. NST-ESD knives. ST-ESD, scissor-type endoscopic submucosal dissection; NST-ESD, non-scissor-type endoscopic submucosal dissection.

knives for ESDs across various locations in the gastrointestinal tract. The findings of this study provide a compelling argument for including ST-ESD knives in an endoscopist's arsenal. Further prospective studies are needed to clarify its role, either as an initiation tool for trainees or as an adjunct based on the complexity of the procedure.

This study has a few limitations. All of these studies were performed in Japan, where the ESD technique was pioneered and has been in practice for over two decades. It is important to note that even non-experts in some of these studies were endoscopists with significant ESD experience. For example, in a study by Hayashi et al.,<sup>11</sup> an endoscopist with up to 50 previous ESD procedures was still considered a non-expert. This is very different from the Western setting, particularly an ESD training program. Some of the findings of this study, such as procedure time, which can be significantly affected by expertise, should be interpreted with consideration of this fact. There were also insufficient data regarding specific parameters such as the depth of invasion of lesions and details on patient comorbidities, which limited our ability to evaluate these. Needle-type and other ESD knives have been in practice for a much longer

time than scissor-type knives, and experts have experience with them. It is essential to recognize that a potential limitation of this study is that only a trend favoring ST-ESD knife in *en bloc* and R0 resections was seen. No superiority was demonstrated for this important primary endpoint. Further prospective studies comparing outcomes, primarily when trainees perform ESDs in Western endoscopy training programs, are warranted to evaluate the relevance of our findings.

## CONCLUSIONS

The results of this meta-analysis showed a significant reduction in the odds of perforation with an ST-ESD knife compared to an NST-ESD knife. There was also a trend favoring the ST-ESD knife in reducing the risk of delayed bleeding and improving *en bloc* and R0 resection rates, although this was not statistically significant. These findings support the consideration of the ST-ESD knife as an additional tool to increase the safety of ESDs, particularly when performed by non-experts. It can also be a useful secondary tool for challenging ESD procedures.

## Ethical Statements

Not applicable.

## Conflicts of Interest

Neil R Sharma is a consultant for Boston Scientific, Medtronic, Steris, and Olympus. The authors declare no conflicts of interest. The other authors have no potential conflicts of interest.

## Funding

None.

## Author Contributions

Conceptualization: HG, NRS; Data curation: HG; Formal analysis: SRP; Investigation: HG, IV; Methodology: HG; Supervision: SRP, NRS; validation: NRS; Visualization: SRP; Writing—original draft: HG; Writing—review & editing: IV, SRP, NRS.

## ORCID

Harishankar Gopakumar <https://orcid.org/0000-0002-4921-8794>  
 Ishaan Vohra <https://orcid.org/0000-0002-9715-8829>  
 Srinivas Reddy Puli <https://orcid.org/0000-0001-7650-6938>  
 Neil R Sharma <https://orcid.org/0000-0001-6248-2445>

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