Success rates of fixation techniques on prevention of esophageal stent migration: a systematic review and meta-analysis

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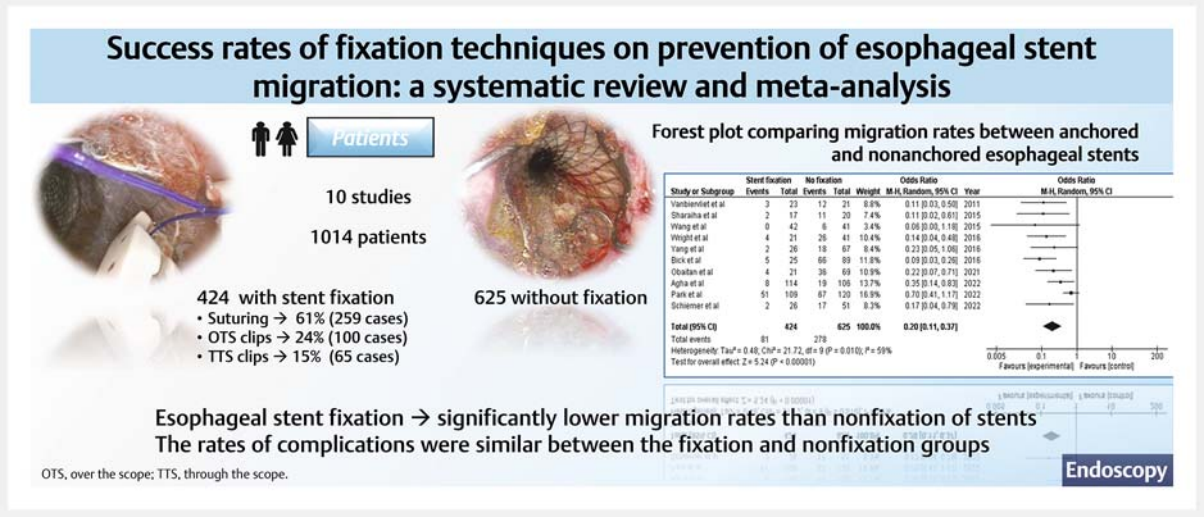
GRAPHICAL ABSTRACT



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ABSTRACT

Background Esophageal stenting is an important intervention for managing malignant and benign dysphagia, with stent migration representing a common drawback. This systematic review with meta-analysis aimed to assess the benefit of stent fixation over nonfixation.

Methods A systematic search was performed in MEDLINE, Cochrane, Scopus, and ClinicalTrials.gov databases until January 2023 for comparative studies evaluating the migration rates of esophageal stents with versus without (control) fixation. The primary outcome was migration rate. Secondary outcomes included adverse event rate. A subgroup analysis stratified the results based on different fixation techniques: suturing, over-the-scope (OTS) clipping, and through-the-scope (TTS) clipping. Meta-analysis was

based on a random effects model and the results were reported as odds ratios (ORs) with 95 %CIs.

Results 10 studies (1014 patients) were included. The rate of stent migration was significantly lower after fixation (OR 0.20, 95 %CI 0.11–0.37; I^2 = 59 %, P = 0.01). The adverse event rate was similar between fixation and control groups (OR 0.65, 95 %CI 0.28–1.52; I^2 = 55 %, P = 0.06). In the subgroup analysis, all fixation techniques remained superior to nonfixation of stents (suturing OR 0.23, 95 %CI 0.10–0.53; OTS clips OR 0.31, 95 %CI 0.17–0.58; TTS clips OR 0.10, 95 %CI 0.03–0.38); however, only the OTS and TTS clip groups achieved nonsignificant heterogeneity (I^2 = 0 %, P = 0.67 and P = 0.73, respectively). No difference between techniques was recorded for migration rates.

Conclusion Esophageal stent fixation was associated with significantly lower migration rates compared with nonfixation of stents, regardless of fixation technique and stenting indication.

Introduction

Esophageal stenting has been a widely used approach to managing symptomatic dysphagia in benign and malignant esophageal diseases [1, 2]. Palliation of malignant dysphagia represents the most common indication for esophageal stenting, as esophageal cancer is mainly diagnosed in advanced stages in the majority of patients [3, 4]. Postoperative leaks, fistulas, and perforations can be treated endoscopically with stenting, thus offering a minimally invasive option with low morbidity. Additionally, esophageal stenting could be an option in selected patients with benign strictures, and in patients with acute variceal bleeding and failed ligation, where stent placement could offer a life-saving solution by providing a time window for further interventions [1].

One of the most common concerns for endoscopists performing esophageal stenting is stent migration. The placement of fully covered metal stents carries a higher risk of migration compared with uncovered or partially covered stents owing to the absence of tissue ingrowth to support the anchoring of the stent. About one-third of esophageal stents placed for benign indications migrate, compared with one-quarter of those for malignant stricture, and it has been suggested that endoscopically traversable strictures, subsequent radio/chemotherapy, prolonged survival, and fully covered stents compared with partially covered stents are independent risk factors for migration [5–7]. Stent migration may lead to complications such as ulceration, pain, hemorrhage, and even obstruction. Furthermore, reintervention for stent retrieval and replacement adds further to the morbidity. Initial research efforts targeted at modification of stent structure, material, and design have not yielded any significant benefits [8–10]. Alternatively, there is an increasing interest in stent fixation, with accumulating data on different techniques. Current guidelines recommend, albeit weakly, that fixation of esophageal stents could be considered, especially in cases of previous migration, though routine fixation is not clearly suggested due to the low quality of collected evidence [1, 11].

To date, two meta-analyses have assessed the migration rates of esophageal stents after fixation with suturing and over-the-scope (OTS) clips by assessing cumulative pooled rates of cohort and case series [12, 13]. The reduced pooled rates of stent migration are promising for both fixation techniques; however, evaluation comparing fixation and nonfixation was not performed. Emerging comparative studies evaluating different fixation techniques have been published, thus allowing the accumulation of their results to clarify the value of esophageal stent fixation [12].

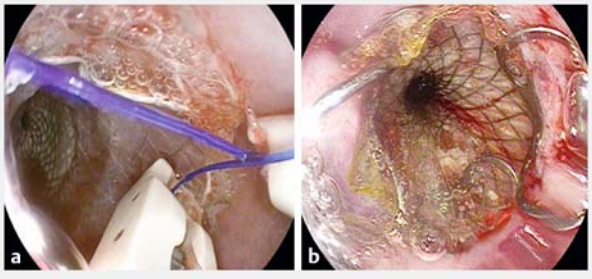
The aim of this systematic review and meta-analysis was to present the performance of fixation techniques with regard to esophageal stent migration and adverse events overall and according to the different fixation techniques (▶ **Fig. 1**).

Methods

Our research was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (see **Table 1 s** in the online-only Supplementary material) [14]. A predefined protocol was registered in the international prospective platform for systematic reviews (PROSPERO Registration Number: CRD42023394009).

Inclusion and exclusion criteria

The primary question was structured according to the PICO framework (population, intervention, control, and outcomes) and included the evaluation of esophageal stent fixation techniques in terms of any stent migration and adverse events [15]. Comparative, case–control, and randomized controlled studies assessing any of the existing techniques were included in the final analysis when the following inclusion criteria were met: 1) patients: adult patients (≥ 18 years old), with indication for esophageal stenting; 2) interventions: placement of a self-expandable metal stent (SEMS) of any type (ie, uncovered, partially



▶ **Fig. 1** Techniques for esophageal stent fixation. **a** Endoscopic suturing. **b** Over-the-scope clipping.

covered, fully covered) with fixation; 3) comparators: patients (controls) with an indication for esophageal SEMS, without stent fixation; 4) outcomes: any stent migration, defined as proximal or distal displacement of the stent or by radiographic imaging of displacement into the stomach; adverse events including clinically significant tissue ingrowth, chest pain or discomfort necessitating SEMS removal, bleeding, and SEMS-associated esophago-respiratory fistula; and clinical success, defined as symptom relief for malignant cases, therapeutic benefit for benign cases, with absence of clinically significant stent migration. Studies were excluded if they were not written in the English language, were missing substantial data required for analysis, or were case reports or series, single-arm cohorts, or animal studies.

Search strategy

An initial search was conducted using MEDLINE/PubMed, Cochrane, Scopus, and ClinicalTrials.gov databases up to 20 January 2023. The search algorithm included the following Boolean search terms: "stent fixation" OR "esophageal stent clip" OR "esophageal stent fixation" OR "esophageal stent suturing" OR "esophageal stent migration." Additional relevant articles were identified by hand-searching the reference lists of retrieved publications and grey literature (ie, Global Health Database and National Grey Literature Collection), and by using the "similar article" function within PubMed. No publication date restriction was set, and only English articles were considered. For studies with missing data, the first and/or corresponding author was contacted. Two investigators (A.P., P.G.) independently selected articles based on the inclusion and exclusion criteria. In cases of multiple publications from the same study, only the most recent and complete article was included.

Data extraction and quality assessment

Data on study-, participant-, and intervention-related parameters were retrieved into a standardized form by two investigators (A.P. and K.B.), and a third author (P.G.) checked the datasets for any discrepancies. Disagreements were resolved by a senior investigator (R.H.) in order to reach a consensus.

Quality assessment was carried out independently by two authors (D.R. and G.T.) using the validated Newcastle–Ottawa Scale (**Table 2s**).

Outcomes

The primary outcome of our meta-analysis was the rate of any stent migration, which was compared between fixation and control groups.

Rates of adverse events, other than migration, and clinical success were secondary outcomes. Moreover, differences in migration rates and adverse events according to fixation technique (ie, suturing, OTS clipping, through-the-scope (TTS) clipping) were also assessed.

Fixation techniques

Suturing-based fixation is performed using the OverStitch device (Apollo Endosurgery, Austin, Texas, USA). This tool can be mounted onto a double-channel endoscope or as an OTS attachment on a conventional gastroscope. The initial stitch is placed into the esophageal mucosa through the openings of the proximal edge of the stent. Using the anchor exchange, the suture is recaptured onto the needle driver and the second stitch is placed into the esophageal mucosa 1–2 cm above the stent, with or without the assistance of the Tissue Helix device (Apollo Endosurgery).

The OTS clip fixation technique is applied using the Stentfix OTSC System (Ovesco Endosurgery AG, Tübingen, Germany). The device is loaded onto a gastroscope and consists of an attachment with a preloaded clip, thread, thread retriever, and hand wheel, but the modified cap has a smaller diameter than the standard device and U-shaped notches to facilitate positioning on the stent edge. The scope tip is guided in a way that positions the cap over the stent edge and the esophageal wall; suction is then applied to capture both the stent and esophagus, and the clip is deployed by turning the wheel clockwise.

There are various commercially available TTS clips; none, however, is dedicated to stent fixation. The upper mesh of the stent is captured by one arm of the clip and the other arm anchors to the esophageal mucosa, followed by suction and deployment.

Statistical analysis

The study outcomes included comparisons between the two groups through a random-effects model based on DerSimonian and Laird random effects model that incorporated both between-study and within-study variation, and results were expressed in terms of odds ratio (OR) and 95 %CI, when appropriate [16].

Heterogeneity between study-specific estimates was assessed using the inconsistency index (I^2), and cutoff points of < 30 %, 30 %–59 %, 60 %–75 %, and > 75 % were considered to suggest low, moderate, substantial, and considerable heterogeneity, respectively, accompanied by a relative *P* value to indicate significance [17]. Any potential publication bias was verified through the visual assessment of funnel plots.

Subgroup analysis was performed to evaluate potential differences between various fixation techniques as sources of heterogeneity. All results between the subgroups were compared to investigate statistically significant differences. Publication bias was estimated using the Egger's test [18]. Additionally, sensitivity analysis including only fully covered SEMSs was performed to investigate any impact on the results.

Statistical analysis was conducted using RevMan version 5 from the Cochrane collaboration [19]. For all calculations, a two-tailed *P* value of < 0.05 was considered statistically significant [20].

Quality of evidence

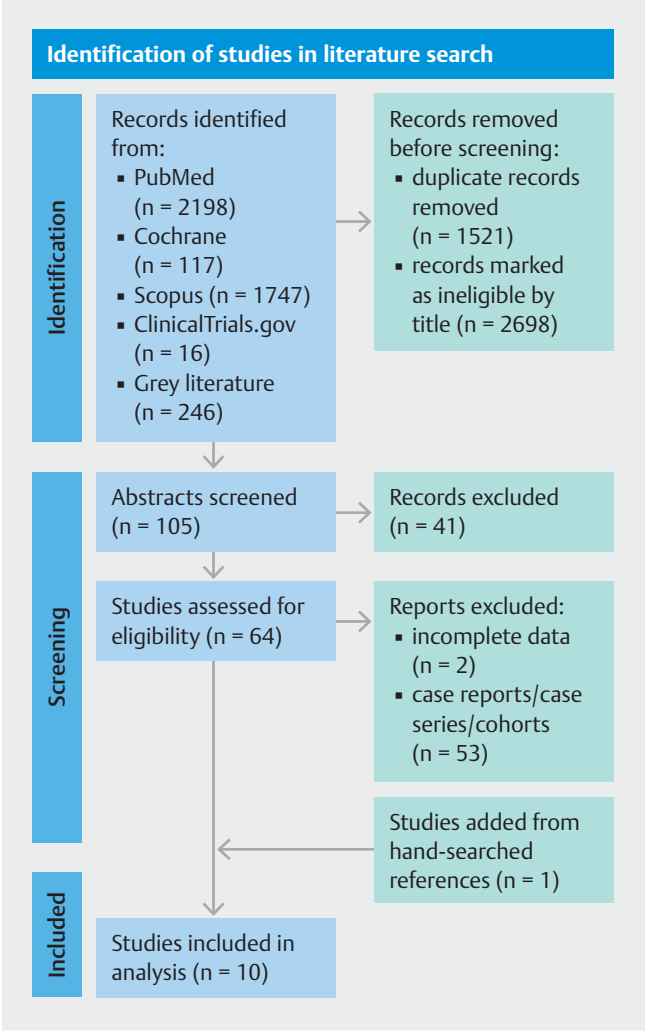
The quality of the provided evidence was rated based on the Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) criteria [21].

Results

Characteristics of included studies

The initial search resulted in 4324 individual articles. After applying the exclusion criteria, 10 studies [22–31], including 1014 patients, were eligible for analysis. ▶ **Fig. 2** depicts the PRISMA flow chart and ▶ **Table 1** summarizes the main characteristics of the included studies. All of the studies were retrospective [22, 23, 25–29, 31], except for those assessing TTS clip fixation, which included one prospective comparative study [24] and a randomized controlled trial [30]. A total of 424 patients underwent SEMS fixation, whereas 625 patients underwent esophageal stent placement without fixation (control group). Some patients underwent stent placement more than once and were recorded as different cases.

The male-to-female ratio was 1.4:1 and the age ranged from 20 to 87 years. The indication was clearly presented for 850 patients across nine studies; one study [27] included pathologies along the entire gastrointestinal tract. In 454 of the 850 patients (53.4 %), the indication was esophageal strictures, which were malignant in 271 (31.9 %) and benign in 90 (10.6 %); one study did not distinguish between benign and malignant strictures (n = 93) [26]. Treatment for esophageal leak or fistula was offered to at least 310 patients (36.5 %), whereas an esophageal stent was placed in 64 patients (7.5 %) after perforation. Of the 424 patients who underwent stent fixation, endoscopic suturing was performed in 61.1 % (n = 259), a dedicated OTS clip (Stentfix OTSC System; Ovesco Endosurgery AG) was placed in 23.6 % (n = 100), and a TTS clip was placed in 15.3 % (n = 65). The vast majority (82.0 %) of inserted stents were fully covered SEMSs (n = 831), whereas 10.1 % (n = 102) were partially covered and 7.9 % (n = 81) were uncovered.



▶ **Fig. 2** Study flow chart.

Quality assessment

All studies, but one [29], were graded as having very good quality, scoring at least 8/9 according to the Newcastle–Ottawa Scale. More specifically, six of them scored 9/9 [22, 24, 26–28, 30] and three scored 8/9 [23, 25, 31] due to absence of details on follow-up. Only one study [29] did not provide any information about follow-up to explain the time of stent migration assessment, especially in asymptomatic patients (**Table 2 s**).

Primary outcome

The cumulative comparison of migration rates between anchored and nonanchored esophageal SEMSs revealed a significantly lower rate of migration in the fixation group, with an overall OR of 0.20 (95 %CI 0.11–0.37; I^2 = 59 %, P = 0.01) (▶ **Fig. 3**). The pooled rates of stent migration were 14.9 % (95 %CI 6.2–23.6) in the fixation group and 44.6 % (95 %CI 30.1–59.3) in the control group.

Secondary outcome

The rates of adverse events were similar between the fixation and control groups (OR 0.65, 95 %CI 0.28–1.52; I^2 = 55 %, P = 0.06), with pooled prevalence of 6.6 % (95 %CI 2.8–10.4) and 10.9 % (95 %CI 3.7–18.1), respectively (**Fig. 1 s**). Detailed description of adverse events was available in three studies [25, 26, 28]. In the fixation group, all complications included post-procedure chest pain (7/7, 100 %), whereas in the control group, tissue overgrowth/ingrowth was recorded in 10 patients (35.7 %), chest pain in 9 (32.1 %), bleeding in 5 (17.9 %), perforation in 1 (3.6 %), and fistula formation in 3 (10.7 %). No death related to the procedure was recorded in any included study.

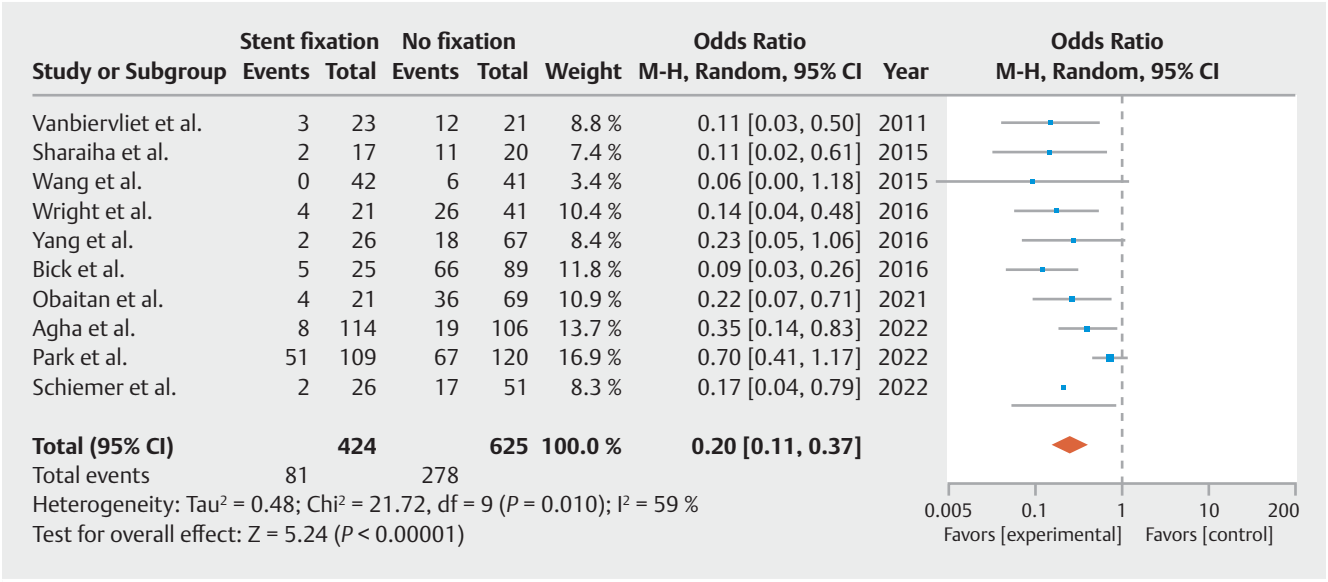
Clinical success was achieved in 72.4 % (95 %CI 56.1–88.7; 122/184) of patients after stent fixation and in 53.0 % (95 %CI 38.1–67.8; 149/283) of patients without stent fixation, with an OR of 2.33 (95 %CI 0.87–6.25; I^2 = 75 %, P = 0.008) (**Fig. 2 s**).

Subgroup analysis

To assess the source of moderate heterogeneity in the primary outcome, we performed a subgroup analysis based on the different fixation techniques (**Fig. 3 s**). The SEMS migration rates after endoscopic suturing (17.2 %, 95 %CI 4.5–29.9) were significantly lower compared with controls (OR 0.23, 95 %CI 0.10–0.53), though with high heterogeneity (I^2 = 74 %, P < 0.001). On the other hand, OTS clip fixation yielded nil heterogeneity (I^2 = 0 %, P = 0.67), and maintained the superiority over nonfixation

▶ **Table 1** Main characteristics of included studies.

No.	First author, year [ref] Country	Study design	Recruitment period	Patients, n	Age, mean (SD)/ median (range)	Female sex, n (%)	Benign stricture, n (%)	Post-surgical stricture, n (%)	Malignant stricture, n (%)	Leak/ fistula, n (%)	Perforation, n (%)	Other, n (%)
1	Vanbiervliet, 2012 [24] France	Prospective single center	2008–2010	44		19 (43)	18 (40.9)	6 (13.6)	4 (9.0)	18 (40.9)	4 (9.0)	
2	Sharaiha, 2015 [25] USA	Retrospective multicenter	2011–2013	37	57.2 (16.3)	19 (51.4)	9 (24.3)	5 (13.5)	7 (18.9)	21 (56.8)		
3	Wang, 2015 [30] China	Randomized controlled study	2011–2013	83	68.69	27 (33)	0 (0)		83 (100)			
4	Bick, 2017 [26] USA	Retrospective single center	2005–2015	101	58.2 (14.0)	37 (36.6)	93 (50.5)			91 (49.5)		
5	Wright, 2017 [29] USA	Retrospective single center	2012–2015	51	58	35 (68.6)	10 (16.1)		4 (6.5)	19 (30.6)	29 (46.8)	
6	Yang, 2017 [28] USA	Retrospective multicenter	2011–2015	93	67.7	25 (26.9)	0 (0)		93 (100)			
7	Obaitan, 2021 [31] USA	Retrospective single center	2006–2019	90	59 (20–87)	33 (36.2)			0 (0)	67 (73.6)	16 (17.6)	8 (8.8)
8	Schiemer, 2022 [22] Germany	Retrospective single center	2017–2020	77	66.4 (13.5)	22 (28.6)			43 (55.8)	16 (20.8)	15 (19.5)	3 (3.9)
9	Agha, 2022 [23] USA	Retrospective multicenter	2013–2021	220		94 (42.7)	53 (24.1)		37 (16.8)	78 (35.5)		
10	Park, 2022 [27] USA	Retrospective single center	2013–2021	218	58 (45–69)	109 (50)	206 (47.6)		55 (12.7)	172 (39.7)		



▶ **Fig. 3** Forest plot reporting the odds ratios of migration rates between anchored and nonanchored esophageal stents. M-H, Mantel-Haenszel.

(OR 0.31, 95 %CI 0.17–0.58). Similarly, TTS clips achieved homogeneously lower stent migration rates, with an OR of 0.10 (95 %CI 0.03–0.38; $I^2 = 0$ %, $P = 0.73$). The migration rates for esophageal stenting after OTS and TTS clipping were 13.9 % (95 %CI 2.0–25.8) and 5.1 % (95 %CI 0.001–16.1), respectively. The chi-squared test for differences between the migration rates of subgroups did not reveal statistical significance ($P = 0.31$).

Sensitivity analysis

Most of the included studies provided data on fully covered SEMSs, although in four studies [22, 23, 26, 30] partially covered and uncovered SEMSs were also used. In order to assess any impact of these stents on the final outcome, a sensitivity analysis included only studies with clear data of patients who received fully covered SEMSs [24–29, 31]. The stent migration rates after fixation were still significantly lower compared with the control group (OR 0.14, 95 %CI 0.05–0.40; $I^2 = 81$ %, $P < 0.001$] (**Fig. 4 s**).

Quality of evidence

Given that all but one [30] of the included studies were observational, the quality of evidence was rated as low. No reasons for further downgrading were recognized. Although one randomized controlled trial was included [30], this could not change the overall quality of the collected data. Therefore, based on the meta-analysis, a low quality of evidence was associated with the comparisons among the presented techniques.

Publication bias

The funnel plot for the primary outcome is presented in **Fig. 5 s**; Egger's test indicated publication bias (–2.88, $P < 0.001$).

Discussion

This meta-analysis is the first to analyze existing data on techniques for esophageal stent fixation and compare the migration rate with that for standard SEMS placement without fixation. More specifically, after applying any fixation technique, the incidence of stent migration was 80 % less than without fixation, thus providing a significant clinical benefit for patients. This result was maintained in the subanalysis of individual fixation techniques, where suturing reduced the risk of SEMS migration by 77 %, OTS clips by 69 %, and TTS clips by 90 %, without significant difference between these rates. Moreover, the use of fixation modalities did not increase the risk of complications compared with the control stenting group. In terms of clinical impact, fixation of stents was associated with higher success compared with stenting without fixation, albeit with marginally nonsignificant difference. However, this outcome had significant heterogeneity, which was a reflection of the various definitions among studies (eg, dysphagia relief for malignant strictures, stricture or leak/fistula resolution for benign conditions) and limits the safe interpretation of this result.

Previous meta-analyses in this field have attempted to establish stent fixation as a reasonable approach and supported the beneficial role of suturing [12] and OTS clips [13], though with absence of strong evidence owing to their design and type of included studies. Law et al. [12] included 12 studies, albeit with only 212 patients, and calculated the pooled rate of esophageal stent migration after endoscopic suturing, but did not compare this rate with the rate for nonanchored esophageal stents. The migration rate for esophageal stents after suturing was comparable to that in our study (15.9 % vs. 17.2 %, respectively); however, the advantage over conventional esophageal stent placement was indirectly estimated, based on previously published reports on stent migration [12]. Conversely, in a direct comparison, Park et al. [27] indicated similar

migration rates for sutured and nonsutured esophageal stents, with an OR of 0.99 (95 %CI 0.55–1.78), thus implying the need to reassess the benefit of esophageal stent fixation. In a recent study, Jena et al. [13], assessed the anti-migration role of OTS clips on SEMSs along the gastrointestinal tract, and calculated the pooled rates of stent migration. With regard to esophageal stents, the SEMS pooled migration rate was 8 % compared with 14.9 % in our study, probably as a result of the higher number cohort studies. However, the superiority of stent fixation over nonfixation on migration rates, although prominent, could not be demonstrated from the comparison of pooled rates. Our results seem to fill this gap by clarifying the significance of stent fixation in every case of esophageal stenting.

Another point of consideration for endoscopists is the selection of the most appropriate technique, as the tangential orientation of the endoscope in the esophagus renders fixation challenging. Studies assessing endoscopic suturing, OTS clips, and TTS clips, with a comparator arm, are available in the literature and were included in our analysis. All three modalities achieved significantly lower migration rates for esophageal stenting, with no statistically significant difference between their rates. Interestingly, the rate of SEMS migration was lower with TTS clips, followed by suturing and OTS clip placement. Conversely, the data for endoscopic suturing presented high heterogeneity (I^2 = 74 %) compared with the absolute homogeneity of the clip-based techniques. An apparent explanation for the notable heterogeneity is the higher number of studies assessing suturing (n = 7) compared with OTS clips (n = 3) and TTS clips (n = 2), which might increase the possibility of variability. Another explanation reflects the complexity of this method, the required technical skills, and the specific training. Suture application can be achieved in 96.7 % (95 %CI 92.3–98.6) [12], although this may not be sufficient to guarantee success in stent fixation, because a superficial mucosal stitch can be ineffective compared with transmural suturing. Furthermore, the number of required stitches has not been established, varying from one to more than three at the endoscopist's discretion. Regarding OTS clipping, a dedicated device has been developed to anchor stents, yielding a successful stent capture in 98 % (95 %CI 80–100) of cases, with no difference compared with traditional OTS clips [13]. In the esophagus, where the perpendicular positioning of the cap to capture both the stent and esophageal tissue is difficult, the design of this dedicated OTS clip facilitates successful deployment and transmural entrapment. Two studies have directly compared OTS clipping and endoscopic suturing for fixation of esophageal stents [23, 27]. Park et al. [27] included 218 patients who underwent 433 stent placements along the gastrointestinal tract and revealed that OTS clipping was associated with significantly lower migration rates compared with suturing (P = 0.02); however, this finding was not confirmed by the other report [23]. TTS clipping represents the simplest technique that all endoscopists are familiar with, although the procedure is technically demanding in the esophageal lumen. The subgroup analysis including the two existing studies revealed nil heterogeneity of an optimal antimigration result [24, 30]. Vanbiervliet et al. [24] used 1–4 clips, based on endoscopist judgment of the stability produced, whereas in the randomized controlled trial [30], the protocol required the deployment of two TTS clips to fix uncovered SEMS for malignant stricture. Although this indication and type of stent could decrease the overall rate of migration, the effect of TTS clipping remained significantly superior to nonanchored esophageal stents.

Beyond technical considerations, the incremental overall expenditure associated with using these techniques should also be taken into account. Based on the data of a previous meta-analysis, Shah et al. [32] estimated the cost–benefit of stent fixation using suturing and revealed that, for benign indications, the cost savings could be up to US$1586.36 compared with nonsutured SEMSs. Moreover, given the equivalent clinical result of OTS clipping, its lower cost (approximately US$600 for the clip ± US$400 for the OTS clip cutter if needed) compared with US$1500 for the suturing device, could make it a more affordable option [27]. However, in a cost-effectiveness analysis, suturing was more cost-effective than OTS clipping for esophageal stent fixation, with cost-effectiveness ratios of 5056.79 and 5342.78, respectively [33]. The variability in costs among different areas requires further cost-effectiveness studies to clarify this observation and investigate its applicability based on regional resources. The low cost of TTS clips combined with the high rate of successful anchoring imply an overall theoretical advantage, although studies assessing and comparing TTS clips with alternatives are lacking in the literature. Another argument supporting the use of TTS or OTS clips is their availability compared with suturing devices, which are available only in specialist centers performing bariatric procedures. Additionally, endoscopic suturing is an advanced technique requiring dedicated training [34], whereas clipping is part of basic training, although stent fixation is more challenging than a straightforward clip application for hemostasis.

Fully covered SEMS placement for benign esophageal disease is the only circumstance that the European Society of Gastrointestinal Endoscopy recommends considering stent fixation, whereas the American Gastroenterological Association guideline also includes partially covered SEMSs for malignant strictures under this recommendation [1, 11]. The rate of stent migration in malignant stenoses seems to be comparable to the rate with benign strictures, thus supporting the approach of anchoring regardless of the indication [5, 35]. In our study, risk stratification based on the indication was not feasible using the provided data, and patients with malignant and benign esophageal diseases were included. Nevertheless, in none of the individual studies was the indication associated significantly with migration rates [22–27]. The type of stent used has also been associated with migration, although uncovered SEMSs are no longer indicated for esophageal use [1, 11, 36]. To assess the impact of various types of stents in our study, we performed a sensitivity analysis including only cases with fully covered SEMSs, thus confirming the applicability of our results on all types of stents.

This study has some limitations. First, most of the included studies were retrospective, limiting the quality of the evidence; however, the subgroup analysis managed to address the cause of heterogeneity and provide clear results. Second, the defini-

tion and diagnosis of stent migration varied among studies. Most studies assessed any stent migration as an outcome, although the arbitrary dislodgment of 2 cm was also used in three of the studies [22, 26, 27]. The absence of uniform reporting of additional variables in the included studies was another limitation of our study, making it impossible to evaluate confounders and conduct further subgroup analyses. For example, the indication for stenting and previous stent migration are considered risk factors for subsequent migration, but this information was not available in a way that allowed analysis. Nevertheless, the results are strongly suggestive of the protective role of esophageal stent fixation regardless of other variables. Finally, despite the meticulous search, even in grey literature, publication bias was detected, reflecting the cases represented in retrospective studies and implying the reluctance or inability to publish results with negative outcomes.

In conclusion, this meta-analysis established the superiority of esophageal stent fixation compared with conventional stenting without fixation to reduce the risk of migration in any disease background and with any type of SEMS. Future comparative studies are not expected to dramatically change this outcome, and they should instead focus on the most appropriate technique, after assessing technical difficulties, training requirements, and cost-effectiveness.

Acknowledgments

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Competing Interests

The authors declare that they have no conflict of interest.

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