JGH Open An open access journal of gastroenterology and hepatology
Open Access
JGHF Journal of Gastroenterology and Hepatology Foundation
doi:10.1002/jgh3.12929

SYSTEMATIC REVIEW

Efficacy for diagnoses of scirrhous gastric cancer and safety of endoscopic ultrasound-guided fine-needle aspiration: A systematic review and meta-analysis

Ryuhei Jinushi,*,†,‡ Masafumi Mizuide,† Yuki Tanisaka,† Sakue Masuda,‡ Kazuya Koizumi,‡ Akiko Sasaki,‡ Yo Ishihara,‡ Kento Shionoya,‡ Ryo Sato,† Kei Sugimoto,† Takahiro Shin,† Rie Shiomi,† Akashi Fujita,† Shomei Ryozawa† and Tsutomu Yamazaki*

*Graduate School of Medicine, International University of Health and Welfare, Tokyo, †Department of Gastroenterology, Saitama Medical University International Medical Center, Saitama and ‡Department of Gastroenterology Medicine Center, Shonan Kamakura General Hospital, Kanagawa, Japan

Key words
endoscopic ultrasound-guided fine-needle aspiration, gastroscopy, linitis plastica, scirrhous.

Accepted for publication 11 May 2023.

Correspondence
Ryuhei Jinushi, Department of Gastroenterology, Saitama Medical University International Medical Center, 1397-1 Yamane, Hidaka-city, Saitama 350-1298, Japan.
Email: gk3273@icloud.com

Declaration of conflict of interest: The authors declare no conflicts of interest for this article.
Financial support: No financial grants or any other funding was received for this project.

Abstract

Scirrhous gastric cancer (SGC) is diagnosed using endoscopy and/or biopsy; however, SGC diagnosis remains challenging owing to its special growth form and morphologic features. Hence, endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA), which is minimally invasive and has a high proportion of diagnostic tissue, may be an alternative investigative modality for patients with suspected SGC. This systematic review and meta-analysis aimed to identify and evaluate the evidence for the efficacy and safety of EUS-FNA in patients with suspected SGC. We conducted a systematic review using the PubMed (MEDLINE) and Ichushi-Web (NPO Japan Medical Abstracts Society) databases and included all entries in which SGC was evaluated using EUS-FNA in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement from the databases' inception to October 10, 2022. The primary outcome was the proportion of SGC diagnosed using EUS-FNA. In addition, we analyzed the proportion of adverse events associated with EUS-FNA. The electronic search identified 1890 studies; overall, four studies met the selection criteria and reported data on EUS-FNA performed on 114 patients with suspected SGC. The overall diagnostic yield of EUS-FNA for SGC was 82.6% (95% confidence interval, 74.6–90.6%) and the statistical heterogeneity was 0% ($I^2 = 0\%$), indicating a low heterogeneity. Furthermore, the EUS-FNA diagnostic proportion for SGC lymph node metastasis was 75–100%, indicating a high diagnostic performance. The adverse event rate of EUS-FNA was 0%. EUS-FNA may be an alternative investigation mode for SGC patients with negative esophagogastroduodenoscopy-biopsy results.

Introduction

The diagnosis of advanced gastric cancer (AGC) is occasionally challenging for endoscopists. In particular, Borrmann type 4 AGC is often missed by esophagogastroduodenoscopy (EGD) alone because it may not form obvious ulcers or tumors.[1] Early detection of Borrmann type 4 AGC is difficult, and prognosis is often poor. The 5-year overall survival is reported to be 10.5–27.6% after radical resection and <5% for non-radically-resected cases.[2,3] Considering the rapid progression of Borrmann type 4 AGC, an accurate endoscopic diagnosis of the disease is desirable.

Borrmann type 4 AGC is now widely used as a synonym for linitis plastica (LP)-type gastric cancer (GC) and scirrhous gastric cancer (SGC); however, the endoscopic findings and clinical course are different.[1] Both types are characterized by sclerosis and poor extension of gastric wall on endoscopic findings; however, in LP type GC, tumor invasion is primarily in the gastric body, whereas in Borrmann type 4 AGC, tumor invasion is primarily in the pyloric antrum.[4] SGC is not an endoscopic finding, but rather a pathological finding of marked fibrous connective tissue proliferation in the interstitium of the cancer and is used almost interchangeably with LP-type GC.[5] In this study, all these are collectively referred to as SGC.

SGC is diagnosed using computed tomography (CT), EGD, and EGD-biopsy. In AGC, except for SGC, a definitive diagnosis can be made in >90% of cases when EGD findings are combined with biopsy results. However, SGC is often difficult to diagnose even with EGD-biopsy. One report has indicated that the false-negative proportion of EGD-biopsy in SGC is >50%,[6] because compared to other AGCs, SGC presents a variety of endoscopic findings as well as special growth forms and morphological

features.[7] Therefore, the usefulness of endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) instead of EGD-biopsy in the diagnosis of SGC has recently been reported, and the positive diagnosis proportion is as high as 71.4–82.6%.[8,9] EUS has become popular as a reliable nonsurgical technique for the diagnosis of gastrointestinal submucosal tumors and is becoming more established with the development of EUS-FNA.[10]

Against this background, we believe that EUS-FNA could be an alternative for diagnosing EGD-biopsy-negative SGC. Therefore, we conducted a systematic review and meta-analysis to analyze the EUS-FNA diagnosis rate from previous reports in the diagnosis of SGC, verify the advantages and disadvantages of EUS-FNA, and evaluate the utility of EUS-FNA for the current SGC diagnostic landscape. To the best of our knowledge, this is the first review on EUS-FNA of EGD-biopsy-negative SGC.

Methods

Protocol registration. We performed this systematic review and meta-analysis in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.[11] The study protocol was registered in the UMIN Clinical Trials Registry on October 10, 2022 (No: UMIN000049169; URL: https://center6.umin.ac.jp/cgi-open-bin/ctr_e/ctr_view.cgi?recptno=R000056007).

Search strategy. A systematic review was conducted using the PubMed (MEDLINE) and Ichushi-Web (NPO Japan Medical Abstracts Society) data and included all entries since their inception up to 10 October 2022, in which SGC was evaluated using EUS-FNA. The following electronic search terms were used to retrieve the literature in PubMed: ("endosonography"[MeSH] OR "endosonography"[tiab] OR "EUS"[tiab] OR "biopsy, fine needle"[MeSH] OR "fine needle aspiration"[tiab] OR "fine needle biopsy"[tiab]) AND ("linitis plastica"[MeSH] OR "linitis plastica"[tiab] OR "stomach neoplasms"[MeSH] OR "gastric cancer"[tiab]). Additionally, Ichushi-Web created an electronic search strategy based on the above words.

Selection criteria. This systematic review was conducted in accordance with the following inclusion criteria:

(i) prospective or retrospective studies, (ii) studies having patients with suspected SGC, and (iii) study sample consisting of patients with SGC who were eligible for EUS-FNA.

The exclusion criteria for this systematic review were as follows: (i) guidelines, reviews, editorials, case series, and case reports; (ii) studies of diseases other than SGC, such as malignant lymphoma; (iii) studies that collected specimens using methods other than EUS-FNA, such as jumbo biopsy, bite-on-bite technique, snaring biopsy, tissue retrieval using endoscopic mucosal resection (EMR), or endoscopic submucosal dissection (ESD) techniques; and (iv) studies that did not specify the EUS-FNA diagnosis proportion, which is the primary outcome of this systematic review.

Data collection and quality assessment. Figure 1 shows the flowchart of data collection. Two researchers (RJ and YT) independently searched the databases according to the selection criteria mentioned above. During data collection, the first screening was done by evaluating the title and abstract of each of the studies extracted by the electronic search strategies. Subsequently, articles relevant to this study were selected and evaluated for full-text review; in cases where the opinions of the two researchers (RJ and YT) were different, a third researcher (YI) was also consulted. For quality assessment, the Newcastle–Ottawa Scale (NOS) was used. Two researchers (RJ and YT) independently assessed the quality of the studies, and disagreements were resolved in consultation with a third researcher (YI).

Outcomes and definitions. The following data were collected from each study: first author, title, year of publication, study design, sex, age, the number of patients eligible for EUS-FNA, the number of SGC patients, overall diagnostic yield of EUS-FNA for SGC, diagnosis yield of EUS-FNA for SGC lymph node metastasis, adverse events of EUS-FNA, and study duration.

The primary outcome was the overall diagnostic yield of EUS-FNA for SGC. As secondary outcomes, diagnosis yield of EUS-FNA for SGC lymph node metastasis and adverse events of EUS-FNA were also examined.

The definitive diagnosis of SGC was based on pathological evaluation. Adverse events related to this study were in accordance with the recommendations of the American Society for Gastrointestinal Endoscopy.[12]

EUS-FNA equipment and procedures for each study. Ye *et al.*[8] used Pentax EG-3270UK (Pentax, Tokyo) and Hitachi Preirus (Hitachi, Ltd., Tokyo). A 19-gauge needle EchoTip Ultra (Cook Medical, Inc., Winston-Salem, NC, USA) was used and stroked 10–20 times while suctioning. Collected specimens were first injected into 10% formalin for histologic examination and the remaining specimens were injected onto dried glass for cytologic examination by an on-site cytopathologist.

Liu *et al.*[9] used Pentax EG-3270UK and EG-3870UTK (Pentax) and Hitachi Preirus (Hitachi, Ltd.). Specimens were collected by stroking with a 19-, 22-, and 25-gauge needle EchoTip Ultra or Precore (Cook Medical) combined with 5–10 mL suction technique. After rapid on-site evaluation (ROSE), the collected specimens were divided into those for cell blocks and those for injection into formalin for histologic examination. Takada *et al.*[13] used GF-UCT260 (Olympus Medical Systems, Tokyo, Japan) and an ALOKA ProSound F75 or an ALOKA ARIETTA 850 processor (Hitachi Aloka Medical, Tokyo). A 22-gauge needle EZ Shot 3 Plus (Olympus Medical Systems) or a 22-gauge needle Acquire (Boston Scientific, Natick, MA, USA) was used and stroked 10–15 times combined with 20 mL suction technique. ROSE was not performed on the collected specimens, and the adequacy of the specimens was confirmed by the visual judgment of the endoscopist. In principle, the number of punctures was set to 3 and, when the specimens were insufficient, up to 5 times. Assaf *et al.*[14] used GF-UCT140 or GF-UCT180 (Olympus Medical Systems). A 20- or 22-gauge needle Procore (Cook Medical) or a 22-gauge needle Acquire was used, and slow pull and/or suction was used for tissue acquisition. ROSE was not performed and the collected specimens were injected into 10% formalin for histologic examination. The puncture was repeated until the endoscopist visually judged that

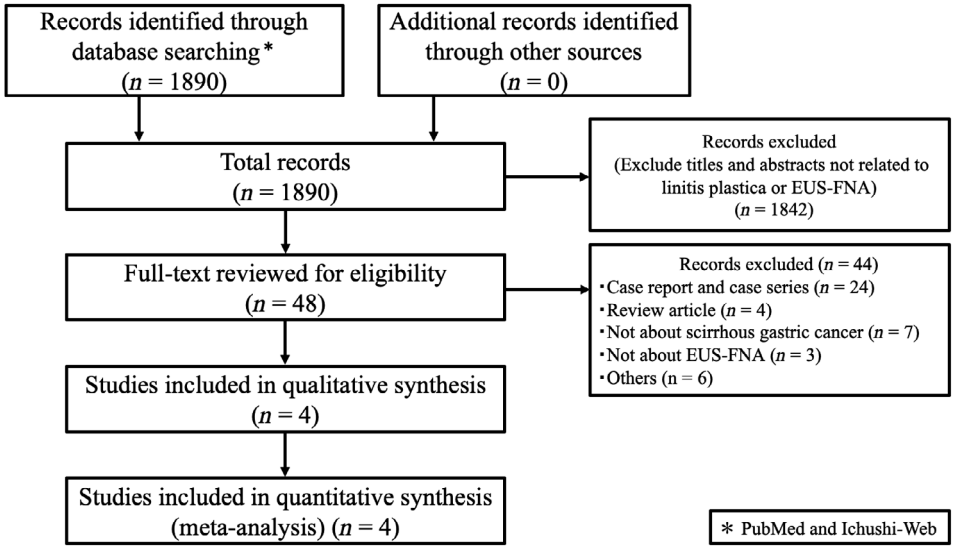

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.

sufficient specimens had been obtained. In all the four studies, the procedures were performed by experienced endoscopists.

Data analysis. Two researchers (RJ and YT) each evaluated the methodological quality of the relevant studies. Based on the random-effects model, 95% confidence interval (CI) of EUS-FNA diagnostic proportions was calculated and forest plots were generated, and the statistical heterogeneity was assessed using I^2 statistics. The I^2 statistics was classified as <30%, 30–60%, 61–75%, and >75%, indicating low, moderate, and high heterogeneity, respectively.[15] All analyses were performed using STATA v. 17 (StataCorp, College Station, TX, USA), and statistical significance was set to P-values of <0.05.

Results

Characteristics of this systematic review. Table S1 shows the PRISMA checklist. The first search identified 1890 studies, of which 48 were retained for full-text review. Of these, four studies met the selection criteria for analysis[8,9,13,14] (Table 1). In these 4 studies, 241 patients with suspected SGC were included, of whom 114 patients underwent EUS-FNA.

Table 1 Characteristics of the four studies included in the meta-analysis

Study	Study design	Sample size, *n*	SGC patients, *n*[†]	Sex, Female, *n* (%)	Age, year (SD or IQR)	Tumor thickness, mm (SD or IQR)	Patients with EGD-biopsy, *n*	Definitive diagnosis by EGD-biopsy, *n* (%)	Study duration (months)
Ye *et al.*[8]	Retrospective, Single-center	46	40	26 (56.5)	47 (10.3)	15.7 (5.8)	40[‡]	0 (0)[‡]	84
Liu *et al.*[9]	Retrospective, Single-center	107	26	17 (65.4)	54.4 (29–70)	12.9 (8.3–22.7)	19	9 (47.4)	69
Takada *et al.*[13]	Retrospective, Single-center	54	54	25 (46.3)	66 (50–72)	19.1 (3.5)[§]	54	40 (74.1)	55
Assaf *et al.*[14]	Retrospective, Single-center	34	10	4 (40)	60 (43–82)	N/A	N/A[¶]	N/A[¶]	48

[†]The number of patients with SGC confirmed by pathology and fulfilling the selection criteria of each literature.
[‡]Considering that the sample in this literature is based on scirrhous gastric cancer with a negative EGD-biopsy.
[§]The values are calculated from actual cases in which EUS-FNA was performed (*n* = 13).
[¶]Of the total 10 cases, 8 were not diagnosed with at least one EGD.
SGC, scirrhous gastric cancer; EGD, esophagogastroduodenoscopy; *n*, number; SD, standard deviation; IQR, interquartile range; N/A, not available.

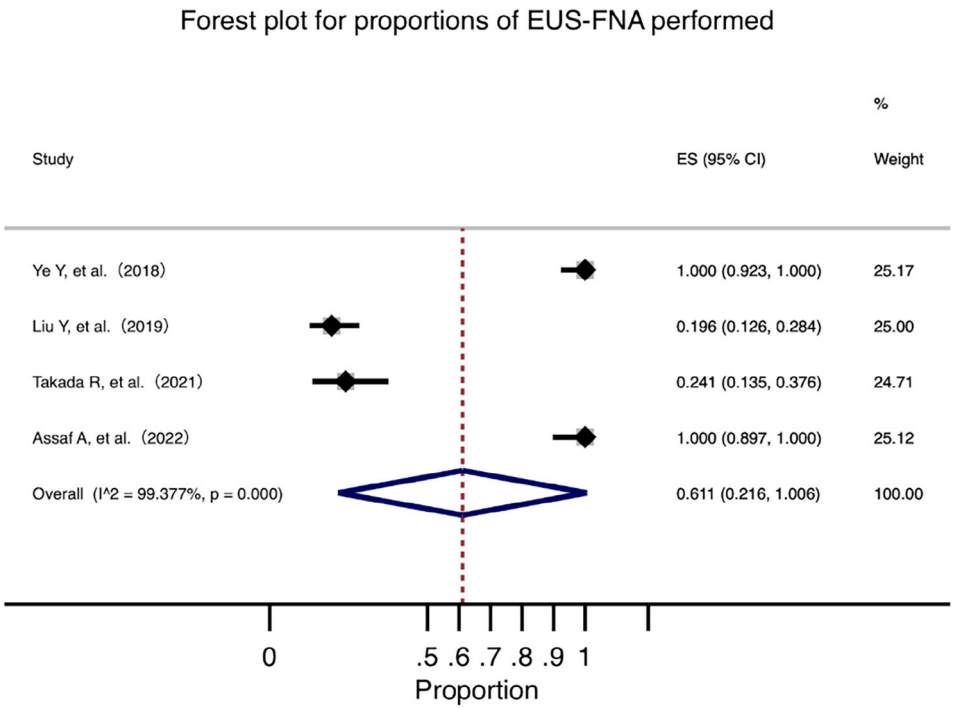

Figure 2 Forest plot for the proportions of endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) performed. The proportion of EUS-FNA performed was 61% (95% confidence interval [CI], 22–100%).

Overall, the proportion of EUS-FNA performed was 61% (95% CI: 22–100%). The statistical heterogeneity was 99.4% (i.e., $I^2 = 99.4\%$), indicative of high heterogeneity (Fig. 2). Furthermore, the mean duration of these studies was 64 months (standard deviation [SD], 16 months). These four studies were single-center, retrospective studies and consisted of patients with suspected SGC.[8,9,13,14] The mean overall quality by NOS for the four included studies was 5.5 (SD = 0.58; Table S2).

Clinical outcomes of EUS-FNA. Table 2 shows the overall diagnostic yield of EUS-FNA for SGC, the diagnostic yield of EUS-FNA for SGC lymph node metastasis, and adverse events. In all four studies, the EUS-FNA technique for patients with suspected SGC was performed without any problems. In patients with SGC, the overall diagnostic yield of EUS-FNA, as the primary outcome, was 82.6% (95% CI: 74.6–90.6%), and the statistical heterogeneity was 0 ($I^2 = 0\%$), indicating a low heterogeneity (Fig. 3). Furthermore, focusing on the puncture sites, the EUS-FNA diagnostic proportion for SGC lymph node metastasis was 75–100%, indicating a high diagnostic performance. All EUS-FNA specimens were evaluated pathologically. No apparent adverse events were observed in these four studies. Although the aforementioned results cannot be compared with those of other tissue diagnostic methods such as EGD-biopsy, it should be noted that EUS-FNA provides a stable and high diagnostic proportion with few procedure-related contingencies.

Publication bias. In this meta-analysis, no publication bias was determined from funnel plot of EUS-FNA diagnostic proportions in SGC (Fig. 4).

Table 2 Clinical outcomes of endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA)

	Overall diagnostic yield of EUS-FNA for SGC		Diagnostic yield of EUS-FNA for SGC lymph node metastasis		
Study	Technical success, *n* (%)	Definitive diagnosis, *n* (%)[†]	Lymph node metastasis, *n*	Definitive diagnosis, *n* (%)	Adverse events, *n* (%)
Ye Y *et al.*[8]	40 (100)	34 (85)	24	18 (75)	0 (0)
Liu Y *et al.*[9]	21 (100)	15 (71.4)	16	15 (93.8)	0 (0)
Takada R *et al.*[13]	13 (100)	10 (76.9)	N/A[‡]	N/A[‡]	0 (0)
Assaf A *et al.*[14]	10 (100)	9 (90)	3	3 (100)	0 (0)

[†]EUS-FNA diagnostic proportion for scirrhous gastric cancer (definitive diagnosis by EUS-FNA/ patients with SGC).
[‡]Details regarding lymph node metastasis were not specified.
SGC, scirrhous gastric cancer; *n*, number; N/A, not available.

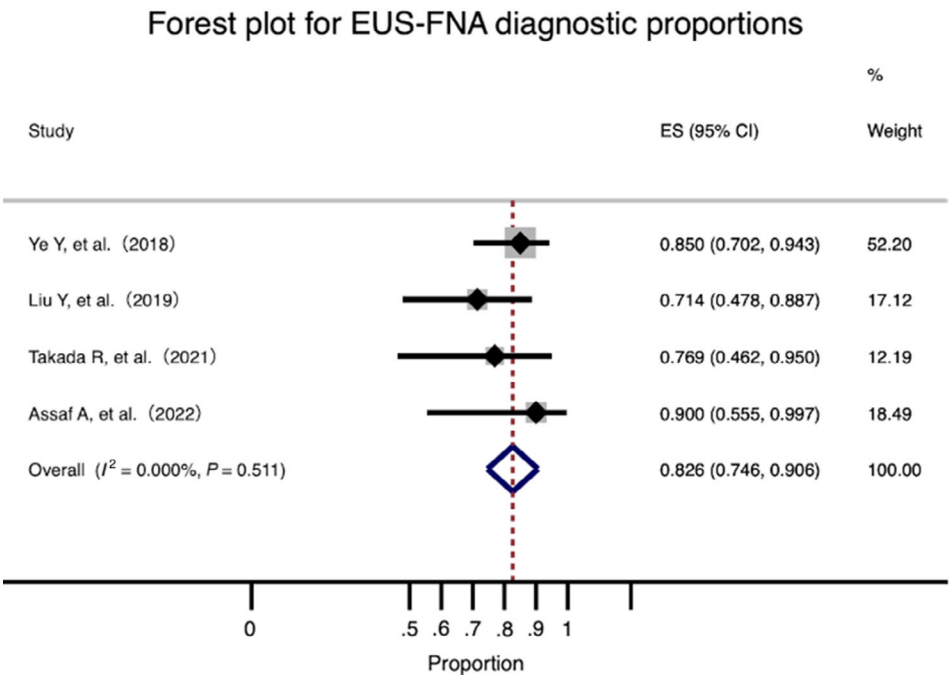

Figure 3 Forest plot for endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) diagnostic proportions in patients with scirrhous gastric cancer. EUS-FNA diagnostic proportion, the primary outcome, was 82.6% (95% confidence interval [CI], 74.6–90.6%) with low heterogeneity.

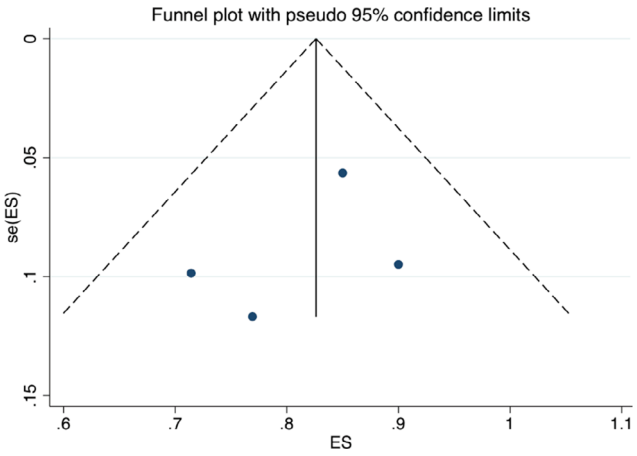

Figure 4 Funnel plot for endoscopic ultrasound-guided fine-needle aspiration diagnostic proportions in patients with scirrhous gastric cancer. There was no publication bias based on the funnel plot.

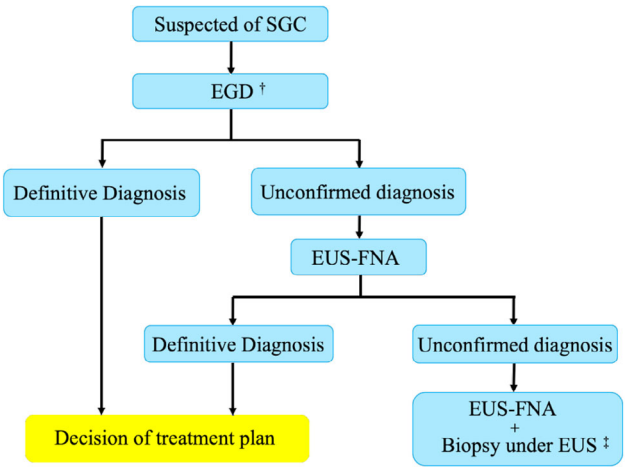

Figure 5 Diagnostic algorithm for suspected scirrhous gastric cancer at our institution. †Including endoscopic findings and sophagogastroduodenoscopy-biopsy. ‡In addition to endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) re-examination, biopsy of the site of gastric wall thickening under endoscopic ultrasonography should be performed in combination.

Discussion

In contrast to other GCs, SGC is a special type of carcinoma in which poorly differentiated carcinoma cells or signet-ring cells invade the submucosa primarily.[16,17] Therefore, changes in tumor on the surface of the gastric mucosa are rare, and when they do occur, the endoscopic findings are varied and atypical, making early detection difficult.[8] Even when SGC could be detected, it is common for the patient to present with lymph node metastasis or peritoneal dissemination.[1] Currently, the incidence of SGC is on the rise, requiring increasingly rapid and accurate diagnosis.[17] Generally, the diagnosis of SGC is made by a combination of CT, endoscopy, and EGD-biopsy; for AGC other than SGC, the combination of endoscopy and EGD-biopsy is said to provide a

definitive diagnosis of >90%; however, when limited to SGC, the definitive diagnostic proportion is reported to be approximately 50%.[6,7] CT, especially delayed phase scan, is reported to be more accurate than EGD because it has a relatively high SGC diagnostic proportion of approximately 75% and can also search for lymph node and distant metastases. However, the main drawback of CT is that it does not allow pathological evaluation.[7] Considering this background, the following methods have also become increasingly popular in recent years to improve the diagnostic proportion of SGC: jumbo biopsy, bite-on-bite technique, snaring biopsy, and tissue retrieval using EMR and ESD techniques.[18–20] Compared to EGD-biopsy, these tissue collection methods may contribute to a somewhat higher diagnostic proportion. However, the difficulty of reliable tissue collection from the submucosa and a certain number of adverse events such as bleeding and perforation make them impractical.[20] Therefore, we conducted this study because we believed that EUS-FNA, which combines endoscopic, ultrasonographic, and pathologic functions, may contribute to improved diagnostic proportion of SGC.[21] To our knowledge, this is the first systematic review and meta-analysis of SGC diagnostic proportion by EUS-FNA. The strength of our study is the detailed extraction of EUS-FNA diagnostic proportion, adverse event rates, and study duration in patients with suspected SGC according to clearly defined selection criteria. In this study, the technical success proportion of EUS-FNA, SGC diagnostic proportion, and adverse events rates in patients with SGC were 100%, 82.6% (95% CI: 74.6–90.6%), and 0%, respectively, with a low heterogeneity. Furthermore, the mean duration of these studies was 64 months (SD = 16 months). EUS-FNA, which allows minimally invasive and reliable tissue collection from the submucosal layer, is still likely to be useful in patients with suspected SGC. EUS-FNA is the next best choice, especially for EGD-biopsy-negative patients with suspected SGC, because it can evaluate minimal endoscopic findings and the ultrasound function allows detailed observation of the wall structure of the suspected tumor site. EUS findings in SGC include thickening of the gastric wall with relatively preserved layered structure due to diffuse interfascicular infiltration or loss of layered structure due to cancer cell proliferation within all layers. Considering the growth form and morphologic characteristics of SGC, the ability to collect tissue from deeper layers, such as the submucosa and muscular layer, would markedly contribute to improving the diagnosis proportion. Through this study, we propose a diagnostic algorithm for SGC in our institution (Fig. 5).

The limitations of our study are as follows: First, few studies have examined EUS-FNA diagnostic proportions for patients with suspected SGC. Second, the results of this meta-analysis were derived from only four retrospective studies. Third, we were able to compare the diagnostic proportion of SGC only between EUS-FNA and EGD-biopsy and not with any other diagnostic modalities, including EMR and ESD. Fourth, since EUS-FNA requires more endoscopic skills than EGD, it may not ensure uniformity in the skill of endoscopists, even though it can be compared with the previously reported SGC diagnostic proportion by EGD-biopsy.

Overall, the results of our systematic review and meta-analysis suggest that EUS-FNA may be useful for patients with SGC with negative EGD-biopsy. Further studies comparing EUS-FNA with other definitive diagnostic methods, including EGD-biopsy, for patients with suspected SGC are warranted.

Conclusion

We believe that EUS-FNA is a useful examination modality because of its minimally invasive nature and high tissue diagnostic proportion. In particular, we consider it to be a useful alternative for patients with suspected SGC who cannot be definitively diagnosed by CT or EGD-biopsy.

Acknowledgments

We thank our study participants for their invaluable contribution to this project. Support for compiling the manuscript based on the authors' detailed instructions was provided by Editage (www.editage.com), a division of Cactus Communications.

References

1 Jung K, Park MI, Kim SE, Park SJ. Borrmann type 4 advanced gastric cancer: focus on the development of scirrhous gastric cancer. *Clinc. Endosc.* 2016; **49**: 336–45.
2 Zhu YL, Yang L, Sui ZQ, Liu L, Du JF. Clinicopathological features and prognosis of Borrmann type IV gastric cancer. *J. B.U.ON.* 2016; **21**: 1471–5.
3 An JY, Kang TH, Choi MG, Noh JH, Sohn TS, Kim S. Borrmann type IV: an independent prognostic factor for survival in gastric cancer. *J. Gastrointest. Surg.* 2008; **12**: 1364–9.
4 Lee DH. Early endoscopic finding of Borrmann type IV. *Korean J. Gastrointest. Endosc.* 2005; **30**: S81–6.
5 Lee JH. Hypertrophic gastritis and Borrmann type IV. *Korean J. Gastrointest. Endosc.* 2010; **40**: S83–5.
6 Voutilainen ME, Juhola MT. Evaluation of the diagnostic accuracy of gastroscopy to detect gastric tumours: clinicopathological features and prognosis of patients with gastric cancer missed on endoscopy. *Eur. J. Gastroenterol. Hepatol.* 2005; **17**: 1345–9.
7 Kim JI, Kim YH, Lee KH *et al*. Type-specific diagnosis and evaluation of longitudinal tumor extent of Borrmann type IV gastric cancer: CT versus gastroscopy. *Korean J. Radiol.* 2013; **14**: 597–606.
8 Ye Y, Tan S. Endoscopic ultrasound-guided fine-needle aspiration biopsy for diagnosis of gastric linitis plastica with negative malignant endoscopy biopsies. *Oncol. Lett.* 2018; **16**: 4915–20.
9 Liu Y, Chen K, Yang XJ. Endoscopic ultrasound-guided fine-needle aspiration used in diagnosing gastric linitis plastica: metastatic lymph nodes can be valuable targets. *J. Gastroenterol. Hepatol.* 2019; **34**: 202–6.
10 Zhou XX, Ji F, Xu L *et al*. EUS for choosing best endoscopic treatment of mesenchymal tumors of upper gastrointestinal tract. *World J. Gastroenterol.* 2011; **17**: 1766–71.
11 Page MJ, McKenzie JE, Bossuyt PM *et al*. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021; **372**: n71.
12 Cotton PB, Eisen GM, Aabakken L *et al*. A lexicon for endoscopic adverse events: report of an ASGE workshop. *Gastrointest. Endosc.* 2010; **71**: 446–54.
13 Takada R, Minaga K, Hara A *et al*. Diagnostic value of EUS-guided fine-needle aspiration biopsy for gastric linitis plastica with negative endoscopic biopsy. *J. Clin. Med.* 2021; **10**: 3716.
14 Assaf A, Terris B, Palmieri LJ *et al*. Endoscopic ultrasound guided fine needle biopsy in patients with suspected gastric linitis plastica. *Clin. Res. Hepatol. Gastroenterol.* 2022; **46**: 101903.

15 Guyatt GH, Oxman AD, Kunz R *et al*. GRADE guidelines: 7. Rating the quality of evidence—inconsistency. *J. Clin. Epidemiol.* 2011; **64**: 1294–302.
16 Ikeguchi M, Miyake T, Matsunaga T *et al*. Recent results of therapy for scirrhous gastric cancer. *Surg. Today*. 2009; **39**: 290–4.
17 Luo Y, Gao P, Song Y *et al*. Clinicopathologic characteristics and prognosis of Borrmann type IV gastric cancer: a meta-analysis. *World J. Surg. Oncol.* 2016; **14**: 49.
18 Komanduri S, Keefer L, Jakate S. Diagnostic yield of a novel jumbo biopsy "unroofing" technique for tissue acquisition of gastric submucosal masses. *Endoscopy*. 2011; **43**: 849–55.
19 Liu YM, Yang XJ. Endoscopic ultrasound-guided cutting of holes and deep biopsy for diagnosis of gastric infiltrative tumors and gastrointestinal submucosal tumors using a novel vertical diathermic loop. *World J. Gastroenterol.* 2017; **23**: 2795–801.
20 Zhou XX, Pan HH, Usman A *et al*. Endoscopic ultrasound-guided deep and large biopsy for diagnosis of gastric infiltrating tumors with negative malignant endoscopy biopsies. *World J. Gastroenterol.* 2015; **21**: 3607–13.
21 Pellicano R, Bruno M, Fagoonee S, Ribaldone DG, Fasulo R, De Angelis C. Endoscopic ultrasound in the preoperative staging of gastric cancer: key messages for surgeons. *Minerva Chir.* 2015; **70**: 417–27.

Supporting information

Additional supporting information may be found in the online version of this article at the publisher's website:

Table S1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 checklist.

Table S2. Newcastle–Ottawa Scale (NOS) for assessing the quality of retrospective studies included in the systematic review. The mean overall quality score of NOS for the included four studies was 5.5.