ISSN 1007-9327 (print)
ISSN 2219-2840 (online)

World Journal of *Gastroenterology*

World J Gastroenterol 2022 December 14; 28(46): 6433-6618

Published by Baishideng Publishing Group Inc

World Journal of Gastroenterology

Contents

Weekly Volume 28 Number 46 December 14, 2022

REVIEW

MINIREVIEWS

ORIGINAL ARTICLE

Basic Study

Clinical and Translational Research

Clinical Trials Study

Randomized Controlled Trial

World Journal of Gastroenterology

Weekly Volume 28 Number 46 December 14, 2022

Contents

World Journal of Gastroenterology

Weekly Volume 28 Number 46 December 14, 2022

Contents

NAME OF JOURNAL

World Journal of Gastroenterology

ISSN

ISSN 1007-9327 (print) ISSN 2219-2840 (online)

LAUNCH DATE

October 1, 1995

FREQUENCY

Weekly

EDITORS-IN-CHIEF

Andrzej S Tarnawski

EDITORIAL BOARD MEMBERS

http://www.wjgnet.com/1007-9327/editorialboard.htm

PUBLICATION DATE

December 14, 2022

INSTRUCTIONS TO AUTHORS

https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS

https://www.wjgnet.com/bpg/GerInfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH

https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS

https://www.wjgnet.com/bpg/GerInfo/288

PUBLICATION MISCONDUCT

https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE

https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS

https://www.wjgnet.com/bpg/GerInfo/239

ONLINE SUBMISSION

https://www.f6publishing.com

World Journal of Gastroenterology

Submit a Manuscript: https://www.f6publishing.com

World J Gastroenterol 2022 December 14; 28(46): 6564-6572

DOI: 10.3748/wjg.v28.i46.6564

ISSN 1007-9327 (print) ISSN 2219-2840 (online)

ORIGINAL ARTICLE

Clinical Trials Study

Diagnostic evaluation of endoscopic ultrasonography with submucosal saline injection for differentiating between T1a and T1b early gastric cancer

Ji Young Park, Tae Joo Jeon

Specialty type: Gastroenterology and hepatology

Provenance and peer review: Invited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): C, C
Grade D (Fair): 0
Grade E (Poor): E

P-Reviewer: Arigami T, Japan; Ban T, Japan; Bestetti AM, Brazil

Received: August 24, 2022
Peer-review started: August 24, 2022
First decision: September 2, 2022
Revised: September 22, 2022
Accepted: November 22, 2022
Article in press: November 22, 2022
Published online: December 14, 2022

Ji Young Park, Tae Joo Jeon, Department of Internal Medicine, Inje University College of Medicine, Sanggye Paik Hospital, Seoul 01757, South Korea

Ji Young Park, Department of Internal Medicine, Yonsei University College of Medicine, Seoul 03722, South Korea

Corresponding author: Tae Joo Jeon, MD, PhD, Professor, Department of Internal Medicine, Inje University College of Medicine, Sanggye Paik Hospital, 1342, Dongil-ro, Nowon-gu, Seoul, Seoul 01757, South Korea. drjtj@paik.ac.kr

Abstract

BACKGROUND

Endoscopic ultrasonography (EUS) has become a reliable method for predicting the invasion depth of early gastric cancer (EGC). However, diagnostic accuracy of EUS is affected by several factors. In particular, it is difficult to differentiate between T1a and T1b EGC through EUS.

AIM

To confirm whether submucosal saline injection (SSI) could improve the accuracy of EUS in distinguishing T1a and T1b lesions in EGC.

METHODS

Twenty-four patients with EGC were examined by EUS and subsequently by SSI combined EUS to compare the degree of tumor invasion. Then, they underwent endoscopic or surgical resection within 7 d. The diagnostic accuracy of EUS and SSI combined EUS was evaluated based on the final pathological findings postoperatively. Saline injected into the submucosa acted as an echoic contrast enhancing agent and had the effect of distinguishing the mucosal and submucosal layers clearly.

RESULTS

Of total 24 patients, 23 were diagnosed with EGC (T1 cancer: 13 as T1a, and 10 as T1b). Standard EUS identified 6 of 13 T1a cancer patients and 3 of 10 T1b cancer patients. Whereas, EUS-SSI identified 12 of 13 T1a cancer patients and 6 of 10 T1b cancer patients. In this study, SSI combined EUS was more accurate than EUS alone in diagnosing T1a and T1b lesions of EGC (75.0% and 37.5%, respectively).

CONCLUSION
SSI improved the diagnostic accuracy of EUS in distinguishing between the T1a and T1b stages in EGC.

Key Words: Endoscopic ultrasonography; Gastric cancer; Endoscopy; Surgery

Core Tip: Submucosal saline injection improved the diagnostic accuracy of endoscopic ultrasonography in distinguishing between the T1a and T1b stages in early gastric cancer.

Citation: Park JY, Jeon TJ. Diagnostic evaluation of endoscopic ultrasonography with submucosal saline injection for differentiating between T1a and T1b early gastric cancer. *World J Gastroenterol* 2022; 28(46): 6564-6572
URL: https://www.wjgnet.com/1007-9327/full/v28/i46/6564.htm
DOI: https://dx.doi.org/10.3748/wjg.v28.i46.6564

INTRODUCTION

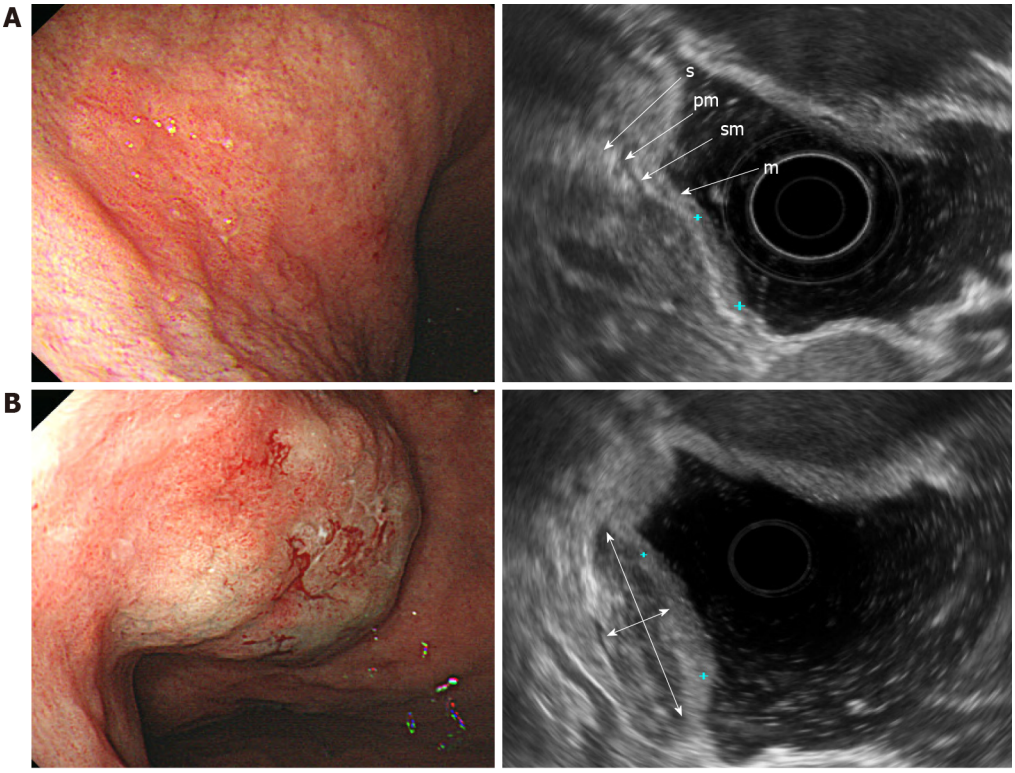
Early gastric cancer (EGC) is a malignant lesion confined to the mucosa or submucosa (SM), regardless of lymph-node metastasis[1,2]. Endoscopic submucosal dissection (ESD) is widely used to treat EGC, and the indications for ESD are expanded in the cases assumed to have a low risk of lymph-node metastasis[3-5]. Even if the pathological depth of invasion is T1b (tumor invading the SM), ESD can be performed if the invasion is confined to SM1 (submucosal invasion to < 500 μm from the muscularis mucosae)[6,7]. However, an additional surgery is recommended for EGC when deep submucosal invasion is identified by pathological evaluation after ESD (more than SM2; depth of submucosal invasion, ≥ 500 μm) owing to the risk of lymph-node metastasis[8]. Therefore, the depth of invasion (T-stage) of gastric cancer is vital for determining the treatment strategy[3-7]. Endoscopic ultrasonography (EUS) has been used for T-staging of gastric cancer[9,10]. Although previous studies showed the clinical efficacy of EUS in T-staging of gastric cancer, the results have revealed a wide level of variability[1,2,11]. The diagnostic accuracy may be affected by endoscopic findings, lesion location, tumor size, and the skill of the examiner[1,12]. Specifically, EUS is difficult to distinguish between T1a (tumor invading the lamina propria and muscularis mucosae) and T1b lesions because the boundary between the mucosa and submucosa is thin and the difference in echogenicity is unclear[1,10].

Submucosal saline injection (SSI) is routinely administered prior to ESD to prevent damage to the surrounding tissue of the gastric wall and to avoid perforation during ESD[13]. SSI creates a cushion within the loose connective tissues of the submucosa, which has been reported as an effective medium and echoic contrast-enhancing agent for ultrasound transmission, enabling good distinction between the mucosal and submucosal layers[13-15]. Moreover, saline can increase the thickness of the submucosa [13-15]. According to previous studies, SSI improved the performance of EUS in characterizing the invasion depth of esophageal and colorectal cancers[13-15]. Therefore, this study was conducted to confirm whether SSI could be a method to improve the accuracy of EUS in distinguishing T1a and T1b lesions even in EGC and determine the feasibility of EUS for beginners.

MATERIALS AND METHODS

Case series

Methods: During March–April 2019, 24 endoscopically diagnosed EGC lesions in 24 patients were examined by EUS. The macroscopic tumor classification was as follows: type I (protruded), type IIa (superficial elevated), type IIb (flat), type IIc (superficial depressed), and type III (excavated). Types I and IIa were classified as the elevated type, and IIb IIc, and III as the depressed type. All patients underwent standard EUS followed by EUS with SSI (EUS-SSI). EUS findings of T1a gastric cancers were defined as low-echoic lines of muscularis mucosae that were clearly demarcated from the submucosa, and T1b gastric cancers on EUS were defined as low-echoic line lesions that were not clearly distinguished from the boundary of submucosal layer. Subsequently, they underwent endoscopic or surgical resection within 7 d. Definitive classification was determined based on the postoperative pathology. All recruited patients agreed to be enrolled as participants in this clinical trial and were provided informed consent. This study was approved by the Institutional Review Board of the Inje University Sanggye Paik Hospital (SGPAIK2021-10-019).



DOI: 10.3748/wjg.v28.i46.6564

Figure 1 Endoscopic and ultrasonographic images and associated schematic diagrams of T1a early gastric cancer. A: Standard endoscopic ultrasonography (EUS) showing that it is difficult to differentiate the extent of invasion from the mucosal layer to the submucosal layer; B: EUS after submucosal saline injection showing clearly the boundary between the mucosa and the submucosa, meaning that the T1a stage can be easily identified. m: Mucosa; sm: Submucosa; pm: Proper muscle; s: Serosa; double arrow, saline layer.

EUS examination and staging were simultaneously conducted by one endoscopist with only 6 mo' experience with EUS. The examiner performed EUS with a 12-MHz ultrasonic probe (Olympus GF-UE260-AL5 Endoscopic System, Olympus Co., Tokyo, Japan). SSI was thereafter conducted as follows: after the lesion was confirmed by conventional endoscopy and subsequently by iodine dye-enhanced endoscopy, the examiner injected 3–5 mL saline slowly into the submucosa using a single-use 22G mucosal needle (Endo-Flex Co., Voerde, Germany). The puncture points were located 0.5 cm beyond the edge of the lesion, and saline injection was stopped once the gastric mucosa had been elevated by approximately 1 cm. After SSI, the examiner determined the depth of the lesion using EUS.

RESULTS

All patients showed good tolerance of EUS-SSI without severe adverse events, such as significant bleeding, asphyxia, perforation, or problems related to anesthetics.

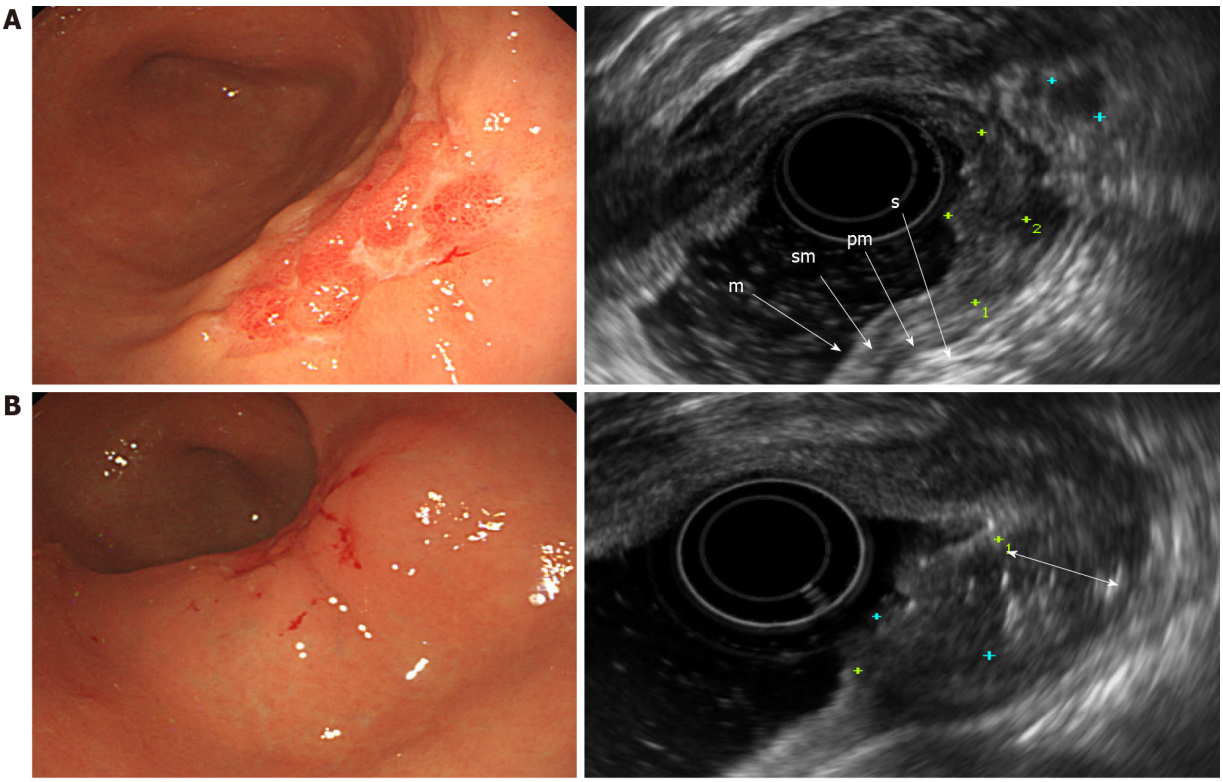
Of total 24 patients, 23 were diagnosed with EGC (T1 cancer: 13 as T1a, and 10 as T1b), except for one who was diagnosed with T2 cancer after the surgery. According to the macroscopic classification of tumors, there were 4 patients with elevated type lesions and 20 with depressed-type lesions. In 12 of the patients, the pathological T-stage was different between the standard EUS and EUS-SSI. Among them, EUS-SSI findings were consistent with the final pathological findings in 10 patients and standard EUS findings were consistent in one patient. The other patient was diagnosed with EGC stage-T2, which differed before and after the surgery (Table 1).

EGC was observed by using standard EUS as a localized thickening of the gastric mucosa or depression of the mucosal wall with a relatively low echogenicity. In patients with stage T1a disease, the muscularis mucosae was displayed as a low-echoic line between the mucosa and submucosa (Figure 1A). On the other hand, in patients with stage T1b, the muscularis mucosae was not clearly distinguished, and the boundary between the submucosal layer and the lower margin of the lesion was blurred, making it difficult to determine the degree of invasion of the submucosal layer on standard EUS (Figure 2A). After SSI, the mucosa had relatively enhanced echogenicity compared to the submucosa that was filled with saline. The boundary between the edge of the lesion and submucosa was apparent after SSI due to the saline-formed cushion in the submucosa (Figure 1B and 2B). Since the echoic difference between the lesion and the surrounding normal tissue became clear in EUS-SSI, the

Table 1 Clinical features, endoscopic ultrasonography findings before and after submucosal saline injection, and pathological results of 24 patients with early gastric cancer

Patient No.	Age	Sex	Location	Size (max, mm)	Endoscopic morphology (EGC type)	Ulcer	EUS-assessed preoperative stage		Final pathology	Type of resection	Differentiation	Regional LN invasion	Vascular invasion
							Before SSI (EUS-only)	After SSI (EUS-SSI)					
1	72	M	Lower third	20	0-III	Y	T1a	T1b	T1b (sm3)	Surgery	Mod		
2	64	M	Lower third	20	0-IIc		T1b	T1b	T1b (sm1)	Surgery	Poor (signet ring)	Y	
3	59	M	Lower third	10	0-IIc		T1b	T1b	T1b (sm1)	Surgery	Poor		
4	53	M	Upper third	27	0-IIa		T1a	T1a	T1a	Surgery	Mod		
5	56	F	Lower third	38	0-IIc		T1b	T1a	T1a	Surgery	Poor		
6	73	M	Upper third	22	0-IIc		T1b	T1a	T1a	Surgery	Mod		
7	62	M	Mid third	65	0-IIc		T1b	T1a	T1a	Surgery	Mod		
8	68	M	Upper third	8	0-IIb		T1a	T1a	T1a	ESD	Well		
9	69	M	Lower third	15	0-IIa		T1a	T1a	T1a	ESD	Well		
10	71	M	Lower third	17	0-IIb		T1b	T1a	T1a	ESD	Poor		
11	54	F	Lower third	25	0-IIc		T1b	T1a	T1a	Surgery	Poor (signet ring)		
12	82	M	Upper third	15	0-IIb		T1a	T1a	T1b (sm1)	ESD	Poor		
13	71	F	Lower third	25	0-IIc		T1b	T1b	T1b (sm3)	Surgery	Poor	Y	Y
14	36	F	Lower third	20	0-IIc		T1a	T1b	T1b (sm3)	Surgery	Poor	Y	
15	60	M	Lower third	10	0-IIc		T1a	T1a	T1a	ESD	Mod		
16	62	F	Mid third	50	0-IIc		T2	T1b	T1b (sm3)	Surgery	Poor		
17	74	F	Upper third	25	0-IIb		T1a	T1a	T1b (sm1)	Surgery	Poor		
18	60	F	Upper third	15	0-IIa		T1a	T1b	T2	Surgery	Poor (signet ring)		
19	80	F	Lower third	15	0-IIb		T1a	T1b	T1a	ESD	Poor		
20	48	F	Lower third	45	0-IIc		T1a	T1a	T1b (sm3)	Surgery	Poor		
21	72	F	Lower third	10	0-IIc		T1a	T1a	T1b (sm1)	ESD	Mod		
22	50	M	Lower third	27	0-IIb		T1a	T1a	T1a	ESD	Well		
23	74	M	Upper third	15	0-IIc		T1b	T1a	T1a	Surgery	Mod		
24	76	M	Upper third	23	0-Is		T1b	T1a	T1a	Surgery	Well		

EGC: Early gastric cancer; EUS: Endoscopic ultrasonography; SSI: Submucosal saline injection.



DOI: 10.3748/wjg.v28.i46.6564

Figure 2 Endoscopic and ultrasonographic images and associated schematic diagrams of T1b early gastric cancer. A: Standard endoscopic ultrasonography (EUS) showing that it is difficult to differentiate the extent of invasion from the mucosal layer to the submucosal layer; B: EUS after submucosal saline injection (SSI) showing clearly the boundary between the mucosa and the submucosa, meaning that the lesion, its infiltration depth into the mucosa, and the submucosa can be easily identified. m: Mucosa; sm: Submucosa; pm: Proper muscle; s: Serosa; double arrow, saline layer.

extent of tumor invasion was more distinct than that demonstrated by standard EUS (Figure 3).

Standard EUS identified 6 of 13 T1a cancer patients and 3 of 10 T1b cancer patients. Whereas, EUS-SSI identified 12 of 13 T1a cancer patients and 6 of 10 T1b cancer patients. The diagnostic accuracies of the standard EUS and EUS-SSI are shown in Table 2 (37.5% and 75.0%, respectively).

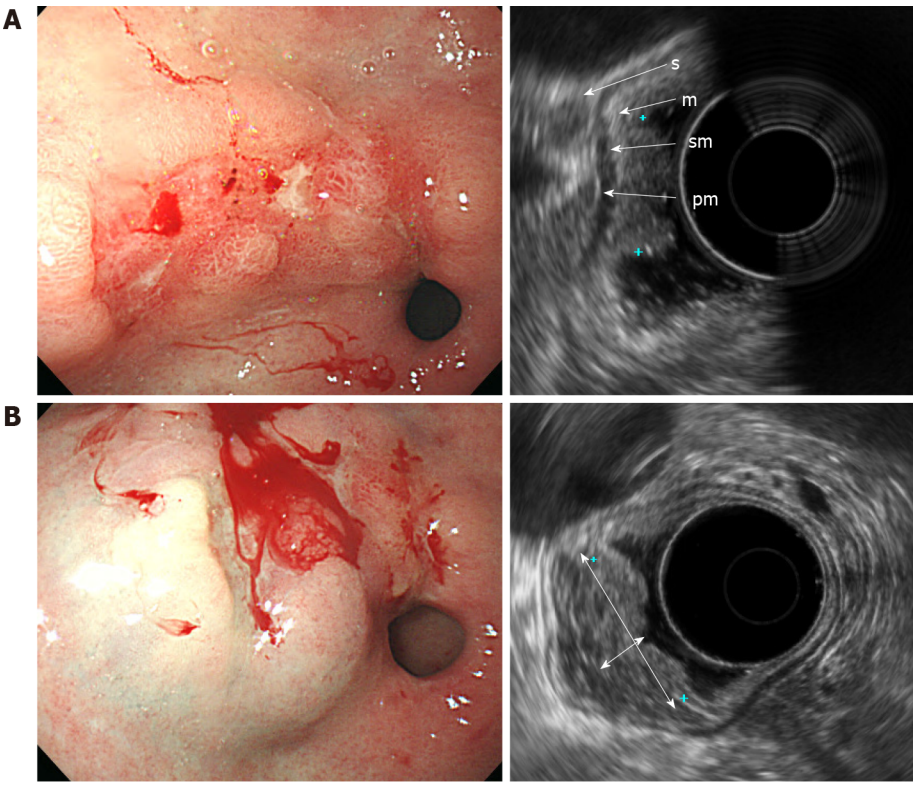
DISCUSSION

EUS accurately characterizes the locoregional stage of gastric cancer and although the diagnostic accuracy of EUS in evaluating the invasion of depth of EGC has been reported, the results lack a consensus and have varying accuracy rates of 64.8%-92%[9-11]. Several studies also concluded that EUS has no significant advantage over conventional endoscopy in predicting the invasion depth[16]. Hence, it has been clarified that the accuracy of EUS can vary greatly depending on the experience of the endoscopist, macroscopic type of tumor, presence of ulceration, tumor located in the stomach, tumor size, and differentiation type[1,9,10,12]. Regarding ulcerative lesions, submucosal fibrosis occurs, which is observed on EUS as a hypoechoic lesion, similar to tumor invasion[2,10,16]. For lesions in the upper third of the stomach, the accuracy of EUS may decrease because of the different thicknesses of the stomach layer and presence of fibrosis or blood vessels surrounding the tumor[10,16]. In addition, it is difficult to fill the deaerated water and locate the EUS probe near the lesion because of the angulation of the EUS scope[10,16]. Previous studies have reported that a large tumor size is a risk factor for misdiagnosing the depth of invasion[10]. This is probably because the lesions might not extend even if the deaerated water is stored in cases of large tumors[11]. Undifferentiated-type tumors might have a diffuse or vesicular invasion of tumor cells to the submucosal layer of the gastric wall compared to differentiated-type tumors[11]. Thus, EUS cannot visualize these microinvasions and might underestimate the depth of invasion[11]. In our study, reviewing 15 patients with different results between final pathology and EUS-only findings, all patients had tumors located in the upper third of the stomach, sized ≥ 2 cm, ulcerative lesions, or undifferentiated type.

Table 2 Preoperative and postoperative stages for early gastric cancer in the endoscopic ultrasonography after submucosal saline injection and endoscopic ultrasonography -only examinations

Preoperative EUS reported stage	Postoperative pathologic stage	
	T1a	T1b
EUS-SSI, *n* (%)		
T1a	12 (92.3)	4 (40)
T1b	1 (7.7)	6 (60)
EUS-only, *n* (%)		
T1a	6 (46.2)	6 (66.7)
T1b	7 (53.8)	3 (33.3)

EUS: Endoscopic ultrasonography; SSI: Submucosal saline injection.



DOI: 10.3748/wjg.v28.i46.6564

Figure 3 Endoscopic and ultrasonographic images and associated schematic diagrams of T1a early gastric cancer. A: With the use of standard endoscopic ultrasonography (EUS), the boundary between the lesion and the submucosal layer was unclear. The distance between the mucosa and the submucosa was short. This lesion was diagnosed as T1b as it appeared to partially invade the submucosa when observed with standard EUS; B: With the use of endoscopic ultrasonography after submucosal saline injection (EUS-SSI), the boundary between the lesion and the submucosal layer was apparent. It was much easier to determine whether the lesion had invaded the submucosal layer due to the increased thickness of the gastric wall and an effect of increasing echoic contrast by saline cushion. This lesion was diagnosed as T1a as the submucosal layer was intact when observed with EUS-SSI. m: Mucosa; sm: Submucosa; pm: Proper muscle; s: Serosa; double arrow, saline layer.

Regardless of the tumor characteristics, the diagnostic accuracy of EUS in predicting the T-stage of EGC in this study was 37.5%, which is low compared to that reported in previous studies. This study was conducted by a beginner endoscopist with approximately 6 mo' experience. To increase the diagnostic accuracy of EUS for staging of gastric cancer, an endoscopist with a high experience and proficiency is required, but some techniques are also required for the classification of EGC. EUS may overestimate the depth of invasion due to underlying inflammation or fibrosis[10,11,16]. EUS-SSI showed improved results in reducing the overestimation and overall diagnostic accuracy (Table 3). By reducing over-staging, an unnecessary surgery can be avoided, surgery-related adverse events can be prevented, the recovery period can be further shortened, and the patient's quality of life can be

Table 3 The misdiagnosis rate for T staging of early gastric cancer in the endoscopic ultrasonography after submucosal saline injection and endoscopic ultrasonography -only examinations

	EUS-only	EUS-SSI
Overstaging, *n* (%)	8 (33.3)	1 (4.2)
Understaging, *n* (%)	7 (29.2)	5 (20.8)

EUS: Endoscopic ultrasonography; SSI: Submucosal saline injection.

improved.

As limitations, we noted that EUS-SSI required a longer examination time than EUS-only, which may cause more patient discomfort. However, the patients in this study did not complain of discomfort and did not develop any adverse events related to SSI.

In our study, SSI improved the diagnostic accuracy of EUS in distinguishing between the T1a and T1b stages in EGC. This is probably because the saline injected into the submucosa serves as an echoic contrast-enhancing agent for the clear visualization of the boundary between the mucosa and the submucosa. However, our study is a clinical study conducted at a single institution, and the sample size is small, so there is a limit to interpreting the results. Therefore, a large-scale, prospective, randomized clinical trials for this are needed in the future. In particular, we suggest that beginners who are beginning EUS should try the EUS-SSI method when evaluating the depth of invasion of gastric cancer.

CONCLUSION

SSI improved the diagnostic accuracy of EUS in distinguishing between the T1a and T1b stages in EGC in this study. However, this needs to be confirmed in large-scale, prospective, randomized clinical trials in the future.

ARTICLE HIGHLIGHTS

Research background

Although endoscopic ultrasound (EUS) is a method to predict the depth of invasion in early gastric cancer (EGC), it is still difficult to differentiate between T1a and T1b EGCs *via* EUS.

Research motivation

In particular, we considered a method to increase the accuracy of diagnosis for endoscopists who are beginning to perform EUS. It was thought that submucosal saline injection (SSI) during endoscopic mucosal resection may be helpful for examination because it can expand the submucosal layer.

Research objectives

The objectives of this study was to confirm whether SSI could be a method to improve the accuracy of EUS in distinguishing T1a and T1b lesions even in EGC and determine the feasibility of EUS for beginners.

Research methods

During March-April 2019, 24 endoscopically diagnosed EGC lesions in 24 patients were examined by EUS. All patients underwent standard EUS followed by EUS with SSI (EUS-SSI). Thereafter, endoscopic or surgical resection was performed within 7 days. T1a and T1b lesions were diagnosed based on the final pathology results after treatment. The diagnostic accuracy of EUS and EUS-SSI for T stage was compared.

Research results

Standard EUS identified 6 of 13 T1a cancer patients and 3 of 10 T1b cancer patients. Whereas, EUS-SSI identified 12 of 13 T1a cancer patients and 6 of 10 T1b cancer patients. In this study, SSI combined EUS was more accurate than EUS alone in diagnosing T1a and T1b lesions of EGC (75.0% and 37.5%, respectively).

Research conclusions

SSI improved the diagnostic accuracy of EUS in distinguishing between the T1a and T1b stages in EGC

in this study. However, this needs to be confirmed in large-scale, prospective, randomized clinical trials in the future.

Research perspectives

In our study, SSI improved the diagnostic accuracy of EUS in distinguishing between the T1a and T1b stages in EGC. In particular, we suggest that beginners who are beginning EUS should try the EUS-SSI method when evaluating the depth of invasion of gastric cancer. However, our study is a clinical study conducted at a single institution, and the sample size is small. Therefore, a large-scale, prospective, randomized clinical trials for this are needed in the future.

FOOTNOTES

Author contributions: Jeon TJ and Park JY contributed to conception and design; Park JY contributed to acquisition of data (acquired and managed patients); Jeon TJ contributed to development of methodology; Jeon TJ and Park JY contributed to analysis and interpretation of data; Park JY contributed to writing and review of manuscript; Park JY and Jeon TJ contributed to study supervision.

Institutional review board statement: The study was reviewed and approved by the Institutional Review Board of the Inje University Sanggye Paik Hospital (SGPAIK2021-10-019).

Clinical trial registration statement: This study is registered at "Clinical Research Information Service (https://cris.nih.go.kr)". The registration identification number is KCT0007919.

Informed consent statement: All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

Conflict-of-interest statement: Dr Ji Young Park and Tae Joo Jeon declare that they have no conflicts of interest.

Data sharing statement: No additional data are available.

CONSORT 2010 statement: The authors have read the CONSORT 2010 statement, and the manuscript was prepared and revised according to the CONSORT 2010 statement.

Country/Territory of origin: South Korea

ORCID number: Ji Young Park 0000-0002-5299-3820; Tae Joo Jeon 0000-0002-8137-1633.

S-Editor: Liu JH
L-Editor: A
P-Editor: Liu JH

REFERENCES

1 **Tsuzuki T**, Okada H, Kawahara Y, Nasu J, Takenaka R, Inoue M, Kawano S, Kita M, Hori K, Yamamoto K. Usefulness and problems of endoscopic ultrasonography in prediction of the depth of tumor invasion in early gastric cancer. *Acta Med Okayama* 2011; **65**: 105-112 [PMID: 21519368 DOI: 10.18926/AMO/45269]
2 **Park JS**, Kim H, Bang B, Kwon K, Shin Y. Accuracy of endoscopic ultrasonography for diagnosing ulcerative early gastric cancers. *Medicine (Baltimore)* 2016; **95**: e3955 [PMID: 27472672 DOI: 10.1097/MD.0000000000003955]
3 **Fukunaga S**, Nagami Y, Shiba M, Ominami M, Tanigawa T, Yamagami H, Tanaka H, Muguruma K, Watanabe T, Tominaga K, Fujiwara Y, Ohira M, Hirakawa K, Arakawa T. Long-term prognosis of expanded-indication differentiated-type early gastric cancer treated with endoscopic submucosal dissection or surgery using propensity score analysis. *Gastrointest Endosc* 2017; **85**: 143-152 [PMID: 27365265 DOI: 10.1016/j.gie.2016.06.049]
4 **Lee S**, Choi KD, Han M, Na HK, Ahn JY, Jung KW, Lee JH, Kim DH, Song HJ, Lee GH, Yook JH, Kim BS, Jung HY. Long-term outcomes of endoscopic submucosal dissection *vs* surgery in early gastric cancer meeting expanded indication including undifferentiated-type tumors: a criteria-based analysis. *Gastric Cancer* 2018; **21**: 490-499 [PMID: 29052052 DOI: 10.1007/s10120-017-0772-z]
5 **Fujiya K**, Takizawa K, Tokunaga M, Kawata N, Hikage M, Makuuchi R, Tanizawa Y, Bando E, Kawamura T, Tanaka M, Kakushima N, Ono H, Terashima M. The value of diagnostic endoscopic submucosal dissection for patients with clinical

submucosal invasive early gastric cancer. *Gastric Cancer* 2018; **21**: 124-132 [PMID: 28484889 DOI: 10.1007/s10120-017-0724-7]

6 **Sanomura Y**, Oka S, Tanaka S, Noda I, Higashiyama M, Imagawa H, Shishido T, Yoshida S, Hiyama T, Arihiro K, Chayama K. Clinical validity of endoscopic submucosal dissection for submucosal invasive gastric cancer: a single-center study. *Gastric Cancer* 2012; **15**: 97-105 [PMID: 21785925 DOI: 10.1007/s10120-011-0076-7]

7 **Ojima T**, Takifuji K, Nakamura M, Nakamori M, Yamaue H. Feasibility of Endoscopic Submucosal Dissection for Submucosal-invasive Gastric Cancer and the Predictors of Residual or Recurrent Cancer. *Surg Laparosc Endosc Percutan Tech* 2016; **26**: 401-405 [PMID: 27636148 DOI: 10.1097/SLE.0000000000000315]

8 **Gotoda T**, Yanagisawa A, Sasako M, Ono H, Nakanishi Y, Shimoda T, Kato Y. Incidence of lymph node metastasis from early gastric cancer: estimation with a large number of cases at two large centers. *Gastric Cancer* 2000; **3**: 219-225 [PMID: 11984739 DOI: 10.1007/pl00011720]

9 **Hwang SW**, Lee DH. Is endoscopic ultrasonography still the modality of choice in preoperative staging of gastric cancer? *World J Gastroenterol* 2014; **20**: 13775-13782 [PMID: 25320515 DOI: 10.3748/wjg.v20.i38.13775]

10 **Kuroki K**, Oka S, Tanaka S, Yorita N, Hata K, Kotachi T, Boda T, Arihiro K, Chayama K. Clinical significance of endoscopic ultrasonography in diagnosing invasion depth of early gastric cancer prior to endoscopic submucosal dissection. *Gastric Cancer* 2021; **24**: 145-155 [PMID: 32572791 DOI: 10.1007/s10120-020-01100-5]

11 **Shi D**, Xi XX. Factors Affecting the Accuracy of Endoscopic Ultrasonography in the Diagnosis of Early Gastric Cancer Invasion Depth: A Meta-analysis. *Gastroenterol Res Pract* 2019; **2019**: 8241381 [PMID: 31933632 DOI: 10.1155/2019/8241381]

12 **Ahn HS**, Lee HJ, Yoo MW, Kim SG, Im JP, Kim SH, Kim WH, Lee KU, Yang HK. Diagnostic accuracy of T and N stages with endoscopy, stomach protocol CT, and endoscopic ultrasonography in early gastric cancer. *J Surg Oncol* 2009; **99**: 20-27 [PMID: 18937292 DOI: 10.1002/jso.21170]

13 **Li JJ**, Shan HB, Gu MF, He L, He LJ, Chen LM, Luo GY, Xu GL. Endoscopic ultrasound combined with submucosal saline injection for differentiation of T1a and T1b esophageal squamous cell carcinoma: a novel technique. *Endoscopy* 2013; **45**: 667-670 [PMID: 23807801 DOI: 10.1055/s-0033-1344024]

14 **He LJ**, Xie C, Wang ZX, Li Y, Xiao YT, Gao XY, Shan HB, Luo LN, Chen LM, Luo GY, Yang P, Zeng SC, Xu GL, Li JJ. Submucosal Saline Injection Followed by Endoscopic Ultrasound *vs* Endoscopic Ultrasound Only for Distinguishing between T1a and T1b Esophageal Cancer. *Clin Cancer Res* 2020; **26**: 384-390 [PMID: 31615934 DOI: 10.1158/1078-0432.CCR-19-1722]

15 **Watanabe H**, Miwa H, Terai T, Imai Y, Ogihara T, Sato N. Endoscopic ultrasonography for colorectal cancer using submucosal saline solution injection. *Gastrointest Endosc* 1997; **45**: 508-511 [PMID: 9199910 DOI: 10.1016/s0016-5107(97)70182-2]

16 **Kim J**, Kim SG, Chung H, Lim JH, Choi JM, Park JY, Yang HJ, Han SJ, Oh S, Kim MS, Kim HJ, Hong H, Lee HJ, Kim JL, Lee E, Jung HC. Clinical efficacy of endoscopic ultrasonography for decision of treatment strategy of gastric cancer. *Surg Endosc* 2018; **32**: 3789-3797 [PMID: 29435750 DOI: 10.1007/s00464-018-6104-5]

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: bpgoffice@wjgnet.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com