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Original Article

Variations in Clinical Practice of Esophageal High-resolution Manometry: A Nationwide Survey

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Background/Aims
Esophageal high-resolution manometry (HRM) enables the comprehensive evaluation of the esophageal motor function. However, protocols are not uniform and clinical practices vary widely among institutions. This study aims to understand the current HRM practice in Korea.

Methods
The survey was sent via email through the Korean Society of Neurogastroenterology and Motility. The questions covered descriptive information, preparation, techniques, analysis, and reporting of esophageal HRM.

Results
The survey was completed in 32 (74.4%) out of 43 centers, including 24 tertiary and 8 secondary referral centers. Of the 32 centers, 25 (78.1%) performed HRM in a sitting position, while 7 centers (21.9%) reported performing HRM in a supine position. All the centers utilized single wet swallows as a standard, but the volume, frequency, and interval between swallows varied widely. Sixteen centers (50.0%) applied adjunctive tests, including multiple rapid swallows (n = 16) and rapid drink challenges (n = 9). Parameters assessed and documented in the report were similar. In addition to the assessment of the esophagogastric junction and esophageal body, 27 centers (84.8%) and 18 centers (56.3%) included measurements for the upper esophageal sphincter and the pharynx, respectively, in the HRM protocol.

Conclusions
We found a variation in the available HRM practice among centers, even though they broadly agreed in the data analysis. Efforts are needed to develop a standardized protocol for HRM measurement.
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Key Words
Clinical practice pattern; Esophageal motility disorders; Manometry

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Introduction

Esophageal manometry is indicated in patients with dysphagia and is considered the gold standard for the diagnosis of achalasia.[1] Esophageal high-resolution manometry (HRM) enables the comprehensive evaluation of esophageal motor function.[2,3] Although the Chicago classification for esophageal motor disorders is widely accepted as a standard, the detailed measurement protocols are not uniform and vary according to centers and physicians.[4] In addition, the presumed normative values are different according to the measurement position, the measurement system, or the software used in the analysis.[5-7] In a recent international survey, marked variations were observed across centers in the data acquisition, analysis, and reporting of esophageal HRM.[8]

We hypothesized that the current practice of esophageal HRM varied widely among different centers within the same country. This study aims to understand the current esophageal HRM practices in Korea, especially the measurement protocols.

Materials and Methods

We collected the data on the current esophageal HRM practice using a survey sent by email to 43 centers in Korea where HRM is performed. The centers without clinical experience of esophageal HRM were not eligible for participation. This study did not involve patient-specific clinical data and did not require ethical approval.

Following a literature review, we drafted the survey which was reviewed by the members of the Dysphagia Research Group Under the Korean Society of Neurogastroenterology and Motility. Our goal was to focus on the protocols used for esophageal HRM measurements. We edited and tailored the questions to cover topics such as tools and equipment, indications, preparation, measurement protocols, data analysis, and reporting. We included closed and open-ended questions in the survey instrument. Any questions deemed not effective were re-worded until the intended aim of the question was reached. Finally, the survey included 20 questions available in Korean and was estimated to take 10 minutes (Supplementary Material).

The survey was sent by email starting October 2019 through the Korean Society of Neurogastroenterology and Motility, and the responses were received until March 2020. We sent the survey to a representative doctor in each center and collected one response on behalf of each center. We sent monthly reminders to maximize response rate. The data were analyzed quantitatively using the number of observations and proportions.

Results

The survey was completed by 32 centers out of 43, which gave a response rate of 74.4%. Among the respondents, 24 centers (75.0%) were tertiary referral centers, and 8 (25.0%) were secondary referral centers.

Equipment and Preparation

More than half of the surveyed centers used the Given Imaging system (Given Imaging Ltd, Los Angeles, CA, USA) (n = 17 [53.1%]), followed by the Sandhill Scientific (Sandhill Scientific Inc, Ranch, CO, USA) (n = 12 [37.5%]) and the Medical Measurements Systems (MMS, Enschede, Netherlands) (water-perfused system, n = 3 [9.4%]). The indications for esophageal HRM included dysphagia, noncardiac chest pain, and reflux symptoms (Table 1). Out of the 32 centers, 17 (53.1%) recommended not to eat or drink at least 6 hours before the HRM study, whereas 14 centers (43.8%) recommended fasting at midnight. Most centers reviewed the medication history of the patients, especially for antispasmodics, calcium channel blockers, nitrates, and opioids. Among the surveyed centers, 27 (84.4%) recommended discontinuing medication 2 to 7 days before test, while 5 centers did not recommend any change. In terms of withholding medication before tests, antispasmodics were not allowed in 26 centers (81.3%),

Table 1. Indications and Preparation of Esophageal High-resolution Manometry

Variables	n (%)
Indications	
Dysphagia	32 (100.0)
Reflux symptoms	24 (75.0)
Refractory GERD	27 (84.4)
Noncardiac chest pain	28 (87.5)
Before anti-reflux surgery	20 (62.5)
Fasting before HRM	
6 hours	17 (53.1)
8 hours	1 (3.1)
Midnight NPO	14 (43.8)
Discontinuation of medication before HRM	27 (84.4)
Antispasmodics	26 (81.3)
Calcium channel blockers	23 (71.9)
Nitrates	19 (59.4)
Opioids	16 (50.0)

GERD, gastroesophageal reflux disease; HRM, high-resolution manometry; NPO, nil per os.

calcium channel blockers in 23 centers (71.9%), nitrates in 19 centers (59.4%), and opioids in 16 centers (50.0%). Twenty-five centers (78.1%) applied a local anesthetic to the nares using a lidocaine jelly or a spray before the insertion of the catheter.

Measurement Protocol

More than three-quarters of the centers (n = 25 [78.1%]) reported performing esophageal HRM in the sitting position, while 7 centers (21.9%) performed the measurement in the supine position (Table 2). Two centers performed the measurement in both the supine and the semi-recumbent positions. The reference pressure was set at atmospheric pressure in 7 centers and gastric pressure in 13 centers.

All the centers used single wet swallows as a standard. However, the volume of each swallow, the overall numbers of swallows, and the interval between swallows varied according to the centers (Fig. 1). Eighteen centers (56.3%) performed wet swallows 10 times using 5 mL of water or saline, with at least 30 seconds of intervals between the swallows. Additionally, 4 centers (12.5%) performed viscous swallows and 1 center utilized solid swallows. Sixteen centers (50.0%) employed provocation tests, including multiple rapid swallows (MRS, n = 16) and rapid drink challenges (RDC, n = 9). Out of the 16 centers utilizing provocation tests, 7 centers (21.9%) conducted them with all patients, whereas 9 centers (28.1%) used them as additional tests when needed.

Table 2. Study Protocols for Esophageal High-resolution Manometry

Variables	n (%) or median (range)
Position	
Supine	7 (21.9)
Sitting	25 (78.1)[a]
Semi-recumbent	2 (9.4)[a]
Swallows	
Volume (mL)	5 (2-20)
Number (times)	10 (10-15)
Interval between swallows (seconds)	30 (10-40)
Utilization of provocation test	16 (50.0)
All patients	7 (21.9)
Selected patients	9 (28.1)
Provocation test	
Multiple rapid swallows	16 (50.0)
Rapid drink challenges	9 (28.1)
Viscous swallow	4 (12.5)
Solid swallow	1 (3.1)

[a]One center performed the test in both supine and sitting position, and another center performed the test in both sitting and semi-recumbent position.

Data Analysis

The parameters routinely documented in reporting are summarized in Figure 2. All centers reported the resting lower esophageal sphincter pressure and the integrated relaxation pressure (IRP). Twenty-four centers (75.0%) assessed the morphology of the esophagogastric junction (EGJ) and 15 centers (46.9%) estimated the EGJ-contractile integral. Most centers assessed the distal contractile integral and the distal latency, and 22 centers (68.8%) included the contractile front velocity in the analysis. The characteristics of the upper esophageal sphincter were determined in 27 centers (84.8%). Additionally, 18 centers (56.3%) included pharyngeal measurements in their HRM protocol.

Discussion

In this study, we investigated the pattern in the current practices of esophageal HRM using a nationwide survey. Although the

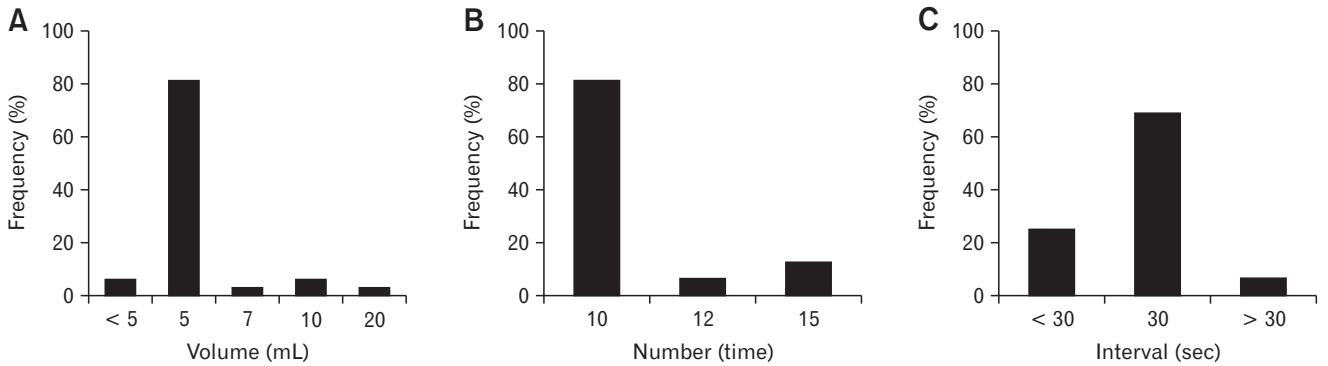

Figure 1. Frequency of protocols used for single wet swallow during esophageal high-resolution manometry. (A) Volume of each swallow. (B) Total number of swallows required for analysis. (C) Interval between swallows.

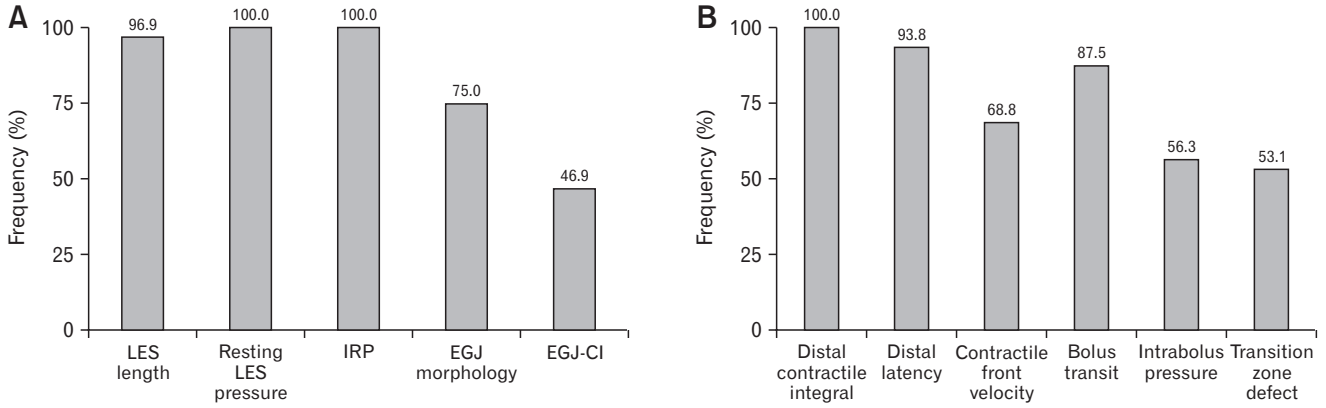

Figure 2. Measurement parameters utilized to determine the esophageal motor function. (A) Esophagogastric junction (EGJ). (B) Esophageal body. EGJ-CI, esophagogastric junction-contractile integral; IRP, integrated relaxation pressure; LES, lower esophageal sphincter.

HRM metrics used for data analysis and reporting were similar, the study protocols varied widely among centers. We found a great heterogeneity in terms of the study position, the frequency and volume of single wet swallows, and the utilization of provocation tests among the different Korean centers.

The current HRM criteria for the diagnosis of esophageal motility disorders are based on the analysis of ten 5 mL swallows performed in the supine position.[4] Interestingly, in our survey, we found that only 21.9% of the centers performed the study in the supine position, whereas more than three-quarters of them used the sitting position. A previous international survey also found that 41.8% of the centers included seated swallows in the analysis and 17.6% performed upright-seated swallows only.[8] The rationale for using the sitting position is based on the concept that an upright or a seated position is more physiologic than a supine position, which can generate a risk of aspiration during the study in patients with dysphagia. The current recommendation does not discourage the use of the upright or seated positions and the measurement positions are not likely to affect the diagnosis of the major motility disorders.[9,10] On the other hand, recent systematic reviews consistently showed that the distal contractile integral is significantly lower in the upright position than in the supine position.[10,11] Since at least some HRM metrics are position-dependent, it is necessary to establish and utilize posture-specific normative values in esophageal HRM.[6,12-15] Otherwise, a change of position could be included in the standard supine protocol as an adjunctive or complementary tool to enhance the diagnostic performance of esophageal HRM.

In our survey, all centers utilized single wet swallow as a standard. However, we found that the detailed protocol to collect single swallows varied widely among centers. The differences included the volume of each swallow, the overall number of swallows, and the interval between swallows. About half of the centers performed wet swallows using 5 mL of water or saline, with an interval of 30 seconds or more. In contrast, 6.3% of the centers utilized less than 5 mL of water or saline for single swallows, and 25.0% of them preceded subsequent sequence within 30 seconds. In addition, 18.8% of the centers performed more than 10 wet swallows during the study. Similarly, an international survey found that 69.2% of the centers utilized 15 to 20 liquid swallows, which may reflect the physicians' effort to obtain high-quality data.[8] The current guideline recommends the use of ten 5 mL wet swallows with an interval of 20 to 30 seconds between swallows for the testing of esophageal motility and the interpretation of data.[9] However, the optimal frequency or the minimum requirement of single swallows to obtain analyzable data remain uncertain and require further standardization. The results of this survey could be helpful to better understand the current clinical practice patterns and to establish a consensus for esophageal HRM.

Increasing the volume and the consistency of swallows may also provide additional information on alternative diagnoses and may reveal pathology undetectable with the current protocol. In a previous study, viscous and solid swallows revealed obstructive physiology in 14.7% of the patients whose IRP was normal or borderline with single wet swallows.[14] In addition, standardized test meals can be used to detect EGJ obstruction.[16] These tests are more likely to induce symptoms and thus increase the diagnostic yield of esophageal HRM. However, at the same time, several HRM parameters can be changed according to the bolus volume and consistency.[17] Therefore, it is recommended to follow a standard protocol using an established volume of wet swallows and to use additional provocative bolus challenges including viscous and solid swallows. In our survey, 81.3% of the centers utilized 5 mL swallows, while the

others performed single wet swallows with various amount of bolus. These variations in the measurement protocol should be further standardized to improve the quality of esophageal HRM.

Adjunctive tests, including MRS and RDC, provide clinically relevant information regarding the esophageal motor function.[18-20] The clinical usefulness of MRS has been studied in patients with gastroesophageal reflux diseases or ineffective esophageal motility, as a tool to estimate their peristaltic reserve.[21,22] On the other hand, RDC is useful to assess the EGJ function.[23] Although there is a growing body of evidence, the measurement and analysis protocols, and the reproducibility of each provocation test have not been established yet.[24,25] Based on the current survey, only half of the centers utilized adjunctive tests as part of their measurements. Moreover, only 43.8% of these centers included provocation tests in their routine measurement protocol, and others performed provocation tests as required. These results are different from a previous international survey which showed that 92.3% of the centers utilized provocation tests and that 76.9% of them used MRS or RDC.[8] This may reflect a regional difference in the disease spectrum and the presence of indicative symptoms requiring esophageal HRM.[26]

The normative values for esophageal HRM are equipment- or software-specific. Therefore, specific normal values for systems or catheters are required to diagnose esophageal motility disorders correctly according to the Chicago classification.[9] The normative values for esophageal HRM were established initially using catheters with 36 channels solid-state HRM system.[18,27-29] More recently, normal values for water-perfused esophageal HRM have also been established and compared to those for solid-state HRM.[30] Notably, the data obtained from healthy volunteers showed a moderate to good agreement between solid-state and water-perfused HRM for most parameters but showed a fair agreement for IRP.[30] Other studies using a different water-perfused system also showed a lower value in the upper limits of normal for IRP than for solid-state system.[31,32] In terms of data analysis, a previous international survey showed that 71.4% of the centers utilized manufacturer-specific normal values, 22.0% used locally validated normal values, and 13.2% did not use the normal values specific to their systems.[8] In our survey, the majority of the centers used solid-state systems and only 9.4% used water-perfused systems. Given that the normative values for the esophageal HRM parameters in the Korean population have not yet been investigated, further research is needed to establish the normative values for HRM using a standardized protocol. A comparative analysis of the normative values according to each device is also required.

There are several limitations to this study. Firstly, we did not consider the quality and confidence of esophageal HRM in each center. In addition, we did not investigate the volume of centers and patient throughput. Secondly, the clinical practice varies between physicians even within the same center. In the current study, we obtained only one response from each center. Thus, the reporting may not fully represent the practice and views of all the physicians working in the same center. Third, despite a high response rate, the amount of non-response may suggest a possible response bias. However, the response bias is a systematic error inherent to this type of research and we have made every attempt to minimize it by sending out reminders on a monthly-basis. Despite these limitations, this nationwide survey provides the first evidence on the clinical practice of esophageal HRM in Korea and promotes better understanding of the current practice.

In conclusion, we observed variations in the current practice of esophageal HRM among centers, even though they all seemed to broadly agree on the data analysis and reporting. The lack of uniformity was found mainly in the detailed protocol of single wet swallows and the utilization of provocation tests, which stresses the need for standardized protocols for esophageal HRM. These results can be considered as a basis for the future development of a consensus on the standard clinical practice of esophageal HRM.

Supplementary Materials

Note: To access the supplementary material mentioned in this article, visit the online version of *Journal of Neurogastroenterology and Motility* at http://www.jnmjournal.org/, and at https://doi.org/10.5056/jnm20217.

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