Published in final edited form as:

Gastrointest Endosc. 2010 July ; 72(1): 155–160. doi:10.1016/j.gie.2010.01.056.

Efficacy of a Prototype Endoscope with Two Deflecting Working Channels for Endoscopic Submucosal Dissection (ESD): A Prospective Comparative Ex-vivo Study

Suck-Ho Lee, MDPhD¹, Mark A. Gromski, BA², Alexandre Derevianko, MD³, Daniel B. Jones, MD⁴, Douglas K. Pleskow, MD¹, Mandeep Sawhney, MD¹, Ram Chuttani, MD¹, and Kai Matthes, MD, PhD¹

¹ Department of Gastroenterology, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA

² Harvard Medical School, Boston, MA

³ Shapiro Simulation and Skills Center, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA

⁴ Department of Surgery, Division of Minimally Invasive Surgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA

Abstract

Background—Optimizing the visualization of the cutting line of the submucosal layer is essential to performing an effective and safe endoscopic submucosal dissection (ESD).

Objective—To evaluate the prototype R-scope compared to a conventional double-channel endoscope in time required for ESD of mucosal lesions in distinct anatomical locations of the stomach.

Design—A prospective, comparative ex-vivo study.

Methods—An ex-vivo endoscopy simulator utilizing fresh porcine stomachs was used for the resections. Forty lesions located in distinct locations (greater curvature, lesser curvature, anterior and posterior wall) were randomized to undergo ESD with either the conventional endoscope (n = 20) or the R-scope (n = 20).

Setting—N/A

Patients—N/A

Interventions—ESD

Main Outcome Measurements—procedure time (primary endpoint), specimen size, submucosal injection frequency, en bloc resection rate, perforation rate (secondary endpoints)

Corresponding Author : Kai Matthes, MD, PhD Department of Gastroenterology, Beth Israel Deaconess Medical Center 330 Brookline Avenue, Stoneman 4 Phone: (617) 901-7613 Fax: (978) 415-0091 kmatthes@bidmc.harvard.edu.

Institutions Participating in Study: Beth Israel Deaconess Medical Center

Meeting Presentations: None

Disclosures:

Dr. Lee, Mr. Gromski, Dr. Derevianko, Dr. Jones, Dr. Pleskow, Dr. Sawhney and Dr. Chuttani report no disclosures relevant to this study.

Dr. Matthes reports being Chief Executive Officer of Endosim, LLC. He reports no other disclosures relevant to this study.

Results—In the subgroup of resections in the greater and lesser curvature, the mean procedure time was significantly less in the R-scope group compared to the conventional group (8.4 ± 2.1 min vs 11.3 ± 2.1 min, respectively; $P = 0.006$) and the mean submucosal injection frequency was significantly less in the R-scope group compared to the conventional group (1.9 ± 0.6 vs 2.5 ± 0.5 , respectively; $P = 0.025$).

There were no significant differences in procedure time, specimen size, submucosal injection requirements, en bloc resection rate and perforation rate between the two endoscopic groups of all combined anatomic lesions.

Limitations—Small, ex-vivo study.

Conclusions—ESD utilizing the R-scope may provide an improved platform for quicker ESD with equivalent safety, especially in greater and lesser curvature anatomical lesions of the stomach.

INTRODUCTION

Endoscopic mucosal resection (EMR) is an established treatment modality for excision of early stage neoplastic lesions in the GI tract.¹ One problem that is encountered in EMR, however, is the difficulty in achieving a complete en bloc resection. Endoscopic submucosal dissection (ESD) was developed to overcome this problem.^{1,2} Benefits of ESD include the capability of providing higher en bloc resection rates, precise histologic evaluation, and lower recurrence rates of gastrointestinal malignancies.^{1,2} However, ESD has not been widely adopted, due to its technical difficulty, high incidence of complications (bleeding, 10%; perforation, 4-10%), need for advanced endoscopic techniques, and longer procedure times.^{1,2} Therefore, newly designed instruments that overcome these challenges are needed.

Recently, a prototype dual-channel endoscope that offers two working channels with deflectors of the working channel trajectory at the distal tip was introduced (R-scope, Olympus, Tokyo, Japan). This endoscope was initially designed for ESD, but has been used increasingly for other advanced procedures, such as Natural Orifice Translumenal Endoscopic Surgery (NOTES).^{3,4} The two channel deflectors are capable of making two unique, separate and individualized movements. The trajectory of the left working channel is manipulated in a vertical direction by moving a lever next to the steering wheels, similar to the elevator of ERCP duodenoscopes. The deflector of the right working channel changes the direction of the canal in a horizontal direction by turning a wheel at the shaft of the endoscope. By using the vertical lever, the R-scope allows vertical lifting of a lesion to provide adequate visualization of the submucosal layer, while the other channel may utilize the horizontal swing motion to facilitate an easier and more efficient dissection.

The primary aim of this study is to evaluate the R-scope versus a conventional endoscope for time to complete the ESD of mucosal lesions in distinct anatomical locations. The secondary aims include evaluating the R-scope versus a conventional endoscope in specimen size, submucosal injection requirements, en bloc resection rate and perforation rate. We separated the lesions into anatomic location: greater curvature, lesser curvature, anterior stomach and posterior stomach. We hypothesize that the R-scope may perform better, in regards to swifter resection, in the lesser and greater curvature sites, as the visualization of those lesions would situate the lesions in the ideal location for the working channels (allowing the grasping forceps to perform vertical elevation of the lesions).

METHODS

The study was designed as a prospective, randomized ex-vivo study. We used a modified Erlangen Active Simulator for Interventional Endoscopy for the ex-vivo experiments

(EASIE-R™, Endosim, LLC, Berlin, MA). This simulator consists of a porcine upper GI organ package (esophagus, stomach and proximal duodenum) suspended in the EASIE-R simulator (Figure 1). The study was exempt from IRB approval since there were no human research subjects or live animal tissue being involved.

A total of 40 target lesions were created in fresh ex-vivo porcine stomachs at four different anatomical sites. The target areas, measuring 3 cm × 3 cm, were demarcated on: 1) the greater curvature (n=10), 2) the lesser curvature (n=10), 3) the anterior wall (n=10), and 4) the posterior wall (n=10) of the corpus-antrum transition region of the stomachs by monopolar coagulation dots with a needle knife (Olympus KD-1L, Olympus Endotherapy). The lesions were then randomized to undergo ESD with either the conventional double-channel endoscope (GIF-2T 160, Olympus America Inc., Center Valley, PA; n = 20, Conventional Group) or the prototype R-scope (XGIF-2TQ260ZMY, Olympus Japan Inc.; n = 20, R-scope Group) by grouped randomization. Four envelopes marked GC (greater curvature), LC (lesser curvature), AW (anterior wall) and PW (posterior wall) contained ten pieces of paper each, five labeled R (R-scope) and five labeled C (conventional scope). After creation of the target lesion, a piece of paper was drawn from each respective envelope, and the corresponding endoscope was used for that resection. This method was utilized to ensure each anatomical sub-group contained equal numbers of lesions with each respective endoscope.

Using a 23-gauge disposable injector (Olympus NM-201L, Olympus Endotherapy), 0.9% normal saline was injected into the submucosa to lift the lesion. The injection volume was determined to be appropriate by observation of a tissue elevation sufficient to perform ESD safely. Repeated submucosal injections in addition to the initial injection of 0.9% normal saline were administered, if needed, to maintain a safe minimum level of elevation and were counted. A pre-cut incision was made circumferentially with a needle knife and blended electrosurgical unit current (UES-30 generator, 40 W output; Olympus America Inc.).

In the conventional group, direct dissection of the submucosal layer was carried out with the needle knife until complete removal of the lesion was achieved. During the ESD, a transparent distal cap (Olympus Endotherapy) was attached to the tip of the endoscope to optimize visualization (Figure 2a). In the R-scope group, a prototype R-scope was used for the ESD. With the R-scope, a grasping forceps (Olympus FG6L, Olympus Endotherapy) was placed in the left working channel and a needle knife was inserted through the right working channel. The forceps in the left channel were used to grasp the lesion which provided exposure of the submucosal space for dissection (Figure 2b). The forceps were repositioned as needed to give adequate visualization for dissection. Using this arrangement, the needle knife could be moved horizontally to the left or right for effective dissection by using the control wheel.

Procedure time, en bloc resection rate, the size of the specimens resected, frequency of submucosal re-injections, and the number of full thickness gastric perforations were recorded individually by an independent observer. The procedure time was measured from the time of introduction of the selected endoscope to complete excision of the lesion from the stomach bed. The en bloc resection rate, size of the specimens resected and number of full thickness gastric perforations were determined by dissection of the porcine stomachs after completion of the ESD procedures. After dissection and exploration of the stomach, the excised lesion was retrieved and measured with a standard metric measuring tape. The lesion and lesion bed were explored to determine en bloc resection status. The stomach wall was interrogated manually for full thickness gastric perforations. Repeated submucosal injections were recorded. To preclude interprocedural bias, all ESD procedures were performed by a single experienced endoscopist.

The sample size was determined by assuming that a novel device (R-scope) would decrease the procedure time by 30%. Given an $\alpha = 0.05$ and a power of 80%, a sample size of 18 lesions was required for each endoscope group (R-scope vs conventional). Data were analyzed using statistical software (SPSS version 13.0; SPSS Inc, Chicago, IL). Categorical variables were compared by using the χ^2 test and continuous variables were compared using the Student's t-test. We considered a p value < 0.05 to be statistically significant.

RESULTS

All lesions were successfully resected utilizing the ESD technique by an experienced endoscopist. The resected specimens were whole and complete (in one piece, with no appreciable holes or multiple pieces) in 37/40 cases, with no significant difference between the two groups and an average thickness of the resected specimens of 2.8 mm (SD 1.2 mm). All parameters (procedure time, specimen size, injection frequency, en bloc resection status and full-thickness gastric perforations) were successfully recorded by an independent observer for each procedure.

Comparison According to Anatomic Location

We analyzed mean procedure time, mean submucosal injection frequency, mean specimen size, en bloc resection rate and full thickness gastric perforation rate within two separate site categories (greater and lesser curvature / anterior and posterior). In the greater and lesser curvature sites, the mean procedure time was significantly shorter in the R-scope group compared with the conventional group (8.4 ± 2.1 min vs 11.3 ± 2.1 min, respectively; $P = 0.006$). Also, within the greater and lesser curvature division, the mean submucosal injection frequency was significantly less in the R-scope group compared with that of the conventional group (1.9 ± 0.6 vs 2.5 ± 0.5 , respectively; $P = 0.025$). The other comparative parameters, including specimen size, en bloc resection rate and perforation rate, had no significant differences (Table 1).

In the anterior and posterior anatomic group, there were no significant differences in mean procedure time, specimen size, submucosal injection frequency, en bloc resection rate and full-thickness gastric perforation rate (Table 2).

Overall Comparison of Endoscopes

For all anatomical sites, the mean procedure time was 9.7 ± 3.4 min in the R-scope group and 11.3 ± 3.4 min in the conventional group ($P = 0.143$). The mean resected lesion diameter was 29.6 ± 2.5 mm in the R-scope group and 29.9 ± 2.7 mm in the conventional group ($P = 0.715$). The mean submucosal injection frequency was 2.25 ± 0.64 injections in the R-scope group and 2.55 ± 0.61 injections in the conventional group ($P = 0.135$). En bloc resection rate in the R-scope group was 90% and was 95% in the conventional group ($P = 0.545$). Full-thickness gastric perforation rate was 5% in the R-scope group and was 10% in the conventional group ($P = 0.545$).

There were no significant differences in the procedure time, specimen size, submucosal injection frequency, en bloc resection rate or full-thickness gastric perforation between the two groups in all anatomic locations ($P > 0.05$) (Table 3).

DISCUSSION

Improving the cutting line visualization of the submucosal layer is essential to optimizing the effectiveness and safety of ESD.¹ Poor visualization of the submucosal layer may result in a more technically difficult dissection, piecemeal resection, prolonged procedure, increased complications and potential for higher local recurrence of malignancy.^{1,2} There

are two ways to achieve an adequate direct visualization of the submucosal layer. One is utilization of a long-lasting submucosal injection solution and the other is effective tissue traction. To increase the duration of elevation, several solutions with high viscosity, such as hydroxypropyl methylcellulose (HPMC), hyaluronic acid, glycerol and fibrinogen have been proposed.⁶⁻⁹ These solutions have the potential of increasing the en bloc resection rate and decreasing the procedure time, injection volume and the need for additional submucosal injections to maintain the elevation of the lesion. However, there are several limitations encountered, including high cost, infliction of tissue damage, limited commercial availability, smoke production and the possibility of carcinogenesis.⁶⁻⁹

Recently, various traction devices and techniques have been introduced to aid in effective tissue traction, including the specific spring-action S-O clip, internal traction techniques using clips and string, peroral or percutaneous traction, magnetic anchor-guided traction and double-endoscopic intraluminal traction.¹⁰⁻¹⁴ But, these various traction systems have considerable limitations. For instance, percutaneous traction-assisted EMR requires a laparoscopic port, with a trocar and general anesthesia. Peroral traction-assisted ESD cannot be applied in the treatment of colorectal lesions and in cases requiring the dissection to start from the proximal portion of the lesion through retroflexion. S-O clip traction or internal traction using nylon string requires repetitive manipulations of the nylon loop or clip with forceps during the dissection. When utilizing a magnetic anchor system, the most ideal traction requires manipulation in all directions, which requires a large and expensive device.

The prototype R-scope used in this study may improve the lifting of lesions and allow an improved dissection by introducing the unique, separate motions of two individual channels. One channel allows for the use of a grasping forceps which can be moved vertically to lift the lesion up, enabling countertraction, and the second channel allows the use of an electrosurgical knife to be used in a horizontal movement for lesion dissection. This prototype endoscope has the potential to be applied and have the most impact in two different fields of therapeutic endoscopy, NOTES and ESD.

There have been two successful reports regarding the efficacy of the R-scope in NOTES, including transgastric cholecystectomy and transvaginal and transgastric pancreatectomy.¹⁵⁻¹⁸ The authors were able to successfully perform cholecystectomies and pancreatectomies in most survival animals and also decreased the operative time significantly. The R-scope had important roles in adequate tissue exposure and effective dissection. In the field of ESD, a feasibility study and a retrospective comparative study have been reported. Neuhaus and colleagues tested the R-scope for ESD of 17 predetermined gastric areas in eight anesthetized pigs and, later, prospectively obtained data using the R-scope in ESD in 10 human patients with early gastric neoplasia.³ ESD succeeded in 14/17 animal cases (82%) and in 6/10 human cases (60%). Three perforations (18%) occurred in the animal cases and four additional surgeries (40%) were required in the human cases (two for perforation and two for incomplete resection). The authors interpreted that their sub-optimal results may have been related to insufficient volume of solution being injected submucosally, excessively forceful lifting of the specimen or the short learning period. This study also utilized an earlier R-scope version which had a “swan neck” double bending section on the distal end and the lifting channel on the right side, which is different from the current R-scope prototype. On the contrary, Yonezawa and colleagues retrospectively compared 20 consecutive patients with superficial gastric neoplasms who underwent resection of their tumor by ESD using the R-scope with 40 size- and location-matched gastric neoplasms resected using conventional ESD.⁴ The authors concluded that the rates of curative en-bloc resection, complications and local recurrence using the two ESD methods were comparable. However, the mean operating time was significantly shorter for the ESD procedures using the R-scope compared to conventional ESD. Due to the

conflicting results between these two studies, this prospective comparative study was conducted.

It was hypothesized in this study that the use of the prototype R-scope would decrease the procedure time compared to the use of a conventional endoscope. In our study, the procedure time and the requirements for repeated submucosal injections of normal saline were significantly decreased in the R-scope group in the greater and lesser curvature anatomical sites. This faster ESD is likely explained by the specific axial motion of the R-scope. In the greater and lesser curvature sites, the lesion was visualized horizontally, allowing vertical elevation with the grasping forceps and effective dissection with the horizontal swinging of the knife.

On the contrary, in the anterior and posterior anatomic sites, there was not a significant decrease in procedure time with the R-scope. In these anatomic locations, the lesions were visualized in the vertical plane. With the lesion oriented vertically to the axis of the scope, the dissection had to be performed with an up-down movement of the needle knife while providing retraction of the lesion using the forceps in the horizontally directed working channel. This orientation was considered slightly more challenging due to the fact that ideal motions could not be accomplished effectively in the anterior and posterior sites with the R-scope, in comparison to the greater and lesser curvature positions.

Other end points of this comparative study were en bloc resection rate, specimen size and full-thickness gastric perforation. These rates using the two different ESD methods were comparable and not significantly different. This study was not powered to detect significant differences in complications, such as gastric perforation, thus the safety profile may not be able to be accurately characterize the safety profile of each endoscope.

One limitation of this study is the character of the lesions. We used only moderate-sized (20-30mm) lesions. Also, the lesions were classified into four discreet anatomical regions. It can be presumed that large and proximally located lesions are more difficult to perform successful ESD, compared to small and distally located lesions. Thus, a future study will be designed to test the efficacy of the R-scope with more various size and site categories.

Another limitation is the inability to assess bleeding as a complication in this model. Bleeding is an important complication of ESD and the ability to provide hemostasis for bleeding vessels is an important skill for any endoscopist performing ESD. Considering this, however, our primary outcome was not the occurrence of bleeding or the ability to provide hemostasis for bleeding, since that complication is rather operator skill- and experience-dependent. We set out to focus on endoscope-dependent outcome variables. The lack of bleeding as a potential complication may have decreased the time required to perform ESD in this study. The time may be shorter than some clinical settings due to a.) our focus on the feasibility and speed of performing the resections in order to compare the two different endoscopes efficiently by their technical function for ESD b) the lesions were standardized, uniform and of limited size c.) there was no potential for bleeding.

In conclusion, the R-scope may be considered an effective endoscope to optimize the efficiency of ESD in greater and lesser curvature anatomic locations of the stomach. The R-scope may decrease injection frequency and result in a shorter procedure in certain clinical situations.

Acknowledgments

Grant Support:

Endosim, LLC (Material Support)

Olympus America (Material Support)

REFERENCES

1. ASGE TECHNOLOGY COMMITTEE. Kantsevov SV, Adler DG, Conway JD, et al. Endoscopic mucosal resection and endoscopic submucosal dissection. *Gastrointest Endosc.* 2008; 68:11–8. [PubMed: 18577472]
2. Chung IK, Lee JH, Lee SH, et al. Therapeutic outcomes in 1000 cases of endoscopic submucosal dissection for early gastric neoplasms: Korean ESD Study Group multicenter study. *Gastrointest Endosc.* 2009; 69:1228–35. [PubMed: 19249769]
3. Neuhaus H, Costamagna G, Devière J, et al. ARCADE Group. Endoscopic submucosal dissection (ESD) of early neoplastic gastric lesions using a new double-channel endoscope (the “R-scope”). *Endoscopy.* 2006; 38:1016–23. [PubMed: 17058167]
4. Yonezawa J, Kaise M, Sumiyama K, et al. A novel double-channel therapeutic endoscope (“R-scope”) facilitates endoscopic submucosal dissection of superficial gastric neoplasms. *Endoscopy.* 2006; 38:1011–5. [PubMed: 17058166]
5. Matthes K, Cohen J, Kochman ML, et al. Efficacy and costs of a one-day hands-on EASIE endoscopy simulator train-the-trainer workshop. *Gastrointest Endosc.* 2005; 62:921–7. [PubMed: 16301038]
6. Yamamoto H, Yube T, Isoda N, et al. A novel method of endoscopic mucosal resection using sodium hyaluronate. *Gastrointest Endosc.* 1999; 50:251–6. [PubMed: 10425422]
7. Mukai M, Ito I, Mukoyama S, et al. Endoscopic mucosal resection of superficially spreading colonic neoplasms larger than 5 cm in the right colon after injection of dilute sodium hyaluronate: report of two cases. *Endoscopy.* 2003; 35:973–4. [PubMed: 14606024]
8. Feitoza AB, Gostout CJ, Burgart LJ, et al. Hydroxypropyl methylcellulose: a better submucosal fluid cushion for endoscopic mucosal resection. *Gastrointest Endosc.* 2003; 57:41–7. [PubMed: 12518129]
9. Lee SH, Cho WY, Kim HJ, et al. A new method of EMR: submucosal injection of a fibrinogen mixture. *Gastrointest Endosc.* 2004; 59:220–4. [PubMed: 14745395]
10. Sakamoto N, Osada T, Shibuya T, et al. Endoscopic submucosal dissection of large colorectal tumors by using a novel spring-action S-O clip for traction (with video). *Gastrointest Endosc.* 2009; 27:1370–4. [PubMed: 19403131]
11. Chen PJ, Chu HC, Chang WK, et al. Endoscopic submucosal dissection with internal traction for early gastric cancer (with video). *Gastrointest Endosc.* 2008; 67:128–32. [PubMed: 18054010]
12. Jeon WJ, You IY, Chae HB, et al. A new technique for gastric endoscopic submucosal dissection: peroral traction-assisted endoscopic submucosal dissection. *Gastrointest Endosc.* 2009; 69:29–33. [PubMed: 19111686]
13. Von Delius S, Karagianni A, von Weyhern CH, et al. Percutaneously assisted endoscopic surgery using a new PEG-minitrocar for advanced endoscopic submucosal dissection (with videos). *Gastrointest Endosc.* 2008; 68:365–9. [PubMed: 18561928]
14. Gotoda T, Oda I, Tamakawa K, et al. Prospective clinical trial of magnetic-anchor-guided endoscopic submucosal dissection for large early gastric cancer (with videos). *Gastrointest Endosc.* 2009; 69:10–5. [PubMed: 18599053]
15. Sumiyama K, Gostout CJ, Rajan E, et al. Transgastric cholecystectomy: transgastric accessibility to the gallbladder improved with the SEMF method and a novel multibending therapeutic endoscope. *Gastrointest Endosc.* 2007; 65:1028–34. [PubMed: 17531637]
16. Ryou M, Fong DG, Pai RD, et al. Dual-port distal pancreatectomy using a prototype endoscope and endoscopic stapler: a natural orifice transluminal endoscopic surgery (NOTES) survival study in a porcine model. *Endoscopy.* 2007; 39:881–7. [PubMed: 17968804]
17. Matthes, K.; Lee, SH.; Thakkar, SJ., et al. Development of a pancreatic tumor animal model and assessment of feasibility of NOTES® tumor enucleation as a multidisciplinary approach; Abstract, 4th International NOSCARTM Conference on NOTES; 2009. p. P46

18. Matthes, K.; Thakkar, SJ.; Lee, SH., et al. Development of a pancreatic tumor animal model and assessment of feasibility of NOTES® tumor enucleation as a multidisciplinary approach – A NOSCAR®-Funded Project.. Surg Endosc; Abstract, SAGES Annual Meeting; Phoenix, AZ. 2009; 2009. p. S270

Figure 1. EASIE-R simulator (Endosim LLC, Berlin, MA), with a porcine ex vivo upper GI organ package (esophagus, stomach and duodenum).

Figure 2.

a, Endoscopic image showing the clear distal cap attached to the tip of the endoscope (white arrows) to optimize visualization in the conventional endoscope group. b, Endoscopic image showing the forceps in the left working channel of the R-scope (white arrow) grasping the lesion to expose the submucosal space for dissection.

Table 1

Comparison According to Anatomic Location – Greater and Lesser Curvature

	R-scope group (n=10)	Conventional group (n=10)	p Value
Procedure time (min $\pm$ S.D.)	8.4 $\pm$ 2.12	11.3 $\pm$ 2.06	0.006
Specimen size (mm $\pm$ S.D.)	29.6 $\pm$ 2.27	29.4 $\pm$ 2.86	0.865
Injection frequency	1.9 $\pm$ 0.57	2.5 $\pm$ 0.53	0.025
En bloc resection %	90% (9/10)	100% (10/10)	0.230
Perforation %	0% (0/10)	10% (1/10)	0.230

S.D., standard deviation

Table 2

Comparison According to Anatomic Location – Anterior and Posterior wall

	R-scope group (n=10)	Conventional group (n=10)	p Value
Procedure time (min $\pm$ S.D.)	11.0 $\pm$ 3.97	11.3 $\pm$ 4.47	0.876
Specimen size (mm $\pm$ S.D.)	29.6 $\pm$ 2.76	30.4 $\pm$ 2.55	0.509
Injection frequency	2.6 $\pm$ 0.52	2.6 $\pm$ 0.70	1.000
En bloc resection %	90% (9/10)	90% (9/10)	1.000
Perforation %	10% (1/10)	10% (1/10)	1.000

S.D., standard deviation

Table 3

Overall Comparison

	R-scope group (n=20)	Conventional group (n=20)	p Value
Procedure time (min $\pm$ S.D.)	9.7 $\pm$ 3.37	11.3 $\pm$ 3.39	0.143
Specimen size (mm $\pm$ S.D.)	29.6 $\pm$ 2.49	29.9 $\pm$ 2.69	0.715
Injection frequency	2.25 $\pm$ 0.64	2.55 $\pm$ 0.61	0.135
En bloc resection %	90% (18/20)	95% (19/20)	0.545
Perforation %	5% (1/20)	10% (2/20)	0.545

S.D., standard deviation