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EDITORIAL

ORIGINAL ARTICLES

ABSTRACTS

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Author Guidelines

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The Thai Journal of Surgery is the official publication of The Royal College of Surgeons of Thailand and is issued quarterly.

The Thai Journal of Surgery invites concise original articles in clinical and experimental surgery, surgical education, surgical history, surgical techniques, and devices, as well as review articles in surgery and related fields. Papers in basic science and translational medicine related to surgery are also welcome.

Aim & Scope

The Thai Journal of Surgery is dedicated to serving the needs of the members of The Royal College of Surgeons of Thailand, specifically the younger researchers and surgical trainees who wish to have an outlet for their research endeavors. The Royal College strives to encourage and help develop Thai Surgeons to become competent researchers in all their chosen fields. With an international outlook, The Thai Journal of Surgery welcomes submissions from outside of Thailand as well.

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2. Corporate Author:

- The Committee on Enzymes of the Scandinavian Society for Clinical Chemistry and Clinical Physiology. Recommended method for the determination of gamma glutamyltransferase in blood. Scand J Clin Lab Invest 1976; 36:119-25.
- American Medical Association Department of Drugs. AMA drug evaluations. 3rd ed. Littleton: Publishing Sciences Group, 1977.

3. Personal Author(s):

- Osler AG. Complement: mechanisms and functions. Englewood Cliffs: Prentice - Hall, 1976.

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- Rhooder AJ, Van Rooyen CE, comps. Textbook of virology:

for students and practitioners of medicine and the other health sciences. 5th ed. Baltimore: Williams & Wilkins, 1968.

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- Weinstein L, Swartz MN. Pathogenic properties of invading microorganisms. In: Sodeman WA Jr. Sodeman WA, eds. Pathologic physiology: mechanisme of disease. Philadelphia: WB Saunders, 1974:457-72.

6. Agency Publication:

- National Center for Health Statistics. Acute conditions: incidence and associated disability, United States, July 1968-June1969. Rockville. Md.: National Center for Health statistics, 1972. Vital and health statistics. Series 10: Data from the National Health Survey, No. 69: (DHEW publication no. (HSM) 72-1036).

7. Newspaper Article:

- Shaffer RA. Advances in chemistry are starting to unlock mysteries of the brain: discoveries could help cure alcoholism and inso mnia, explain mental illness. How trhe messengers work. Wall Street Journal 1977 Aug 12:(col. 1), 10(col.1).

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- Roueche B. Annals of medicine: the Santa Claus culture. The New Yorker 1971 Sep 4:66-81. 9.

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- Chirappapha P, Arunnart M, Lertsithichai P, et al. Evaluation the effect of preserving intercostobrachial nerve in axillary dissection for breast cancer patient. Gland Surg 2019. doi:10.21037/gs.2019.10.06.
- Chirappapha P, Arunnart M, Lertsithichai P, et al. Evaluation the effect of preserving intercostobrachial nerve in axillary dissection for breast cancer patient. Gland Surg 2019;8:599-608. doi:10.21037/gs.2019.10.06.

Abbreviations

Use only standard abbreviations of commonly used approved abbreviations. Avoid abbreviations in the title. The full term for which an abbreviation stands should precede its first use in the text unless it is a standard unit of measurement.

Statistics

All statistical analyses and the statistical software used must be concisely described. Descriptive statistics for quantitative variables must include an appropriate central tendency measure (e.g., mean or median) as well as a corresponding measure of spread (e.g., standard deviation or range or interquartile range). Categorical variables must be summarized in terms of frequency (counts) and percentage for each category. Ordinal variables can be summarized in terms of frequency and percentage, or as quantitative variables when appropriate. Statistical tests must be named and p-values provided to 3 decimal places. P-values less than 0.001 should be written "< 0.001" and p-values approaching 1 should be written "0.999".

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Randomized controlled trials should be analyzed using the intention-to-treat principle, and as treated analysis should be applied as well if there are significant cross-overs. Further details of statistical issues are available here (http://www.icmje.org/icmje-recommendations.pdf).

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Authors are advised that the Thai Journal of Surgery adheres to standards set by the International Committee of Medical Journal Editors (ICMJE) and the Committee on Publication Ethics (COPE). Reporting guidelines that authors should consult and follow include the CONSORT Guidelines for randomized controlled trials; PRISMA Guidelines for systematic reviews and meta-analyses of randomized controlled trials, MOOSE Guidelines for systematic reviews, and meta-analysis of observational studies; STROBE Guidelines for observational studies; and ARRIVE Guidelines for animal research. Details of these and other guidelines can be obtained from https://www.equator-network.org/reporting-guidelines/.

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(see Format https://bit.ly/3IaP4ZB)

Abstract: should be no more than 300 words in length, and written in a structured format, including the following headings: **Objective,** which can include some background material of 1 to 2 sentences in length, but mainly describing the research question; **Methods,** concisely describing the research design and data procurement; **Results,** describing the main findings of the study; and **Conclusion,** which should concisely answer the research question, and no more. Below the abstract, a list of keywords should be provided.

Main text: should be written in a structured format, including the following headings. **Introduction** should describe the rationale of the study within the context of current knowledge; the gap in knowledge with which the research study will fill must be clearly pointed out and a research question explicitly stated. **Methods (and patients, if applicable)** should clearly describe the details of research methodology and patient or research volunteer recruitment according to Guidelines for each type of research as listed above (…), and how the data was collected and analyzed. A short description of statistics used, and the software and references if appropriate, must be provided. A note on Ethics Committee approval, if applicable, must be given. **Results** should include data or summaries of patient or volunteer characteristics, summaries of risk factors or covariates and outcomes, presented in tabular, graphical or descriptions in the text as appropriate, without significantly duplicating one another. Results of statistical analyses must be clearly displayed and should include point estimates, standard errors, statistical tests, *p*-values, and 95% confidence intervals as detailed (…). Analyses not shown but

referred to must not change the conclusions or outcomes. **Discussion,** which must fully describe the implications of the research results, should include a concise literature review of previous published, related results. These related results must be compared with those of the authors' study, and the differences clearly stated along with plausible explanations. New unexpected findings, especially from subgroup analyses or those for which the research was not designed, should be considered hypothetical and stated as such. Any plausible, relevant clinical application should be indicated. Finally, any significant limitations of the study must be mentioned and possible extensions of research should be briefly provided. **Conclusion,** which should be concerned with answering the research question posed by the current study, should not be summarizing results of previous studies or recommendations. An **Acknowledgement** section can be added at the end of the article. The Reference list should be in the format as described previously.

Basic Science and Translational Research

Use the common format. Emphasis is on clinician comprehension. The **Abstract** uses the same common structured format. In the **Main text,** the **Introduction,** in addition to the usual context setting and rationale, should also contain explanations and descriptions of basic science concepts at the level of the educated layman. The **Methods** section should still be concise with sufficient detail for others to replicate the experiment, but one or two paragraphs in between explaining basic processes in plain English would be helpful. In the **Results** section, similar conciseness is still the rule, but a brief simplified summary of the findings should be provided. In the **Discussion,** clinical implications should be clearly stated. The **Conclusion,** again, should answer the research question.

Case Series and Case Reports

We encourage publication of case series or case reports if a comprehensive review of the literature is included, with the aim of helping the clinician manage rare and challenging diseases or conditions based on best available evidence in conjunction with practical, local experience. For the Thai Journal of Surgery, this implies that the case report format differs somewhat from that of the common format for research articles.

Abstract: Need not be structured. State objective of the case presentation, present a summary of the case, the outcome and learning points in one concise paragraph.

Main text: An **Introduction** is required to set the importance or relevance of the case within the current clinical context, based on a comprehensive literature review. A brief review of anatomy and pathology, or pathophysiology can be provided. **Report of the case** then follows with sufficient details on clinical presentation, diagnostic work up, interesting features, and decision making, to be useful for other surgeons. Surgical management should be concisely described and should be accompanied by high-resolution photographs or high-quality drawings and diagrams, if possible. Unique features of the case, and typical or general features should be distinguished. **Results** of management and follow-up information should be provided. **Discussion** then places the clinical, diagnostic, surgical and pathological features of the case within current knowledge or context and provides reasons for decision making and surgical management or otherwise. Wider implications of the case should be emphasized; for example, when management contradicts existing guidelines or when feasibility of some never-before performed surgery has been demonstrated. The **Conclusion** simply summarizes the case in terms of management implications.

Narrative Review Articles

Abstract: No structure is required. A description of the aims of the article and contents should be sufficient.

Main text: An **Introduction** serves to set the rationale or objective of the review. While systematic reviews focus on narrow research questions with aims of obtaining generalizable knowledge, the narrative review is education-based. The **main content** can be structured in anyway as is necessary for adequate comprehension. Finally, a **Conclusion** summarizes the content in greater detail than the abstract, emphasizing recent developments or future research.

Special Articles

Special articles are often solicited and may have no standard structure. But some structure will aid understanding or entice readers.

Abstract: A brief description of aims and content is sufficient.

Main text: An **Introduction** to set the aims of the article. The **main content** can be structured in any way. A **Conclusion** to summarize the content should be helpful, as well as to place some personal reflections.

Surgical Techniques

Abstract: A short description of what the techniques is about.

Main text: Description of the technique in sufficient detail such that a trained surgeon can perform the technique on his or her own. Good illustrations of the technique, step-by-step if possible, should be provided, in high-resolution photographs or well-executed drawings, or both.

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Editorial

Potchavit Aphinives, MD
Editor-in-Chief of The Thai Journal of Surgery

Siripong Sirikurnpiboon, MD
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The Thai Journal of Surgery was established as a medium for presenting the research results from members or non-members of The Royal College of Surgeons of Thailand, covering all surgical knowledge and other knowledge related to the medical treatment of surgical patients. Therefore, it is not limited to surgery only, whether using drugs, medical food, chemical compounds, herbs, laboratory test results, pathology reports, radiological examinations, etc. All can be submitted for consideration for publication. Even though the results of the research contrary to the assumption, also known as a negative study, may still be considered for publication. If the research process is correct, meets standards, and does not conflict with ethical requirements.

The Thai Journal of Surgery is in the Thai-Journal Citation Index (TCI) Group 2, which can be used as evidence for consideration for an assistant professor position in the university or a specialist position in the Ministry of Public Health. The author will be exempt from publication fees, which are hard to find in current academic journals, especially Open Access journals.

On behalf of the editorial team, I welcome doctors, nurses, pharmacists, and every health personnel to submit your valued manuscript.

Thailand has a high incidence of colorectal cancer (CRC). In 2017, the incidence of CRC was 14.1 per 100,000 for men and 10 per 100,000 for women, which is likely to continue rising. Meanwhile, the Ministry of Public Health established a colorectal cancer screening project and distributed it to perform in each hospital of the 13 health districts. Each health district has reported the incidences of colon polyps and colorectal cancer found in the early stages. However, each health district also has difficulties and challenges in limiting medical staff, patient preparation, medical resources, and screening access. Then, this issue of The Thai Journal of Surgery will present the reports on colon cancer screening and management of obstructive colon cancer, which indicate the various limitations in colorectal cancer screening in Thailand and the current reality, with the hope that a comprehensive plan for colorectal cancer care will completely develop in the future.

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Original Article

Comparison of the Short-Term Outcomes after Primary Anastomosis between an Emergency Operation with Manual Fecal Decompression in Completely Obstructed Left-Sided Colorectal Cancer and Non-Obstructed Colorectal Cancer in Elective Bowel Preparation: A Retrospective Single Center Study

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Department of Surgery, Buri Ram Hospital, Buri Ram, Thailand

Abstract

Background: There are several emergency surgical methods for completely obstructed colorectal cancer, such as colostomy, tumor resection with Hartmann's procedure, or primary anastomosis with on-table lavage, sometimes adding protective ostomy. This treatment depends on the patient's condition and the surgeon's experience. As a result, patients need to undergo more than one operation. Therefore, if the effects of emergency surgery combined with manual fecal decompression and primary anastomosis are as effective as elective surgery, it will reduce patient complications.

Objective: To compare the short-term outcomes after primary anastomosis between an emergency operation with manual fecal decompression in completely obstructed left-sided colorectal cancer and non-obstructed colorectal cancer in elective bowel preparation.

Methods: A retrospective study comparing the short-term outcomes after primary anastomosis in completely obstructed left-sided colorectal cancer between an emergency operation with manual fecal decompression and elective bowel preparation in non-obstructed left-sided colorectal cancer in Buriram Hospital from 2009-2023. Short-term outcomes were analyzed, including anastomotic leak, surgical site infection, hospital stay, Dindo-Clavien classification, readmission, and mortality within 30 days after the operation. Given a statistically significant difference of p-value < 0.05.

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Results: There were 105 left-sided colorectal cancer patients, 52 men and 53 women. Emergency surgery, manual fecal decompression, and primary anastomosis 49 cases (46.7%), and elective surgery 56 cases (53.3%). There was no statistically significant in postoperative complication, Dindo-Clavien classification, and mortality in 30 days (p-value > 0.05). None of the patients had to be re-hospitalized within 30 days. Risk factors for complications were age ≥ 60 and preoperative comorbidity.

Conclusion: Emergency surgery for completely obstructed left-sided colorectal cancer with manual fecal decompression and primary anastomosis is as effective as the short-term outcomes in elective bowel preparation surgery for non-obstructed left-sided colorectal cancer.

Keywords: Left-sided colorectal cancer, Manual fecal decompression, Bowel preparation

Introduction

New cases of colorectal cancer are the fourth leading cause of death. Colon and rectal cancer prevalence is 38.55 and 38.73 per 100,000 people, respectively.[1] The sites of colorectal cancer are the cecum 14%, ascending colon 11%, transverse colon 5%, descending colon 5%, sigmoid colon 22%, and rectum 27%.[2] Signs and symptoms are colonic obstruction 78%, pain 71%, and weight loss 41%. Surgery is performed based on the location of colon cancer and the patient's condition at the time, with sigmoidectomy 39%, right hemicolectomy 29%, left hemicolectomy 14%, colostomy 8%, total colectomy 4%, transversectomy and ileostomy 3%, there are many surgical procedures after colon cancer resection such as terminal stoma technique 34%, primary anastomosis 26%, mucosal fistula 16%, derivative stoma 10%, and anastomosis with stoma protection 7%.[3] There are several treatment methods for colon cancer patients with colonic obstruction, such as colonic stent insertion, ileus catheterization, colonic lavage, and emergency surgery. It was found that colonic lavage can perform one-stage anastomosis in 37 out of 39 cases (94.8%).[4] Y. Hong discovered complications caused by left colon surgery and underwent colonic irrigation and primary anastomosis surgery. There was only one case of anastomotic leak (2.6%) and 7 cases of superficial surgical site infection (18.4%).[5] K L R Cross performed surgical treatment for colonic obstruction, using a decompression bowl technique at the height of 25 centimeters above the suture line with side-to-side anastomosis; there was 1 out of 29 cases of anastomotic leak (3.46%).[6] L Koskenvuo found no different results of preoperative bowel preparation plus antibiotics compared to no bowel preparation in elective right or left colon cancer surgery in surgical site infection, total complication index score, and anastomotic dehiscence.[7] Similarly, in the Selcuk Kaya study in obstructed colon cancer patients ≥ 65-year-old, using the on-table lavage technique, there was no difference between surgical site infection, anastomotic leak, intra-abdominal bleeding & infection, elongated ileus, and surgical evisceration.[8] Dung Anh Nguyen studied the surgical outcomes of obstructive colon cancer in the right-sided colon, left-sided colon, and rectum. There was no difference in anastomotic leak, surgical site infection, and mortality rate; 27 out of 110 patients (24.5%) with cancer in the left-sided colon underwent manual decompression.[9] Anemia, GFR ≤ 45 mL/min/1.73 m^2, and metastasis were factors that protective stroma surgery in obstructed left-sided colorectal cancer could not be closed.[10] Elective surgery is a preparatory surgery that results in a more planned outcome and fewer complications than emergency surgery. Therefore, if treating patients with obstructed left-sided colorectal cancer by emergency surgery, manual fecal decompression, and primary anastomosis is as effective as elective bowel preparation surgery in short-term outcomes, it would greatly benefit the patient. This study compares the short-term outcomes after primary anastomosis between an emergency operation with manual fecal decompression in completely obstructed left-sided colorectal cancer and non-obstructed colorectal cancer in elective bowel preparation.

Materials and Methods

A retrospective study of left-sided colorectal cancer patients admitted in Buriram Hospital from 2009-2023. The inclusion criteria for the emergency surgery group were completed colonic obstruction in left-sided colorectal cancer diagnosed by symptoms, abdominal signs, and acute abdominal series. After oncologic resection, the meticulous milking technique for manual fecal decompression started at the cecum, following through the distal end until nearly clear fecal content in the colon.

A 10% Povidone-iodine solution was applied at the proximal and distal parts of the colon before primary anastomosis. In the elective surgery group, non-obstructed left-sided colorectal cancer patients prepared their colon using polyethylene glycol 129.2 grams diluted in 2 liters of water and drinking from 18.00-20.00 O'clock until the defecation was a clear watery stool. Exclusion criteria were patients who had undergone a colostomy, Hartmann's procedure, or a protective ostomy. Two groups compared the short-term surgical outcomes of anastomotic leak, surgical site infection, hospital stay, Dindo-Clavien classification, readmission, and mortality, which were monitored within 30 days after the operation. Statistical data were analyzed using the statistical package for social sciences version 29.0 (SPSS Inc., Chicago, IL, USA). Kolmogorov-Smirnov tested distribution data and then reported as a number, percentage, and median. Odd ratio and Chi-Square were used for multivariate analysis. Statistically significant differences were determined with a p-value < 0.05. The Ethics Committee of Buriram Hospital approved this research (number BR 0033.102.1/32).

Results

There were 105 left-sided colorectal cancer patients, including 52 males (49.5%) and 53 females (50.5%), with a median age of 62. The completely obstructed colorectal cancer group received emergency surgery, manual fecal decompression, and primary anastomosis in 49 cases (46.7%) and elective bowel preparation surgery for non-obstructed colorectal cancer in 56 cases (53.3%). The most common cancer sites were 50 sigmoid colon (47.6%), followed by 21 descending colon (20.0%) and 18 rectum (17.1%). Sigmoidectomy was the primary surgical procedure, with 46 cases (43.8%). The most common cancer staging was 3b, with 29 cases (27.6%). Adenocarcinoma well differentiation was 86 cases (81.9%), as shown in Table 1.

Table 1 Characteristics of left-sided colorectal cancer patients.

Characteristics	Emergency operation with manual fecal decompression group (%)	Elective bowel preparation group (%)	Total (%)	*p*-value*
Numbers	49 (46.7)	56 (53.3)	105 (100)	
Sex				0.774
Male	25 (51.0)	27 (48.2)	52 (49.5)	
Female	24 (49.0)	29 (51.8)	53 (50.5)	
Age: median/IQR (years)	60/17	63/14.5	62/16 (range 18-93)	0.448
Tumor location				0.379
Splenic flexure colon	4 (8.2)	5 (8.9)	9 (8.6)	
Descending colon	14 (28.6)	7 (12.5)	21 (20.0)	
Sigmoid colon	23 (46.9)	27 (48.3)	50 (47.6)	
Rectosigmoid colon	3 (6.1)	4 (7.1)	7 (6.7)	
Rectum	5 (10.2)	13 (23.2)	18 (17.1)	
Upper rectum	2 (4.1)	4 (7.1)	6 (5.7)	
Mid rectum	3 (6.1)	8 (14.3)	11 (10.4)	
Lower rectum	-	1 (1.8)	1 (1.0)	
Surgical procedure				0.086
Left hemicolectomy	18 (36.8)	12 (21.4)	30 (28.6)	
Sigmoidectomy	23 (46.9)	23 (41.1)	46 (43.8)	
High anterior resection	5 (10.2)	8 (14.3)	11 (10.4)	
Low anterior resection	3 (6.1)	13 (23.2)	18 (17.1)	

Table 1 Characteristics of left-sided colorectal cancer patients. (cont.)

Characteristics	Emergency operation with manual fecal decompression group (%)	Elective bowel preparation group (%)	Total (%)	*p*-value*
Staging				0.004
1a	1 (2.0)	1 (1.8)	2 (1.9)	
1b	-	2 (3.6)	2 (1.9)	
2a	13 (26.5)	12 (21.4)	25 (23.8)	
2b	2 (4.1)	4 (7.1)	6 (5.7)	
3a	1 (2.0)	-	1 (1.0)	
3b	14 (28.6)	15 (26.8)	29 (27.6)	
3c	7 (14.3)	9 (16.1)	16 (15.2)	
4	11 (22.4)	13 (23.2)	24 (22.9)	
Pathology				0.004
Well diff. adenocarcinoma	34 (96.4)	52 (92.8)	86 (81.9)	
Moderately diff. adenocarcinoma	14 (28.6)	2 (3.6)	16 (15.2)	
Mucinous adenocarcinoma	1 (2.0)	1 (1.8)	2 (1.9)	
Non-Hodgkin's lymphoma	-	1(1.8)	1 (1.0)	

Notice: *data was analyzed by Chi-square test

According to the analysis, the operative time, postoperative complication (including anastomotic leak, superficial and deep surgical site infection), Dindo-Clavien classification, hospital stay, and mortality within 30 days were not significant statistically differences between emergency surgery, manual fecal decompression, and primary anastomosis to elective surgery with a *p*-value > 0.05. None of the patients required re-hospitalization within 30 days, as shown in Table 2. Risk factors contributing to an increase in postoperative complication and Dindo-Clavien classification (more than class 1) in the emergency surgery, manual fecal decompression, primary anastomosis, and elective surgery groups were age ≥ 60 years, and preoperative comorbidity. The prophylactic factor for surgical complications was normal BMI (18.5 - 22.9). Bowel preparation was a risk factor for postoperative complications, but it was beneficial in more than class 1 Dindo-Clavien classification (adjusted Odd-ratio = 0.435), as shown in Table 3.

Table 2 Comparing short-term outcomes of primary anastomosis in emergency operations with the manual fecal decompression and elective bowel preparation groups

Characteristics	Emergency operation with manual fecal decompression group	Elective bowel preparation group	*p*-value*
Operative time: median/IQR (minutes)	120/50	115/37.5	0.569
Postoperative complications (%)			0.822
Anastomotic leak	2 (4.1)	2 (3.5)	
Surgical site infection			
Superficial	2 (4.1)	2 (3.5)	
Deep	-	1 (1.7)	
Dindo-Clavien classification (%)			0.740
Class 1	40 (81.6)	51 (91.0)	
Class 2	2 (4.1)	1 (1.7)	
Class 3a	3 (6.1)	2 (3.5)	
Class 3b	1 (2.0)	1 (1.7)	
Class 4a	1 (2.0)	-	
Class 4b	-	-	
Class 5	2 (4.1)	1 (1.7)	
Hospital stays: median (days) (%)	9 (18.3)	9 (16.1)	0.624
Readmission in 30 days	-	-	-
Mortality in 30 days (%)	2 (4.1)	1 (1.7)	0.481

Notice: *data was analyzed by Chi-square test

Table 3 Risk factors of postoperative complication and Dindo-Clavien classification; adjusted Odd-ratio

Characteristics	Patients no. (%)	Postoperative complication	Dindo-Clavien classification (more than class 1)
Age (years)		1.556	1.068
≥ 60	60 (57.1)		
< 60	45 (42.9)		
BMI		0.368	0.310
Normal BMI (18.5-22.9)	44 (41.9)		
Abnormal BMI (< 18.5, > 23)	61 (58.1)		
Bowel Preparation		1.102	0.435
Yes	56 (53.3)		
No	49 (46.7)		
Preoperative comorbidity*		1.098	2.144
Yes	68 (64.8)		
No	37 (35.2)		

Notice: * Preoperative comorbidity includes diabetic mellites, hypertension, chronic kidney disease, etc. Some patients may have multiple diseases.

Discussion

According to the study, left-sided colorectal cancer patients with complete colonic bowel obstruction could be treated by emergency tumor resection, combined with manual fecal decompression and primary anastomosis, and there is no statistically significant difference in complications compared to elective bowel preparation in non-obstructed left-sided colorectal surgery. In addition, there is no difference in the operative time, length of hospital stays, and mortality. None of the patients must be re-admitted to the hospital within 30 days. Fecal decompression aims to reduce pressure in the colon caused by the force of the fecal on the colon wall; peristalsis results in the expansion and contraction of the anastomosis. To prevent fecal contamination from manual fecal decompression, use an aseptic technique with multiple layers of swabs; the end of the fecal outlet should protrude outside the abdominal cavity, and perform fecal decompression cautiously. This procedure can reduce the burden of patients who must perform multiple surgeries. The surgical treatment of completely obstructed colorectal cancer has several methods depending on the patient's condition. For example, a colostomy is a surgical procedure that solves the problem of colonic obstruction, changing emergency to non-emergency conditions. After the treatment, additional investigation can be performed to find further cancer staging. When the patient is ready, surgery is performed for elective treatment; the patient has to have it at least two times, which brings various risks, such as side effects from intraoperative anesthesia and postoperative complications. In addition, protective ostomy can also be reduced in case of emergency surgery, tumor resection, and primary anastomosis at the same time. The bowel preparation is more likely to cause complications than without the bowel preparation in this study, with an odds ratio of postoperative complication 1.102, according to Bucher P's study, mechanical bowel preparations pose a risk of anastomotic leak.[11] On the other hand, bowel preparation is beneficial for using the Dindo-Clavien classification, adjusted Odd-ratio 0.435, because the definition from class 2 to class 5 begins with the need for pharmacological treatment (without other than such allowed for class 1) or surgical, endoscopic, and radiological interventions to death then there is more precision in categorizing the complication.

Conclusion

It is safe to do emergency surgery for completely obstructed left-sided colorectal cancer with manual fecal decompression and primary anastomosis. The effectiveness of short-term outcomes is the same as elective bowel preparation in non-obstructed left-sided colorectal cancer surgery.

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Original Article

The One-Year Results of Endovascular Aneurysm Repair for Infrarenal Abdominal Aortic Aneurysm in Rajavithi Hospital

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Abstract

Objectives: To study the one-year results of EVAR for infrarenal AAA patients in Rajavithi Hospital.

Methods: This study conducted a retrospective chart review of all patients with infrarenal AAA who underwent EVAR between January 2017 and February 2021. Medical records were analyzed for demographic data, anatomic features of AAA, procedural details, and 30-day and 1-year outcomes. The primary outcomes were technical success and clinical success at one-year follow-up. Secondary outcomes included perioperative complications, mortality, stent-graft-related complications, and secondary interventions.

Results: This study included 43 patients (32 men) with a mean age of 72 ± 8.4 years. Successful primary technical success was achieved in 40 patients (93%). The mean operative time was 150.8 ± 58 min, and the median estimated blood loss was 150 ml. The median hospital stay was eight days. Major complications occurred in 9 (20.9%) patients, including 1 myocardial infarction, 1 congestive heart failure, 2 cardiac arrhythmias, 3 pneumonia-related respiratory failures, 2 ischemic colitis, and 2 renal failures requiring hemodialysis. The 30-day mortality was 4.7% (2 patients; one with infected AAA with aortoenteric fistula, and one with pneumonia and multisystem organ failure. A 1-year overall mortality was 16.3%, and AAA-related mortality was 2.3%. A 1-year clinical success rate of 91.4% was observed in 32 out of 35 patients. No cases of stent-graft thrombosis, stent-graft infection, ruptured AAA, open conversion, or type III or IV endoleak were documented in the study.

Conclusion: EVAR can be successfully performed at Rajavithi Hospital with high success and low AAA-related mortality rate. However, it is crucial to emphasize the importance of surveillance to promptly detect and effectively treat any potential complications that may arise.

Keywords: Endovascular aneurysm repair, Abdominal aortic aneurysm, EVAR, Endoleak

Introduction

An abdominal aortic aneurysm (AAA) is characterized by the dilatation of the infrarenal aorta, with a diameter exceeding 3 cm or 50% of the aortic diameter.[1] If left untreated, degenerative changes in the vessel wall can result in further dilation and eventual rupture. The prevalence of AAAs in the Western population has been documented to range from 4% to 7.2%.[2-4] Open Surgical Repair of AAA (OSR) has traditionally served as the standard treatment for AAAs. This procedure involves the excision of the dilated area and the placement of a prosthetic graft. Nonetheless, Endovascular aneurysm repair (EVAR) stands out as a minimally invasive procedure for the management of AAAs. EVAR has gained widespread acceptance as an established therapeutic modality for patients with suitable anatomical profiles

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ever since the first case reported by Parodi JC et al. in 1991.[5] Several studies have demonstrated that EVAR decreases perioperative morbidity and mortality, blood loss, and transfusions, the use of the intensive care unit, and the length of hospital stay as compared to an open aortic surgical repair procedure.[6-10]

In Thailand, the management of AAAs through EVAR has notably advanced, with reports demonstrating its safety and favorable outcomes.[11-13] Despite being a tertiary referral center in Bangkok, Thailand, Rajavithi Hospital has not yet implemented EVAR procedures. In an effort to enhance our capacity for treating AAA patients using endovascular techniques, we have initiated the establishment of dedicated vascular and endovascular surgery teams, making the commencement of EVAR procedures within our institution.

The objective of this study is to assess the one-year post-treatment outcomes of patients with infrarenal AAAs who underwent EVAR at Rajavithi Hospital.

Materials and Methods

Patients

This retrospective chart review included all consecutive patients who underwent EVAR due to an infrarenal AAA from January 2017 to February 2021 in the Vascular Unit, Department of Surgery, Rajavithi Hospital. The study protocol was approved by the Rajavithi Hospital Ethics Committee. All patients with an infrarenal AAA have performed computed tomographic angiography (CTA) preoperatively. Eligible patients requiring intervention due to at least one of the following indications:

- AAA-maximal diameter ≥ 55 mm (man)
- AAA-maximal diameter ≥ 50 mm (woman)
- Rapid expansion: > 1 cm / year or 0.5 cm / 6 months
- Any sizes of saccular morphology
- All Symptomatic AAA
- Iliac aneurysm diameter > 30 mm

All patients' clinical preoperative, perioperative, and follow-up data were obtained from the electronic medical record system and chart review. The standardized postoperative protocol was scheduled for outcome assessment at one month and 12 months, involving CTA of the whole aorta. In cases where patients exhibited impaired renal function, a combination of duplex ultrasonography (DUS) and non-contrast CT of the whole abdomen was conducted. The process of planning, sizing, and selecting any devices of EVAR was performed by the vascular surgeon. Patients presented with suprarenal, juxtarenal AAA, or post-cardiopulmonary resuscitation and underwent open surgical repair were excluded from this study.

Preoperative analysis

The following characteristics of the included patients were obtained: age, gender, co-morbidities, American Society of Anesthesiologists (ASA) score, and laboratory tests for renal function (creatinine).

The AAA characteristics measured on the preoperative CTA scans were AAA neck length, AAA neck diameter, calcification and thrombus in the AAA neck, proximal AAA neck angulation, maximum AAA diameter, length and diameter of the common iliac arteries (CIA), and presence of iliac artery aneurysm.

Diameter and length measurements were performed with the use of a center lumen line (CLL). All diameters were measured perpendicularly to the CLL from the outer wall to the outer wall. The aortic neck length was measured from the most distal renal artery to the first discernible level, where the aortic diameter increased by 10%. Aortic neck diameters were measured at the level of the lower border of the most distal renal artery and every 5 mm from this level until the start of the aneurysm. The calcification and thrombus in the aortic neck were measured at 10 mm below the most distal renal artery and were visually quantified and classified into groups of < 25%, 25% to 50%, and > 50% of the aortic circumference lined by thrombus or calcification.

The morphology of the proximal aneurysm neck of the study patients was classified as within or outside the instruction for use (IFU) of the selected stent graft.

Perioperative and 1-month postoperative analysis

The following perioperative characteristics of the study patients were noted: type of anesthesia, type of stent grafts, operation time, the volume of contrast agent used, total minutes of fluoroscopy, estimated total blood loss and blood transfusion, intraoperative adjunctive procedure, endoleak at completion angiography. Also noted were the procedurally-related problems, perioperative complications, postoperative ICU and hospital length of stay, and reinterventions.

Patients who encountered complications such as endoleaks, device migration, stent fractures, graft deterioration, or aneurysm growth necessitating reintervention underwent subsequent assessment.

Following the reintervention procedure, these patients underwent CTA of the whole aorta for the next 6 months and 12 months for continued monitoring and evaluation.

One-year postoperative analysis

All complications, reinterventions, outpatient department visits, readmissions, deaths, causes of death, and additional CTA scans were noted and analyzed. The following characteristics were investigated on the CTA scan performed 1 year after the EVAR procedure: AAA diameter, existence of endoleak, patency of renal arteries, diameter of the AAA neck, and distance from the most distal renal artery to the most proximal stent graft ring. The CTA scans were also checked for any other EVAR-related abnormalities. Additional survival data was obtained by follow-up visits and telephone contact at the end of the study.

Outcomes

Primary outcomes consisted of technical success and clinical success at one year. Secondary outcomes included procedural details, length of intensive care unit (ICU) and hospital stays, perioperative complications, perioperative and one-year mortality, and outcomes of stent-graft-related complications: presence of endoleak, aneurysm expansion, stent graft migration, stent graft thrombosis, AAA rupture, secondary intervention rate, and conversion to open repair.

Definition of success

The definition of success was defined as described by the Society for Vascular Surgery/International Society for Cardiovascular Surgery Ad Hoc Committee on Reporting Standards for Endovascular Aortic Aneurysmi Repair.[14]

In brief, *Technical success* was defined as the successful endograft deployment through a remote site, including the common iliac arteries, to the landing zone with no evidence of type I or III endoleak, limb occlusion, hemodynamically significant stenosis on completion angiography, or need for any unplanned surgical or endovascular interventions on the endograft within the next 24 hours.

Assisted primary technical success referred to aneurysm exclusion and a patent graft after an adjunctive intraoperative procedure.

Clinical success was defined as freedom from aneurysm rupture, aneurysm expansion ≥ 5 mm, type I or III endoleak, graft migration (≥ 10 mm), limb occlusion, aneurysm-related mortality, secondary intervention, or surgical conversion.

Definition of endoleak

Endoleak is defined by the persistence of blood flow outside the lumen of the endoluminal graft but within the aneurysm sac, as determined by an imaging study.[14] Endoleaks were categorized as periprosthetic (type I: inadequate sealing of the attachment zone), branch vessel (type II: retrograde flow via an aortic side branch), transgraft (type III: direct graft fabric defect or disconnection of modular graft components) endoleaks, or a blush of contrast inside the aneurysm sac through graft fabric porosity (type IV). Aneurysm enlargement in the absence of demonstrable perfusion was defined as endotension (type V). For time-to-endoleak analysis, all patients with detectable endoleak during follow-up were counted as positive for endoleak, regardless of whether the endoleak subsided or persisted at the time of the last available follow-up CTA scan study. Immediate treatment was recommended for all type I and III endoleaks. Uncomplicated type II endoleaks were observed.

Statistical analyses

All statistical analyses were conducted using SPSS software (SPSS Inc., Chicago, III, version 20). Continuous data are presented as the means ± standard deviation or median (range) for nonparametric variables (normal distribution evaluated using the KolmogorovSmirnov test); categorical data are given as the counts (percentage).

Results

Demographics and baseline characteristics

Between January 2017 and February 2021, 43 patients with infrarenal AAA were treated with EVAR. Demographic data and comorbidities of the patients are shown in Table 1. Their mean age was 72 ± 8.4 (range, 52 - 90) years, and 74.4% were males. Cardiovascular risk factors and smoking were present in the majority of patients. The mean preoperative serum creatinine value was 1.09 mg/dL (range, 0.39 - 2.92 mg/dL). According to the American Society of Anesthesiologists classification, 4 of the 43 patients (9.3%) were classified as class II, 37 (86%) as class III, and 2 (4,7%) as class IV.

Table 1 Demographic and Clinical Characteristics

Characteristics	Result (n = 43)
Age	72 ± 8.4
Gender	
Male sex	32 (74.4)
Comorbidities	
Smoking	29 (67.4)
Hypertension	35 (81.4)
Hyperlipidemia	20 (46.5)
Diabetes mellitus	8 (18.6)
Coronary artery disease	9 (20.9)
History of myocardial infarction	8 (18.7)
Ejection fraction < 50%	4 (9.3)
Chronic obstructive pulmonary disease	2 (4.7)
Cerebrovascular disease	5 (11.6)
Chronic kidney disease (creatinine > 1.5 mg/dL)	8 (18.6)
Cancer	3 (7.0)
ASA classification	
II	4 (9.3)
III	37 (86.0)
IV	2 (4.7)
Aortoiliac morphology	
Maximum aneurysm diameter (mm)	55.1 ± 13.4
Aortic neck length (mm)	29.5 ± 14.0
Aortic neck diameter (mm)	21.4 ± 2.9
Proximal neck angle (degree)	40 ± 19.0
Neck calcification (No.)	
< 25%	30 (69.8)
25-50%	11 (25.6)
> 50%	2 (4.7)
Neck thrombus (No.)	
< 25%	22 (51.2)
25-50%	18 (41.9)
> 50%	3 (7.0)
Right common iliac artery length (mm)	39.2 ± 18.9
Right common iliac artery diameter (mm)	15.9 ± 7.4
Left common iliac artery length (mm)	40.2 ± 16.7
Left common iliac artery diameter (mm)	13.9 ± 4.4
Common iliac artery aneurysm	
Unilateral	7 (16.3)
Bilateral	2 (4.7)
Diameter (mm)	30.7 ± 8.8
Hypogastric artery aneurysm	
Unilateral	4 (9.3)
Bilateral	0

Value is represented as means ± standard deviation (range) or number (%)

Anatomical characteristics of the abdominal aortic aneurysms are shown in Table 1. All aneurysms were infrarenal, with an average maximal diameter of 55.1 ± 13.4 (range, 27 - 84) mm. Proximal neck anatomy was mostly favorable, with a mean diameter of 21.4 ± 2.9 (range, 17 - 28) mm and a mean length of 29.5 ± 14 (range, 10 - 67) mm. Proximal aortic neck angulation exceeded 60° in 8 patients. Common iliac artery aneurysms and hypogastric artery aneurysms were present in 9 and 4 patients, respectively, while 33 patients had an isolated AAA.

Of the 43 patients, 29 (67.5%) had asymptomatic AAAs, while 14 (32.5%) had symptomatic AAAs, including concealed ruptured AAA in 1 and nonruptured symptomatic AAAs (vague abdominal, back pain or prolonged fever) in 13 patients. The AAA was fusiform in 33 patients and saccular in 10 patients. Four patients had infected AAAs. The primary indication for intervention was preventing AAA rupture in 38 patients and preventing a large iliac aneurysm in 4 patients.

Perioperative results

All EVAR procedures were performed under general anesthesia, and the initial endograft deployment was successful in all patients.

Three different bifurcated endovascular devices were used: an Endurant stent graft in 24, an AFX2 stent graft in 16, and an Ovation iX stent graft in 3 patients. Among patients with Endurant stent graft, six of the 24 patients had at least one anatomic characteristic that was considered a violation of the IFU of the Endurant stent graft: three patients had an aneurysm neck diameter less than 19 mm, two patients had an infrarenal neck angulation exceeding 75°, and one patient had an aneurysm neck length of 10 mm along with an infrarenal angulation exceeding 60°. Among patients with AFX2 stent graft, two of the 16 patients had at least one anatomic characteristic that was considered a violation of the IFU of the AFX2 stent graft: two patients had an aneurysm neck diameter less than 18 mm, and one of these two patients

Table 2 Operative details

Parameter	Result (n = 43)
Primary technical success	40 (93.0)
Assisted-primary technical success	42 (97.7)
Operative time (min)	150.8 ± 58
Estimated blood loss (ml)	150 (10-500)
Packed red cell transfusion (ml)	0 (0-888)
Fluoroscopy time (min)	29 (7-136)
X-ray dose (mGy)	176 (10-643)
Volume of contrast medium (ml)	75 (25-160)
Stent-graft types	
AFX2	16 (37.2)
Endurant	24 (55.8)
Ovation iX	3 (7.0)
Type of stent-graft application according to instruction for use (IFU)	
Within IFU	35 (81.4)
Outside IFU	8 (18.6)
Intraoperative adjunctive maneuvers	17 (39.5)
Proximal aortic extension for type Ia endoleak	1 (2.3)
Hypogastric embolization and distal sealing in EIA	12 (27.9)
PTA of the common iliac artery	1 (2.3)
Additional compliance balloon expansion	2 (4.7)
Additional distal extension	2 (4.7)
Embolectomy	1 (2.3)
Endoleak at completion angiogram	10 (23.2)
Type I	1 (2.3)
Type II	9 (20.9)

Continuous data are presented as means ± standard deviation or median (range); categorical data are given as the number (%)

also had an aneurysm neck length of 13 mm along with an infrarenal angulation exceeding 60°.

Embolization of the hypogastric artery and extension of the stent graft to the external iliac artery (EIA) was performed in 12 patients with an inadequate distal landing zone, a CIA diameter greater than 30 mm, or an accompanying hypogastric artery aneurysm and iliac extension cuff was needed in 2 patients to seal a dilated or aneurysmal common iliac artery. One patient required iliac artery balloon angioplasty before device insertion due to bilateral CIA stenosis. One patient underwent immediate embolectomy due to absent pedal pulses after the EVAR procedure; no thrombus or emboli were found, and the completion angiogram showed a vasospasm. A primary technical success of the EVAR procedure was achieved in 40 (93%) patients. Three patients required an unplanned additional procedure due to intraoperative type Ia endoleaks, for which two patients were successfully treated with a proximal aortic cuff and an additional compliance balloon expansion. One other patient was left with a small amount of type Ia endoleak after an unsuccessful attempt at additional compliance balloon expansion (97.7% assisted primary technical success). Additional interventions were performed during the EVAR procedures in 17 patients; the type of interventions can be found in Table 2.

The mean operative time was 150.8 ± 58 minutes (range, 60-345 minutes), with a median estimated median blood loss of 150 mL (range, 10-500 mL), a median volume of contrast agent used of 75 mL (range, 25-160 mL), and a median fluoroscopy time of 29 minutes (range, 7-136 minutes).

Completion angiography showed a type II endoleak in 9 patients and a type I endoleak in one patient. No conversions to open repair or procedural deaths were noted.

One-month postoperative analysis

The median intensive care unit (ICU) stay was 1 day (range, 0-22 days), and the median length of postoperative hospitalization was 8 days (range, 4-28 days).

Table 3 Perioperative morbidity and mortality

Events	Results
Patients with postoperative complications*	22/43 (51.2)
Cardiac events	8
Cardiac arrhythmia	4
Congestive heart failure	1
Hypertensive urgency	2
Myocardial infarction	1
Pulmonary events	4
Atelectasis	1
Pneumonia	3
Bowel ischemia (Ischemic colitis)	2
Neurological events	0
Renal failure	6
Vascular/Graft-related events	4
Arterial insertion trauma	1
Incidental bilateral IIA occlusion	2
Renal artery occlusion	1
Wound complication	2
Others	3
Delirium	1
Urinary tract infection	2
Mortality	2/43 (4.7)
AAA-related mortality	1
Other cause	1

Value is represented as number or number/number (%)

*One patient may have more than one complication

The 30-day mortality rate was 4.3% (2 patients). One patient underwent emergency surgery due to an infected aneurysm with an aorto-enteric fistula, the American Society of Anesthesiologists (ASA) Class IV. The patient had multiorgan failure and died 22 days after EVAR. One other patient with chronic obstructive pulmonary disease (COPD) died due to pneumonia-related respiratory failure at 27 days postoperatively.

A total of 29 complications were observed among 22 patients, as detailed in Table 3. Major complications included 1 myocardial infarction, 1 congestive heart failure, 2 cardiac arrhythmias, 3 pneumonia-related respiratory failures, 2 ischemic colitis, and 2 renal failures requiring hemodialysis.

Implant-related complications occurred within 30 days of the procedure in four patients. In the first patient, who had a concealed ruptured aneurysm with a neck length of 10 mm and an infrarenal angulation exceeding 60°, a standard EVAR was performed with a stent graft placed below the superior mesenteric artery (SMA). Due to the emergency condition, the physician decided to cover both renal arteries and provide correction if needed. The patient experienced acute renal injury with spontaneous recovery on follow-up, and no long-term hemodialysis was required. The second patient had an access site complication; a left external iliac artery (EIA) dissection was incidentally noted when cannulating the starter wire. A thorough angiography revealed non-flow-limiting dissection, and the patient was effectively managed conservatively without graft-limb thrombosis. Unintentional coverage of the internal iliac artery was observed in two other patients: one with a concomitant sole CIA aneurysm and one with an insufficient length of distal landing zone, in which the hypogastric artery was occluded with a vascular plug at the beginning of the procedure and distal sealing in the external iliac artery was required. In these two patients, incidental occlusion of the hypogastric artery on the opposite side was noted at the completion of angiography. Both patients experienced transient buttock claudication with spontaneous recovery.

Table 4 Outcomes follow up

Outcome	30 days	1 year
Clinical success	37/39 (94.9)	32/35 (91.4)
Overall Mortality	2/43 (4.7)	7/43 (16.3)
AAA-related mortality	1/43 (2.3)	1/43 (2.3)
Other causes	1/43 (2.3)	6/43 (14.0)
AAA sac diameter change		
≥ 5 mm increase	N/A	1/34
< 5 mm change	N/A	16/34
≥ 5 mm decrease	N/A	17/34
Loss to follow-up	5/43 (11.6)	9/43 (20.9)
Available postoperative imaging at 1 year	38/43 (88.4)	34/43 (79.1)
Graft-related complications*		
Endoleak	6	3
Type I	1	0
Type II	5	3
Stent graft migration	1	0
Stent graft thrombosis	0	0
Graft infection	0	0
Graft limb kinking	1	1
AAA rupture	0	0
AAA-related secondary intervention	0	1

AAA, Abdominal aortic aneurysm; N/A, not applicable.
Value is represented as number or number/number (%).
*One patient may have more than one complication.

No reinterventions were required within 30 days following the initial operation. However, five patients (11.6%) were lost to follow-up, including two who passed away within the first 30 days postoperatively. Within the first postoperative month, a total of 38 control CTAs were conducted. Among these CTAs, six endoleaks were identified, including five type II endoleaks and one type Ib endoleak. In one patient with a type II endoleak, graft-limb kinking was detected in one iliac limb without any occlusion or thrombosis. Close follow-up with either CTA or DUS was planned. In the case of the patient with a type IB endoleak, a stent graft migration exceeding 5 mm was observed on the CTA. This patient was treated with stent-graft relining in iliac limb.

One-year postoperative analysis

After one year, 34 (79.1%) patients had access to clinical follow-up and CTA imaging, as detailed in Table 4. There were nine patients who were lost to follow-up, including seven who died. Five additional patients died between the first 30 postoperative days and the 1-year follow-up. Causes of death included cardiac disease in one patient, common bile duct stone with cholangitis in one patient, sepsis caused by urinary tract infection in one patient, and renal failure in one patient. One patient died from an unknown cause, although death caused by a ruptured AAA was considered unlikely since the patient had no endoleaks on an earlier CTA.

The CTAs obtained at 1 year revealed three patients with persistent type II endoleaks. Another two patients with a type II endoleak recorded on the initial follow-up CTA had spontaneous resolution. Endoleaks by type and follow-up interval are reported in Table 5. No type I, type III, or type IV endoleaks have been reported at one year of follow-up.

Table 5 Endoleak by follow-up interval

Interval	Type Ia	Type Ib	Type II	Type III	Type IV
At completion angiogram	1	0	9	0	0
1 month (n = 38)	0	1 (2.6)	5 (13.2)	0	0
New	0	1	2	0	0
Persistent	0	0	3	0	0
1 year (n = 34)	0	0	3 (8.8)	0	0
New	0	0	0	0	0
persistent	0	0	3	0	0

Value is represented as number (%)

Between 30 days and 1-year follow-up, one patient underwent reintervention. Following the index operation, the patient had an endovascular reintervention three months later. Internal iliac artery embolization and iliac stenting extension were successfully performed in a type IB endoleak patient with stent graft migration discovered on the initial follow-up CTA. This patient's one-year follow-up CTA revealed no endoleaks or other complications. There was no stent graft fracture, thrombosis, infection, ruptured AAA, or open surgical conversion during the one-year follow-ups.

On the 34 CTAs performed after 1 year, the mean AAA diameter had decreased to 48.2 ± 14.1 (range, 22-80) mm. Compared with the preoperative values, AAA sac diameter increased ≥ 5 mm in 1 patient, remained stable (< 5 mm change) in 16 patients, and decreased in 17 patients.

Clinical success was achieved in 32 of 35 patients (91.4%) after one year. The patients with clinical failure had one type Ib endoleak that required secondary intervention, one type II endoleak with aneurysm sac growth greater than 5 mm, and one patient died as a result of AAA-related death.

Discussion

EVAR has emerged as a minimally invasive surgical technique involving the placement of a stent graft to effectively exclude the aortic aneurysm from the arterial circulation and systemic pressure. Since its initial introduction by Parodi et al. in 1991, EVAR has been universally recognized as a pioneering milestone in vascular surgery. In cases where the anatomical characteristics of the aneurysm are suitable, EVAR consistently demonstrates acceptable mortality and morbidity rates, particularly when applied to high-risk patients.

Numerous multicenter, prospective, randomized clinical studies have compared the outcomes of open surgical repair (OSR) and EVAR in terms of early, mid-term, and late-term results.[6-10] Overall, these studies have shown that EVAR offers initial advantages over OSR in terms of surgical mortality and complication rates. However, over the mid-and long-term, the benefits tend to diminish. Furthermore, a higher incidence of vascular and endograft-related complications has been reported with EVAR, necessitating a greater need for reinterventions.

During the learning curve period, the initiation of EVAR may present certain challenges. Multiple studies examining EVAR outcomes within a single cohort have reported technical success rates ranging from 86% to 100% and clinical success rates ranging from 91.6% to 97%.[15-19] Our study noted a technical success rate of 97.7% and a clinical success rate of 91.4%. These outcomes are consistent with prior research and are commensurate with results in the earlier studies

Although EVAR was originally considered for patients deemed unsuitable for extensive open surgical interventions, its utilization has progressively expanded to include patients who are appropriate candidates for major surgical procedures. Previous clinical trials have documented 30-day mortality rates spanning from 0% to 3% and one-year all-cause mortality rates spanning from 4% to 12%.[6-9,15-19] Our study revealed a 30-day mortality rate of 4.7% and a 1-year all-cause mortality rate of 16.3%, with the majority of deaths unrelated to abdominal aortic aneurysm (AAA). This relatively elevated mortality rate may be attributed to underlying comorbidities in our analysis.

Endoleak, which can lead to increased reintervention and costs. It remains a significant issue for EVAR. The Major factors affecting endoleak development are neck anatomy, a short aneurysm neck, a neck angle exceeding 60º, increased distal neck diameter, and thrombus or ulcerated plaque in the neck wall.[13,20] Several studies reported an early- and mid-term incidence of endoleak ranging from 5.6% to 22%.[11,15-19,21] In our study, we observed that the incidence of endoleak was 23.2% at the end of the procedure, 15.8% after 30 days, and 8.8% at 1 year postoperatively. There was one patient with type Ia endoleak who experienced spontaneous resolution.

Type Ib endoleak was noticed in one patient treated inside the IFU of the Endurant stent graft; the leak resolved through a reintervention. Type II endoleaks were noted in a total of 11 patients, with only one displaying an aneurysm sac enlargement exceeding 5 mm. According to current guidelines, a conservative approach is recommended for isolated type II endoleaks without sac expansion, and intervention is typically advised when sac enlargement is more than 10 mm.[22,23] In our study, it is worth highlighting that the majority of type II endoleaks spontaneously resolved, and none of the patients necessitated intervention. Nevertheless, in cases where type II endoleaks persist despite conservative management, patients have the option to undergo either endovascular procedure management or surgical correction as part of their treatment strategy. The importance of surveillance cannot be overstated, as it plays a crucial role in the early detection of complications of EVAR and ensures appropriate management of patients undergoing treatment. The surveillance of patients is essential for optimizing their overall care and minimizing the risks associated with their treatment.

Limitations of this study include the retrospective, single-center design with a small sample size, so it was unable to analyze the variables with statistical methods. Nonetheless, the principle aim of this study was to evaluate the one-year postoperative outcomes within the learning curve of the EVAR procedure and establish that our results align with those reported in other studies in the field.

In conclusion, EVAR can be successfully performed at Rajavithi Hospital, as demonstrated by our study, which has shown high success and low AAA-related mortality rates. Nevertheless, it is imperative to underscore the significance of vigilant post-procedural surveillance. This ongoing monitoring is essential for the timely identification and efficient management of any potential complications that may emerge.

Conflict of interest

No authors have any potential conflict of interest to disclosure.

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Original Article

Factors Associated with False Positive Fecal Immunochemical Tests in Trang Colorectal Cancer Screening Program Population

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Abstract

Background and Objective: Early detection of colorectal cancer (CRC) has emerged as an important global issue. Since 2018, fecal immunochemical tests (FITs) have been offered as a primary screening test for CRC by the Thai National Health Service plan despite their varied accuracy according to various factors. The primary aim of this study was to identify demographic factors associated with false-positive (FP) FIT results in CRC screening in the Trang population. The secondary aim was to report the outcomes of the screening program in Trang Province.

Methods: The data of all 542 participants in Trang with positive FIT tests from the CRC screening program conducted at Trang Hospital between 1 October 2021 and 28 February 2023 were retrospectively reviewed. Of these, 347 with complete colonoscopy studies were analyzed. Patients' characteristics, colonoscopy findings, and pathologic data were recorded. Univariable and multivariable logistic regression analysis was performed to determine factors associated with FP FIT results.

Results: Among 347 participants who showed positive FIT with complete colonoscopy for CRC screening, 33 participants (9.5%) had advanced colorectal neoplasia (ACRN), and 314 participants (90.5%) had FP FIT results (no ACRN). The participants aged under 65 had a higher rate of FP results than the older age group. Female gender and aged under 65 were two factors associated with false positivity. Multivariable logistic regression showed that age < 65 was the only independent risk factor associated with FP FIT results in multivariate analysis (OR = 2.81; 95% CI 1.24-6.35; $p = 0.013$).

Conclusion: FP FIT results in the Trang population were relatively high. The age < 65 is a significant factor associated with FP FIT results. This result can be used as a piece of evidence to optimize CRC screening strategies.

Keywords: Fecal immunochemical tests, Colorectal cancer, Screening, False positive

Introduction

Colorectal cancer (CRC) is the third most common cause of death from cancer in Thailand and worldwide.[1,2] Early detection of CRC has emerged as an important global issue. CRC screening programs have been conducted in many countries. In particular, non-invasive screening by Fecal Immunochemical Tests (FITs) has been offered as a primary screening test.[3,4] The participants with positive FIT results are further referred to undergo colonoscopy examinations.

Since 2018, FIT has been offered as a primary screening test for CRC in the Thai National Health Service plan but its accuracy varies due to differences in participant-related factors such as sex, age, metabolic diseases, and the presence of hemorrhoids, etc.[5-10]

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Previous studies have reported false positive (FP) FIT rates of 4.3 - 70%.[5,6] In CRC screening in Trang, more than half of all participants showed positive FIT results with no advanced colorectal neoplasm (ACRN) detected on colonoscopy examinations. False positive results caused psychological stress to the patients,[11] unnecessary colonoscopies, risk of adverse events during the procedures, extra costs, and increased healthcare workloads.

However, the studies of risk factors for FP FIT results remain unclear. Many studies from different populations have conflicts in associated factors with FP FIT results.[5-10] The knowledge about associated factors for FP FIT results will improve the efficiency of the screening program. Therefore, this study aims to identify demographic factors associated with FP FIT results and report the colorectal cancer screening program outcomes in Trang Province.

Materials and methods

The data of all 542 participants with positive FIT tests of the Trang CRC screening program were reviewed between 1 October 2020 and 28 February 2023. All positive FIT participants were referred to perform colonoscopy examinations by general surgeons at Trang Hospital (a province hospital). The cut-off threshold for a positive FIT was ≥ 100 ng Hb/ml buffer. The exclusion criteria were set as follows: denied colonoscopy (33.2%, n = 180), incomplete colonoscopy (1.47%, n = 8), inadequate bowel preparation (1.1%, n = 6), and perforation during the procedure (0.18%, n = 1). As a result, the total number of eligible subjects for the study was 347. The characteristic data, colonoscopy findings, and pathologic data were recorded. An FP FIT result was defi ned as positive FIT results in participants who were identified with no advanced colorectal neoplasm (ACRN) detected.[8] ACRN was defined as cancer or advanced adenoma.[8,12] Advanced adenoma was defined as the presence of one of the following features: > 10 mm diameter, tubulovillous or villous structure, high-grade dysplasia, and three or more adenomas.[8,9,12]

The data were summarized as counts, frequency (%), and mean ± standard deviation (SD). The population characteristics were compared using the chi-square, Fisher's exact test, or t-test as appropriate. Univariate and multivariate logistic regression analysis was performed to determine factors associated with FP FIT results. For each variable, the adjusted odd ratio (OR) and 95% confidence interval (CI) were reported. A p-value < 0.05 was determined to be significant. All statistical analyses were performed using the statistical package SPSS v.26.0 (IBM, New York, USA). Institutional Review Board approval was obtained for this study.

Results

A total of 347 participants who showed positive FIT and completed colonoscopy for CRC screening were eligible for the analysis. The main characteristics of the study population and colonoscope findings are shown in Table 1. The mean age of the overall participant was 59.1 ± 6.6 years (range 43 to 83 years; mode 56). The majority of the participant was female (70%, n = 243). The mean BMI was 25.3 ± 4.1 kg/m^2. More than half of the participants had metabolic syndrome (74.6%, n = 259). The female participants were found to have more BMI and metabolic syndrome than the male. From the colonoscope findings, 162 participants (46.7%) were normal, 33 participants (9.5%) had ACRN, and 314 participants (90.5%) had FP FIT results. Common non-neoplastic findings were hemorrhoids (12.1%) and diverticulosis (10.4%). Other non-neoplastic findings included colitis, proctitis, ulcer, and parasitic worm infections.

Additionally, comparing between genders, there were no significant differences in colonoscope findings between males and females, but a significant difference in FP FIT results between genders was found (p = 0.026).

Table 2 shows the frequencies of FP FITs in the study population, using cut-offs ≥ 100 ng Hb/ml in variables associated with FP FITs. In the univariate analysis, female gender (OR = 2.42; 95% CI 1.17 - 4.99; p = 0.026), age < 65 years old (OR = 2.28; 95% CI 1.06 - 4.87; p = 0.043), non-advanced adenoma (OR = 0; 95% CI 0; p = < 0.001), and hemorrhoids (OR = 0; 95% CI 0; p = 0.022) were significantly associated with FP FIT results.

In multivariable logistic regression (Table 3), the age < 65 was the only independent risk factor for FP FIT results (OR = 2.81; 95% CI 1.24 - 6.35; p = 0.013), whereas apparent associations of gender, non-advanced adenoma, and hemorrhoids with FP FIT results in univariate analyses were not statistically significant.

Table 1 Population characteristics

Characteristic	Total population (%) N = 347	Male (%) N = 104	Female (%) N = 243	*p*-value
Age: years, mean ± SD	59.1 ± 6.6	59.9 ± 5.9	58.8 ± 6.8	0.132
Age range: number (%)				0.322
Age < 65	272 (78.4)	78 (75.0)	194 (79.8)	
Age ≥ 65	75 (21.6)	26 (25.0)	49 (20.2)	
BMI (kg/m^2): mean ± SD	25.3 ± 4.1	24.4 ± 3.6	25.7 ± 4.3	0.002
BMI (kg/m^2) range: number (%)				0.036
< 25	170 (49)	60 (57.7)	110 (45.3)	
≥ 25	177 (51)	44 (42.3)	133 (54.7)	
Underlying diseases: number (%)				
Diabetes	34 (9.8)	9 (8.7)	25 (10.3)	0.698
Hypertension	112 (32.3)	31 (29.8)	81 (33.3)	0.534
Dyslipidemia	113 (32.6)	22 (21.2)	91 (37.4)	0.003
Other underlying diseases	53 (15.3)	25 (24.0)	28 (11.5)	0.005
Colonoscope findings: number (%)				
Normal	162 (46.7)	49 (47.1)	113 (46.5)	0.916
Cancer	6 (1.7)	3 (2.9)	3 (1.2)	0.370
Colonic polyps	113 (32.6)	36 (34.6)	77 (31.7)	0.618
Advanced adenoma	29 (8.4)	14 (13.5)	15 (6.2)	
Non-advanced adenoma	84 (24.2)	22 (21.2)	62 (25.5)	
Diverticulosis	37 (10.7)	12 (11.5)	25 (10.3)	0.708
Hemorrhoids	42 (12.1)	9 (8.7)	34 (14.0)	0.213
Other non-neoplastic findings	9 (2.6)	2 (1.9)	7 (2.9)	0.730
False Positive FIT result: number (%)	314 (90.5)	88 (84.6)	226 (93.0)	0.026

Table 2 Univariate logistic regression analysis for Factors Associated with False-Positive FIT Results (N = 314)

Variable	False positive, n (%)	Univariate analysis	
		OR (95% CI)	*p*-value
Female Gender: n (%)	226 (72.0)	2.42 (1.17 - 4.99)	0.026
Age < 65 years old: n (%)	251 (79.9)	2.28 (1.06 - 4.87)	0.043
BMI < 25 kg/m^2: n (%)	157 (50.0)	1.54 (0.74 - 3.20)	0.276
Diabetes: n (%)	29 (9.2)	0.57 (0.20 - 1.59)	0.349
Hypertension: n (%)	102 (32.5)	1.11 (0.51 - 2.41)	0.848
Dyslipidemia: n (%)	103 (32.8)	1.12 (0.52 - 2.45)	0.847
Other underlying diseases: n (%)	47 (15.0)	0.79 (0.31 - 2.02)	0.613
Non-advanced Adenomas: n (%)	84 (26.8)	0 (0)	< 0.001
Diverticulosis: n (%)	36 (11.5)	4.14 (0.55 - 31.25)	0.230
Hemorrhoids: n (%)	43 (13.7)	0 (0)	0.022

Table 3 Multivariate logistic regression analysis for Factors Associated with False-Positive FIT Results

Variable	Multivariate analysis	
	OR (95% CI)	*p*-value
Female Gender	2.04 (0.95 - 4.36)	0.067
Age < 65 years old	2.81 (1.24 - 6.35)	0.013
Non-advanced Adenomas	0 (0)	0.996
Hemorrhoids	0 (0)	0.997

Discussion

CRC screening program based on fecal immunochemical tests (FITs) has been offered as a primary screening test worldwide as well as in Thailand. Its positive rates marked differences across different programs and countries: Australia, 4.6 - 9.0%, Korea, 7.3 - 11.2%, Netherlands, 5.5 - 8.8%, Italy, 3.7%, Germany, 5.0%, and the USA, 2.6%.[7] In Trang, the CRC screening program as a part of the Thai national health service plan began in 2018. The Trang Health Data Center (THDC) data showed the FIT-positive rates from 2018 to 2022 in Trang's population between 3.8 - 8.9% and FP FIT rates between 84.8 - 90.6%.[13] Due to the COVID-19 pandemic, the colonoscopy program was paused, causing some participants to drop out of the program. This study collected the data from the point program resumed on 1 October 2020 until 28 February 2023. Although the target participants of the Thai National Health Service Plan CRC screening were people aged 50 - 70, this study covered participants aged between 43 and 83.

Of all the positive FIT participants in the study, 10.5% had ACRN, and 90.5% had FP FIT results. This data was similar to the data of THDC.[13] Although the specificity of FIT is relatively high, up to 25% of patients are shown to have the FP results.[14] In a study from Australia, the colonoscopy revealed neoplasia to be absent in 54.5% of those with positive FIT results.[7] The rates of FP FIT results in the Trang screening program are higher than all of the previous studies reporting false positive (FP) FIT rates of 4.3 - 70%.[5,6,8,10,15]

The higher FP FIT rates led to psychological stress for the patients worrying about their chance of having cancer,[11] unnecessary colonoscopies, and increased procedural risks, costs, and healthcare workload. It is, therefore, important to understand the factors associated with FP FIT results. Several studies and meta-analyses have demonstrated that different populations showed different conflicts of participant-related factors associated with FP FIT results. According to the meta-analyses, the most frequently studied risk factors for FP FIT results are the use of anticoagulants and antithrombotic drugs, sex, and age.[6]

Among FP FIT participants, most of them had normal results on colonoscopy examination. Colonic polyps, which were non-advanced adenomas, diverticula, and hemorrhoids, were the most 3 abnormal findings detected in 45.5% of all FP results. Of these factors, this study focused on the most controversial factors associated with FP FITs results, including sex, age, obesity (BMI ≥ 25 kg/m^2), DM/hyperglycemia, dyslipidemia, high blood pressure, hemorrhoids, added-on diverticula, and non-advanced adenomas.

In a systematic review and meta-analysis of Klerk et al., no significant associations were found for the use of anticoagulants or antithrombotic drugs. Many factors also appeared not to affect FP results: family history of CRC, socioeconomic status, obesity, diverticula, high blood pressure, hyperglycemia, low high-density lipoprotein, metabolic syndrome, anemia, use of combined medication, smoking, alcohol drinking and participation in prior screening rounds.[6]

A study in Hong Kong reported that polypoid adenomas were associated with FP results.[10] The result of hemorrhoids, a commonly suspected source of lower gastrointestinal bleeding, showed only a weak, statistically nonsignificant association with FP FIT results in the same way as a German study[5] and meta-analyses[6] in contrast to the Korean study.[8]

A large German CRC screening study conducted by Amitay et al. found that male gender, older age (≥ 65 years), obesity, smoking, and use of aspirin were associated with increased FP FIT.[5] Similarly, the meta-analysis showed that risk factors associated with a lower risk of FP results were male sex and age higher than 65.[6] In contrast, Symonds et al. reported FP was associated with female gender and younger age.[7] This study observed significant differences in FP results between genders, but there was no significant association in multivariate analysis. However, this study found that age < 65 was the only statistically significant independent risk factor for FP FIT results.

In Trang's population, participants below 65 years old might be screened by combining blood-based biomarker tests (CEA, Ferritin) and FIT results required to reduce unnecessary colonoscopy. In a recent study by Peterson et al.,[15] based on 4,048 FIT-positive (cut off ≥ 100 ng Hb/ml) subjects from the Danish National Colorectal Cancer Screening Program. The authors proposed a 2-step screening approach with an initial FIT test followed up by a blood test if the FIT was positive. The combined result of the blood test, FIT result, and demographics (age and sex) decided whether a colonoscopy was required. They tested 2 algorithm models, and the first was a predefined model including FIT result, age, and 3 biomarkers of CEA, Ferritin, and CRP. The second was the exploratory model, which added other 6 biomarkers and sex as potential predictors. Both approaches were significantly better than using FIT alone in the discrimination of cases with CRC vs. cases with no CRC. Overall reduction in colonoscopy requirements by 4 - 11% without reducing detection of colorectal cancer.[15]

Environmental factors may also influence FIT positivity. There were still conflicting findings. Some studies showed the detection of advanced neoplasia in different seasons, while others reported no seasonal effect.[7]

There is currently insufficient evidence to recommend the use of repeat/second FIT to guide colonoscopy.[4,7] Repeat FIT testing may enhance sensitivity after the first negative test (increased sensitivity and decreased specificity), or identify people who may not need colonoscopy unless both tests are positive (decreased sensitivity and increased specificity). Further studies are required.[4]

Though the evidence from Rerknimit et al.,[16] suggests that the optimal cutoff threshold in advanced neoplasia and CRC screening in Thailand is 150 ng/ml, the threshold for FIT positive in this study was set at ≥ 100 ng Hb/ml according to Thai Guidelines for CRC screening program[17] and other foreign studies.[5,18] Some European countries used higher cutoff thresholds ranging between 150 to 750 ng/ml.[15] The FIT threshold used in true screening practice should be chosen based on a balance of reducing the total number of required colonoscopies, procedural complications, and stress of participants without compromising CRC detection.

This study was based on data from 347 participants with a positive FIT result in the Trang Province CRC screening program, a true screening setting consisting of asymptomatic participants; a referral bias was unlikely. Although this was not a large number of subjects studied, it was not small compared to other studies in the meta-analysis.[6] There were several limitations in the current study. First, this was a retrospective study with potential bias in design. Second, data on using anticoagulants or antithrombotic drugs, using NSAIDs, smoking, and alcohol drinking, which could be possible confounders, were unavailable. These factors could increase the risk of FP FIT results.[9,10,19] Future studies on these factors should be done. Lastly, no further examinations were conducted to elucidate reasons for FP FIT results.

Conclusion

The variable positive rates in FIT-based CRC screening suggested differences in results between programs. FP FIT results in the Trang population were relatively high. The knowledge about risk factors associated with FP FIT results could improve the effectiveness and efficiency of the screening program. Therefore, the screening strategy should be adjusted, especially among people aged under 65, which was a significant factor associated with FP FIT results in Trang.

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Original Article

Laparoscopic Salvage of Malfunctional Peritoneal Dialysis Catheters. Outcome and Patency in 37 Patients

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Abstract

Background: There are more than 100,000 patients in Thailand who require long-term renal replacement therapy, and the number continues to grow significantly. Peritoneal dialysis is a viable option with some advantages over hemodialysis. However, malfunction of peritoneal dialysis catheters is the major problem in these patients. Laparoscopic salvage of the catheters can resolve the major cause of malfunction.

Objective: To evaluate the success rate and safety of laparoscopic salvage of malfunctioning peritoneal dialysis catheters and the patency of salvaged catheters in Suratthani Hospital.

Methods: In this retrospective descriptive study, 42 patients who underwent laparoscopic salvage of malfunctioning peritoneal dialysis catheters at Suratthani Hospital were included. All the salvage procedures were performed under general anesthesia using one 10 mm and two 5 mm ports. The various techniques to rescue catheter function included re-positioning the catheter with pelvic fixation, clearing the fibrin clot/sheath, freeing up the omental, adhesion, and partial omentectomy. All patients were followed up for at least 6 months or until using peritoneal dialysis discontinuing.

Results: A total of 42 laparoscopic salvage of catheter malfunctions were attempted and succeeded in 37 cases. The mean operative time was 62.4 minutes. The omental wrapping was the most common cause of catheter malfunction (62.1%). The catheter patency rate was 83.7%, 62.1%, 45.94%, and 24.32% at 1 month, 6 months, 12 months, and 24 months respectively.

Conclusion: Laparoscopic salvage of malfunctioning peritoneal dialysis catheters seems feasible and safe to recuse and prolong peritoneal dialysis catheter usage. Our findings will provide insight for surgeons in salvaging peritoneal dialysis catheter malfunction.

Keywords: Peritoneal dialysis, Laparoscopy, Salvage, Patency

Introduction

There are currently over 100,000 chronic kidney disease patients in Thailand who require long-term renal replacement therapy, and the number continues to grow significantly.[1] Since 1976, peritoneal dialysis has been a viable option for patients with end-stage renal disease[2] with some advantages over hemodialysis, including cost, convenience, patient independence, and improved nutrition.[3] But infection and mechanical malfunction are the major problems of peritoneal dialysis catheters.[3]

The catheter malfunctions are mostly caused by catheter tip migration, omental wrapping, or adhesion.[4-5] Several techniques, including open revision, fluoroscopic-guided manipulation, and laparoscopy, have been used to salvage malfunctioning catheters.[6] The success rate is highly variable between procedures as well as operators.[7-12]

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Laparoscopic salvage of malfunctional peritoneal dialysis catheters with Pelvic Fixation and omentectomy can resolve major malfunction causes.[10-11] This paper describes our surgical technique and treatment outcome.

Material and Methods

This was a retrospective descriptive study including all the patients who had peritoneal dialysis catheter placement malfunction at Suratthani Hospital from 1 January 2017 to 31 December 2020. All patients previously had open peritoneal dialysis catheter placement, and a nephrologist detected the problems. Then, all patients underwent typical conservative treatment such as irrigation, laxatives, thrombolysis agents, etc.

All patients had laparoscopic salvage of malfunctioning peritoneal dialysis catheters under general anesthesia. We created pneumoperitoneum via a previously placed peritoneal dialysis catheter. A 10-millimeter port was placed at the supraumbilical area, and two 5-millimeter ports were placed at the left lower quadrant and the left para-umbilical areas (Figure 1). After identifying and freeing the catheter, we removed and cleaned all the tissue trapped in the catheter (Figure 2). The catheter was fixed to the pelvic peritoneum with Vicryl 3-0 via Carter-Thomason needle. Omentectomy was performed with an energy-sealing device and removed via an umbilical port (Figure 3).

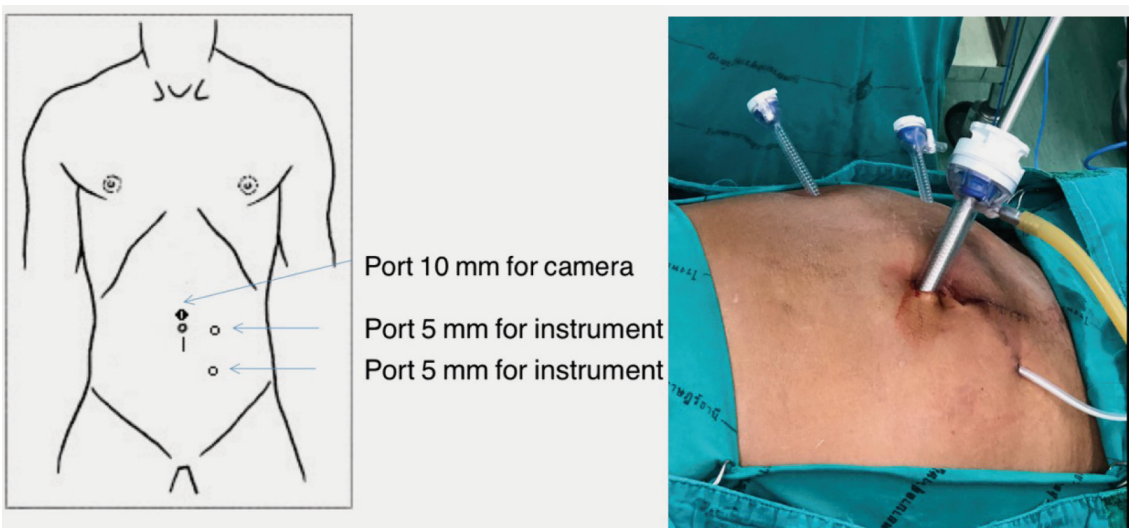

Figure 1 Ports placement

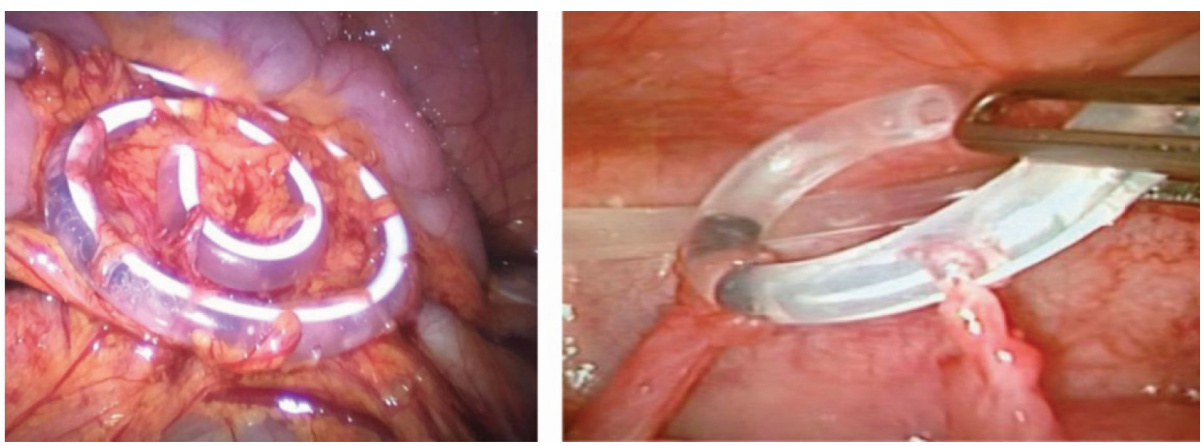

Figure 2 All tissue trapped in the catheter was removed and cleaned

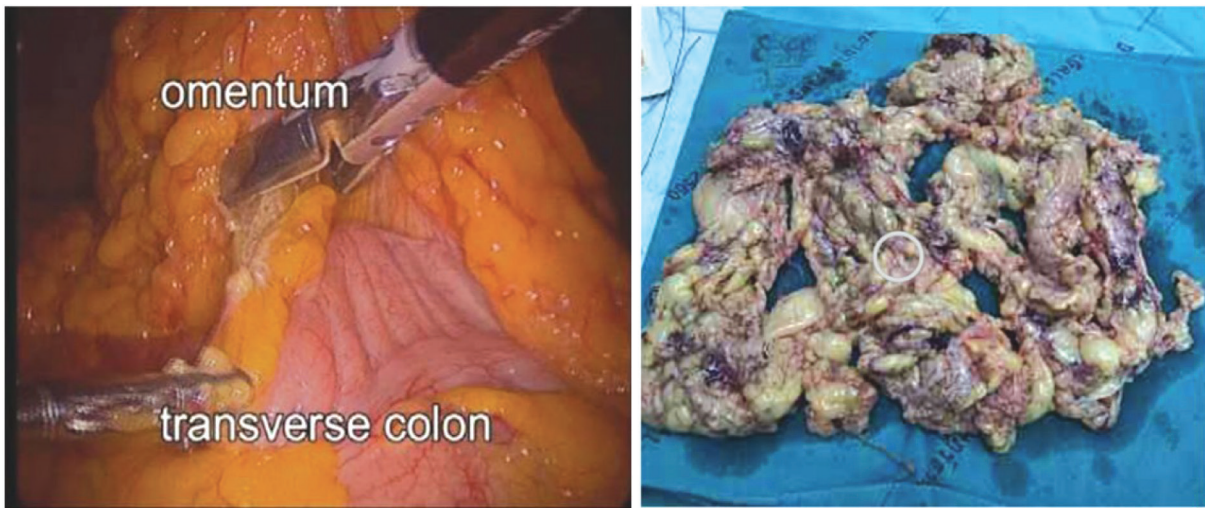

Figure 3 Partial omentectomy

The study was approved by the Clinical Research Ethics Committee of the Suratthani Hospital. The minimum number of required participants was 16 cases to demonstrate the patency of the catheter from the sample size calculation for one sample, a continuous outcome with the patency data from Santarelli et al. study.[10]

All patients were followed up for at least 6 months unless peritoneal dialysis was stopped. We reviewed demographic details of the patients, etiology, and causes of catheter malfunction through medical records. Maneuvers for salvage, operative time, length of stay, and complications were also retrieved. STATA 13.0 was used to analyze. Categorical data were presented as percentages and continuous data as mean ± SD or median [interquartile range (IQR)] as appropriate. Kaplan-Meier curves were generated to demonstrate Catheter patency over observed time.

Results

We attempted to salvage peritoneal dialysis catheter malfunction in 42 patients surgically. Five patients did not receive revision due to intraabdominal infection (2 patients) or severe intraabdominal adhesion (3 patients). Overall, 37 laparoscopic salvage of catheter malfunctions were performed. The demographics and characteristics of the patients are shown in Table 1. For the entire population, the mean age was 60 years (SD 13.4). Most of the patients (97.2%) had hypertension, and half of the patients (51.3%) had diabetes mellitus, followed by gout (24.3%), cardiovascular disease (18.9%) and cerebrovascular disease (16.2%). All the patients had previously undergone opened peritoneal dialysis catheter placement from a median of 62 days (IQR 11-593) ago, and 12 patients (32.4%) had previous other abdominal surgery.

The mean operative time was 62.4 minutes. The omental wrapping was the most common cause of catheter malfunction in 23 cases (62.1%). Other etiologies were catheter malposition in 8 cases (21.6%) and fibrin plug/sheath as well as other adhesion in 6 cases (16.2%). Five patients had 30-day-postoperative complications, including 2 cases with bleeding, 2 cases with surgical site wound infection, and one death from ischemic heart disease. The median catheter patency was 184 days (IQR 36-568). The catheter patency was depicted with the Kaplan-Meier curve in Figure 4. One-month catheter patency was 83.7%. The catheter patency rate was 62.1%, 45.94%, and 24.32% at 6 months, 12 months, and 24 months, respectively. The most common reason to abandon peritoneal dialysis was catheter infection (32.4%), followed by death (18.9%), malfunction (13.5%), and bleeding (2.7%).

Table 1 Patient demographic data and result

Characteristics	(N, %)
Age (years): mean (SD)	60 (13.4)
Sex	
Male	22 (59.4)
Female	15 (40.5)
Underlying disease	
Diabetic mellitus	19 (51.3)
Hypertension	36 (97.2)
Gout	9 (24.3)
Adult polycystic kidney disease	1 (2.7)
Cerebral vascular disease	6 (16.2)
Cardiovascular disease	7 (18.9)
Time of previous catheter placement (days): median (IQR)	62 (11 - 593)
Previous other abdominal surgery	12 (32.4)
Operative time (minutes): mean (range)	62.02 (20-110)
Primary ethology of dysfunction	
Omental wrapping	23 (62.1)
Catheter malposition	8 (21.6)
Fibrin plug and other adhesion	6 (16.2)
30-day postoperative complication	5 (13.5)
Bleeding	2 (5.4)
Surgical site wound infection	2 (5.4)
Death	1 (2.7)
Catheter patency (days): mean (Median) (IQR)	184 (36 - 568)
Patency rate (n, %)	
At 1 month	31 (83.7)
At 6 months	23 (62.1)
At 12 months	17 (45.94)
At 24 months	9 (24.32)
Overall peritoneal dialysis abandon (n, %)	24 (64.8)
Infected catheter	12 (32.4)
Death	7 (18.9)
Malfunction catheter	5 (13.5)
Bleeding	1 (2.7)

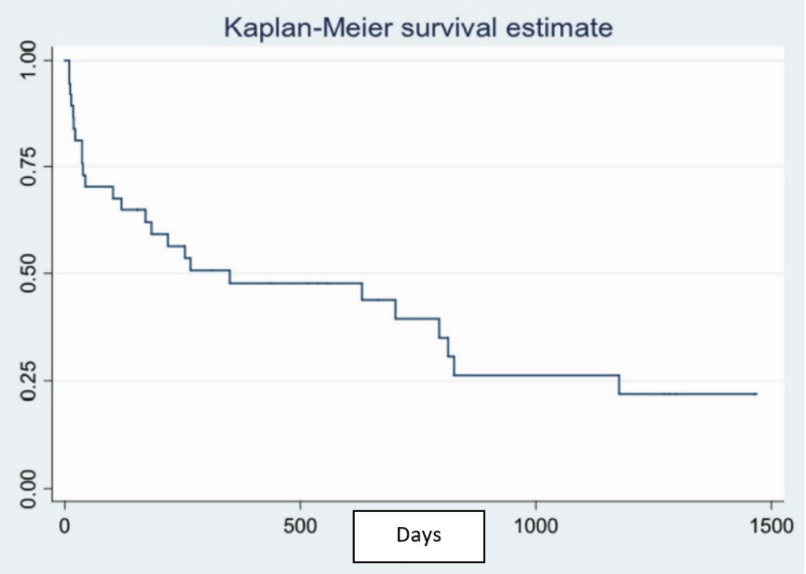

Figure 4 Survival of the peritoneal dialysis catheter

Discussion

Currently, about half of long-term renal replacement therapy in Thailand is peritoneal dialysis.[1] It has some advantages over hemodialysis, including fewer hospital visits and fewer dietary restrictions. The catheter mechanical malfunction is the second most common reason to remove the catheter behind the infection.[4] Instead of the catheter's removal, salvage of the catheter can rescue and prolong the catheter's life. Recently, various procedures have been used to salvage the catheter, including fluoroscopy-guided manipulation, open revision, and laparoscopic revision. The advantage of laparoscopic salvage over other methods is direct visualization and correction of the malfunction's cause.

The most common cause of malfunction in our study is omental wrapping (62.1%). We use sharp dissection with scissors and blunt dissection to strip the omentum from the catheter. Campisi S et al. have described a technique of partial omentectomy at laparoscopy,[13] and we prefer to perform partial omentectomy with an energy-sealing device to prevent the recurrent omental wrapping. Other researchers have described omental folding[11] or complete omentectomy[14] to prevent recurrent omental wrapping, although no data compares those techniques.

Catheter malposition is another common cause of catheter malfunction. It occurred in 8 patients (21.6%) in our study. To prevent malposition, Kumar et al.[15] and Bae et al.[16] described a technique of fixing the catheter to the lower abdominal wall with a suture. Our preference is to perform catheter fixing with the lower abdominal wall in all patients who require salvage of a malfunctioning CAPD catheter.

This study shows the success rate and safety of laparoscopic salvage of catheters. The procedure can prolong catheter life by a median of 184 days with 1-month and 6-month catheter survival rates at 83.7% and 62.1%, respectively, compared favorably to previous studies.[9-11,17] Despite good short-term outcomes, only one-quarter of salvaged catheters survived until 2 years. The survival of salvaged catheters is significantly lower than the new case of peritoneal catheter placement, with a 2-year survival of about 60-80%.[6,10,13]

Our study has some limitations. The study is a retrospective study from a single medical center, which is subjected to selection bias and missing variables. The number of patients is small compared to overall peritoneal dialysis patients. A large prospective study should be done in the future.

Conclusion

We found that most peritoneal dialysis catheter malfunction was caused by omental wrapping and catheter malposition. Laparoscopic salvage of malfunctioning peritoneal dialysis catheters was feasible and relatively safe in most patients. The operation could prolong catheter usage temporarily. However, the long-term catheter patency rate is still unsatisfactory. Newer surgical techniques to prevent recurrent catheter malfunction are warranted.

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Original Article

Association of Diaphragmatic Function by Ultrasound and WIND Classification in Surgical Intensive Care Unit

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Abstract

Background: The issue of weaning patients off mechanical ventilation remains a significant concern within the intensive care unit (ICU). Weaning, as defined by the Weaning according to a New Definition (WIND), is a valuable approach for predicting the probability of successful extubation or potential complications following mechanical ventilation. Ultrasonic diagnostics have emerged as a promising tool for evaluating various aspects of diaphragmatic function.

Objective: To investigate the relationship between ultrasonic diaphragmatic parameters and the WIND classification group.

Methods: This was a prospective observational study in which intubated surgical intensive care unit (SICU) patients were included. Diaphragmatic ultrasounds were performed on these patients. After the patients were discharged from the SICU, they were classified into each WIND group, and the association between the WIND group and diaphragmatic ultrasound parameters was analyzed.

Results: A total of 128 mechanically ventilated patients were included in the study. The majority of atients, 90 (70%), were assigned to the WIND 1 group, while 24 (19%) were assigned to the WIND 2 group, and 8 (6%) were assigned to the WIND 3 group. Additionally, 6 (5%) patients were assigned to the WIND NW group. The median age of the patients was 67, with a range of 53 to 75. The most common type of respiratory failure experienced by the patients was peri-operative, accounting for 68% of cases. There were no significant differences observed in other baseline characteristics among the different groups. However, when examining diaphragmatic thickness at the end inspiration, a statistically significant difference was found on the right side. The WIND 3 group had the lowest measurement of diaphragmatic thickness at 1.5 mm. It is important to note that there were no significant differences in diaphragmatic thickness parameters between the groups.

Conclusions: Diaphragmatic ultrasonography lacks the ability to differentiate between the various WIND groups. However, the success of weaning is different among WIND classifications.

Keywords: Weaning, Mechanical ventilation, Ultrasound, Diaphragm, Diaphragm dysfunction

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Introduction

After undergoing surgery, a subset of surgical patients may require ongoing mechanical ventilation and are subsequently admitted to the surgical intensive care unit (SICU). A follow-up study conducted at nine training institutions in Thailand between 2011 and 2014[1] revealed that the incidence of respiratory failure among patients in SICUs ranged from approximately 2.1% to 3.7%.[2] It is of paramount importance to ensure proper weaning of patients from mechanical ventilation, as improper procedures can lead to prolonged stays in the intensive care unit and potential complications associated with the ventilator. Conversely, if the weaning process is expedited, it can have detrimental effects on the cardiovascular system, necessitating tracheal intubation and resulting in increased complications and mortality.[3-5]

Consequently, the selection of appropriate patients for the weaning process is crucial. Currently, there exist classifications of patients who have successfully been weaned from ventilators, such as the International Consensus Conference (ICC) and weaning according to a new definition (WIND). These classifications serve as valuable tools in predicting the likelihood of success or complications following ventilator weaning. According to the findings of a previous study conducted by WIND group, it has been demonstrated that utilizing the WIND classification system offers several benefits in predicting a patient's mechanical ventilator weaning group, as compared to the previous ICC classification. The results of this study provide valuable insights into the effectiveness of the WIND classification system in clinical practice.[6,7]

Diaphragmatic dysfunction is a prevalent issue among mechanically ventilated patients, which can prolong the duration of mechanical ventilation and impede successful weaning. In the past, assessing diaphragmatic function necessitated invasive instruments and expert interpretation, rendering it inconvenient for critically ill patients. However, with the advent of high-frequency diagnostic equipment, the function of the diaphragm can now be conveniently evaluated at the patient's bedside.[8] Ultrasonic diagnostics enable the measurement of various aspects of diaphragm function, including diaphragmatic excursion, diaphragmatic thickness, and diaphragmatic contraction speed. These measurements, when combined with other parameters, can serve as indicators for successful weaning from the ventilator.[9-11]

The WIND study did not investigate the correlation between diaphragmatic ultrasound assessment. Therefore, the objective of this study is to investigate whether diaphragmatic function tests can be employed to classify patients who have been weaned from ventilators in surgical ICUs and predict the success of ventilator weaning.

Previous research in the field[12-14] has predominantly focused on the Internal Medicine Intensive Care Unit (ICU), with limited attention given to surgical ICUs. Within the surgical ICU, it is common for perioperative patients to encounter diaphragmatic dysfunction. This dysfunction can have multiple underlying causes, including surgical procedures involving the thoracic or abdominal regions. However, this study aims to address this gap by including a patient cohort consisting of individuals in perioperative status and surgical ICUs.

Patients and Methods

This is a single center, prospective observational study of SICU patients at Maharaj Nakorn Chiang Mai Hospital during the ethics committee approval period whose diaphragm function were measured with ultrasound during spontaneous breathing trial.

Ethics committee: Faculty of Medicine, Chiangmai University (study code: SUR-2563-07301).

The inclusion criteria for this study encompassed the following parameters: individuals aged 20 years or older, patients who had undergone post-operative procedures, including urgent, emergent, and elective surgeries, individuals who were intubated or had a tracheostomy and were under invasive mechanical ventilation, patients who were deemed ready to undergo a spontaneous breathing trial, and individuals who did not have any contraindications to undergo ultrasonic assessment in the specific anatomical area. Additionally, written informed consent was obtained from all participants in the study.

The exclusion criteria outlined in this study are essential for defining the specific population that will be included in the analysis. By excluding individuals who are pregnant, have neuromuscular disease, diaphragm paralysis, or cannot be properly visualized by ultrasound.

Sample size

Formula	Previous study	Sample size
Testing two independent proportion $n_1 = kn_2$ $n2 = \frac{(z_{\alpha/2} + z_\beta)^2}{\epsilon^2}\left[\frac{p_1(1-p_1)}{\kappa} + p_2(1-p_2)\right]$	Weaning success TFdi < 26% Success = 0.38 TFdi > 26% Success = 0.83 Incidence of difficult/prolong wean = 0.187[1]	N = 18 per group Incidence = 0.187 The calculate at least enrolled = 96.26 = ***97 patients*** [9,10]

Estimated dropout rate was estimated to 15% then total sample size was 111 patients.

Study protocol

Patients who were admitted to the Surgical Intensive Care Unit (SICU) and required mechanical ventilation (MV) during the ethics committee approval period were prospectively enrolled at Maharaj Nakorn Chiang Mai Hospital. The diaphragmatic ultrasound examinations were conducted by a surgical resident who was supervised by attending ICU staff. Following the patients' discharge, data on mechanical ventilator usage was obtained from the electronic ICU database. This information was then used to categorize the patients into different WIND groups. Subsequently, the association between the WIND group and various diaphragmatic ultrasound parameters was analyzed.

WIND Groups

- Group no weaning (NW): patients never experienced any separation attempt.
- Group 1 (short weaning): the first separation attempt resulted in a termination of the weaning process within 24 hours (successful separation or early death).
- Group 2 (difficult weaning): weaning was terminated after more than 1 day but in less than 1 week after the first separation attempt (successful separation or death).
- Group 3 (prolonged weaning): weaning was still not terminated 7 days after the first separation attempt (by success or death).

Reproduced from Beduneau G, Pham T, Schortgen F, et al. Epidemiology of Weaning Outcome according to a New Definition. The WIND Study. Am J Respir Crit Care Med. 2017[7]

Diaphragmatic Ultrasound

All patients were evaluated in a semi-recumbent position within 24 hours of ICU admission using the Esaote® MyLab™ Gamma Ultrasound.

Diaphragm excursion was assessed in the subcostal area, between the mid-clavicular and anterior axillary lines, using the liver or spleen as acoustic windows. Either a cardiac or abdominal probe (1-5 MHz) can be used to identify the diaphragm as a hyperechoic line, which approaches the probe during inspiration. The inspiratory excursion can be easily measured in M-mode, referred to as diaphragm excursion (DE) (Figure 1).

Diaphragm thickness was evaluated at the zone of apposition, between the 8th and 10th intercostal space in the mid-axillary or anterior-axillary line, 0.5 - 2 cm below the costophrenic sinus. To obtain adequate images of diaphragmatic thickness, a linear high-frequency probe (6-13 MHz) is mandatory. At a depth of 1.5 - 3 cm, two parallel echogenic layers can be easily identified: the nearest line represents the parietal pleura, while the deeper one represents the peritoneum. The diaphragm, which is the least echogenic structure between these two lines, can be assessed for thickness and thickening with inspiration.

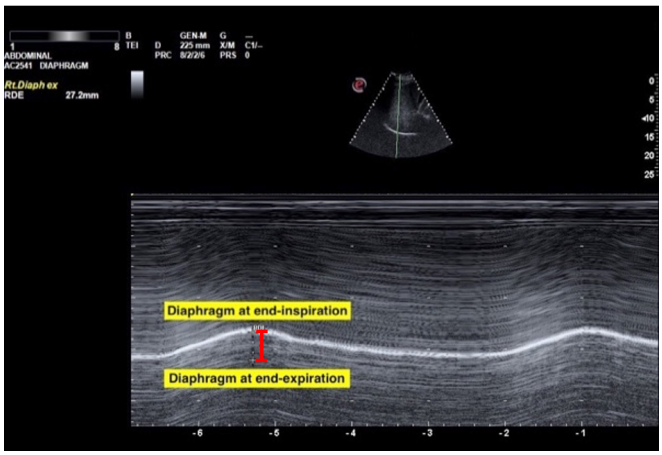

Figure 1 Diaphragm excursion measurement

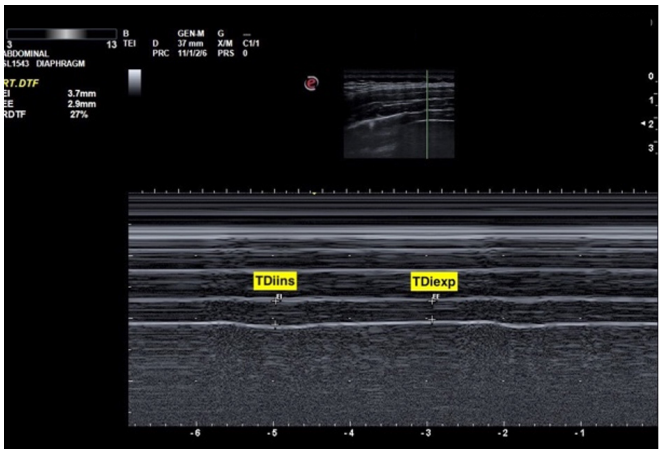

Figure 2 Diaphragm thickness measurement

This is usually done in M-mode and referred to as diaphragmatic thickness at end inspiration (TDi_{ins}) and diaphragmatic thickness at end-expiration (TDi_{exp}). The diaphragm thickness fraction (DTF) can be calculated using the formula $(TDi_{ins} - TDi_{exp})/ TDi_{exp} \times 100$. (Figure 2).

Data Analysis

The data in this study are presented using various statistical measures. These measures include counts, percentages, means with standard deviations, and medians with interquartile ranges, as appropriate for the specific data being analyzed. The Kruskal-Wallis H test was employed to analyze the data across the different WIND groups. In statistical analysis, a *p*-value below 0.05 was considered to indicate statistical significance.

Results

The study began with a cohort of 152 patients. However, 24 individuals were later excluded for various reasons, which are detailed in the accompanying flowchart (Figure 3). As a result, the final sample size for the study consisted of 128 patients. The baseline characteristics of the patients admitted to the Surgical Intensive Care Unit (SICU) are thoroughly presented in Table 1. The results of the study show that, apart from the cause of respiratory failure, specifically peri-operative factors, there were no statistically significant differences observed among the WIND group.

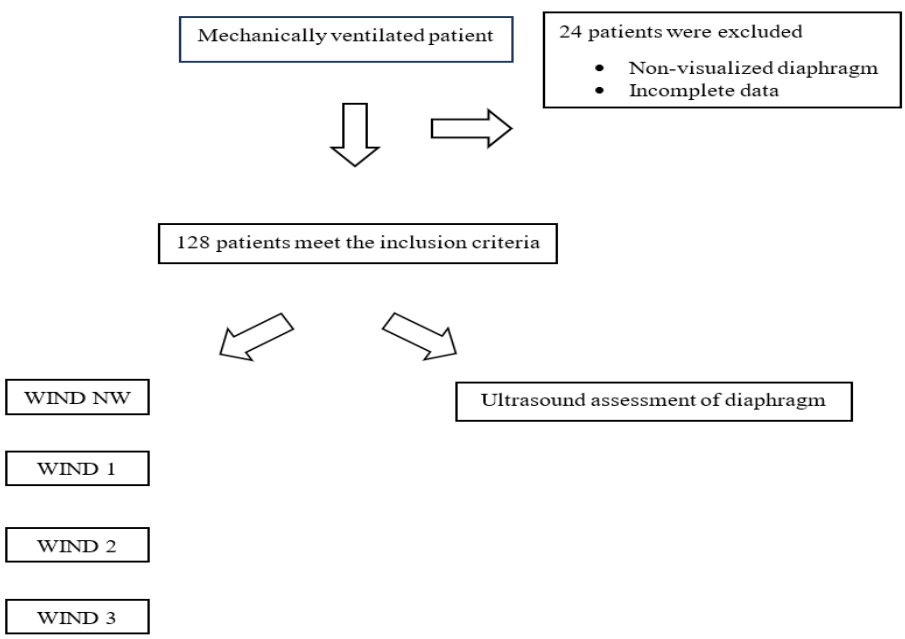

Figure 3 Flow chart of study design and included participants.

Table 1 Characteristics of WIND group patient in SICU

Characteristic	All 128 (100%)	WIND NW 6 (4.69%)	WIND 1 90 (70.31%)	WIND 2 24 (18.75%)	WIND 3 8 (6.25%)	*P*-value
Median age, years (IQR)	67 (53-75)	68.5 (67-72)	63.5 (50-76)	69.5 (64-77)	73 (61.5-80.5)	0.303
Sex, male	69 (54.33)	1 (16.67)	47 (52.22)	16 (66.67)	5 (71.43)	0.117
ASA						
Class 1	2 (1.56)	0 (0.00)	1 (1.11)	1 (4.17)	0 (0.00)	0.225
Class 2	45 (35.16)	1 (16.67)	33 (36.67)	9 (37.50)	2 (25.00)	
Class 3	53 (41.41)	1 (16.67)	41 (45.56)	7 (29.17)	4 (50.00)	
Class 4	28 (21.88)	4 (66.67)	15 (16.67)	7 (29.17)	2 (25.00)	
Class 5	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
Underlying disease						
Hypertension	64 (50.39)	3 (50.00)	41 (46.07)	15 (62.50)	5 (62.50)	0.468
Diabetes	32 (25.00)	2 (33.33)	18 (20.00)	9 (37.50)	3 (37.50)	0.252
COPD	9 (7.03)	0 (0.00)	4 (4.44)	4 (16.67)	1 (12.50)	0.161
CVS disease	28 (21.88)	2 (33.33)	17 (18.89)	8 (33.33)	1 (12.50)	0.364
Cancer	30 (23.44)	2 (33.33)	23 (25.56)	4 (16.67)	1 (12.50)	0.637
Cirrhosis	10 (7.81)	0 (0.00)	7 (7.78)	3 (12.50)	0 (0.00)	0.589
CKD	18 (14.06)	1 (16.67)	14 (15.56)	3 (12.50)	0 (0.00)	0.669
Immunocompromise	6 (4.69)	1 (16.67)	4 (4.44)	0 (0.00)	1 (12.50)	0.239
Cause of respiratory failure						
Hypoxemic	23 (17.97)	4 (66.67)	8 (8.89)	9 (37.50)	2 (25.00)	0.006
Hypercapnic	2 (1.56)	0 (0.00)	2 (2.22)	0 (0.00)	0 (0.00)	
Peri-operative	87 (67.97)	2 (33.33)	67 (74.44)	12 (50.00)	6 (75.00)	
Shock	16 (12.50)	0 (0.00)	13 (14.44)	3 (12.50)	0 (0.00)	

The association between diaphragmatic ultrasound parameters and the WIND group is presented in Table 2 and Figure 4. Notably, the diaphragmatic thickness at end inspiration showed statistical significance for the right side, with the WIND 3 group having the lowest measurements (1.6 mm, 2.3 mm, and 1.5 mm, respectively). However, there were no significant differences observed in other diaphragmatic thickness parameters across the groups. Although the WIND 3 group had the highest diaphragm thickness fraction, this difference did not reach statistical significance. In terms of the diaphragmatic excursion parameter, the WIND 2, WIND 1, and WIND 3 groups displayed the highest values, respectively.

Several mechanical ventilator outcomes were found to be statistically significant. These outcomes, between WIND Group 1, 2, and 3, include the number of patients who were successfully weaned from mechanical ventilation (MV) (91.1%, 83.3%, 12.5%, $p < 0.001$) the rate of reintubation (8.9%, 16.7%, 62.5%, $p < 0.001$), the duration of MV days (2, 4, 12, $p < 0.001$) and the length of stay (LOS) in the hospital (3, 6, 22, $p < 0.001$).

Table 2 WIND group and diaphragmatic parameters association, data was presented in (mm) (IQR) for the diaphragmatic thickness and diaphragmatic excursion and (%) (IQR) for the diaphragmatic thickness fraction.

Characteristic	All	WIND NW	WIND 1	WIND 2	WIND 3	*P*-value
TDi_{ins}						
Right	2.35 (1.8-2.99)	2.5 (2.5-2.5)	2.2 (1.8-2.85)	3 (2.6-3.7)	2.4 (1.3-2.7)	0.054
Left	2.3 (1.8-2.9)	2.6 (2.6-2.6)	2.3 (1.7-2.83)	2.3 (1.9-3.2)	2.55 (2.2-2.7)	0.651
TDi_{exp}						
Right	1.69 (1.3-2.25)	2 (2-2)	1.6 (1.2-2.2)	2.3 (2-3)	1.5 (0.71-2.1)	0.047
Left	1.7 (1.2-2.4)	1.9 (1.9-1.9)	1.6 (1.3-2.25)	2 (1.4-2.7)	1.75 (0.82-2)	0.603
DTF (%)						
Right	33 (24-54)	28 (28-28)	32.5 (24.5-54.5)	32.5 (19-44)	60 (29-93)	0.388
Left	36.5 (24-47.5)	34 (34-34)	36.5 (24.5-47)	29 (21-48)	53.5 (31-72)	0.596
Diaphragmatic excursion						
Right	9.5 (6.85-12.7)	6.7 (6.7-6.7)	9.37 (7-13)	9.7 (6.6-15.1)	7.2 (5-11.5)	0.449
Left	9.1 (6.65-12.55)	19.9 (19.9-19.9)	9.15 (6.5-12)	10.5 (7.4-15.4)	6.9 (5.4-7.2)	0.069

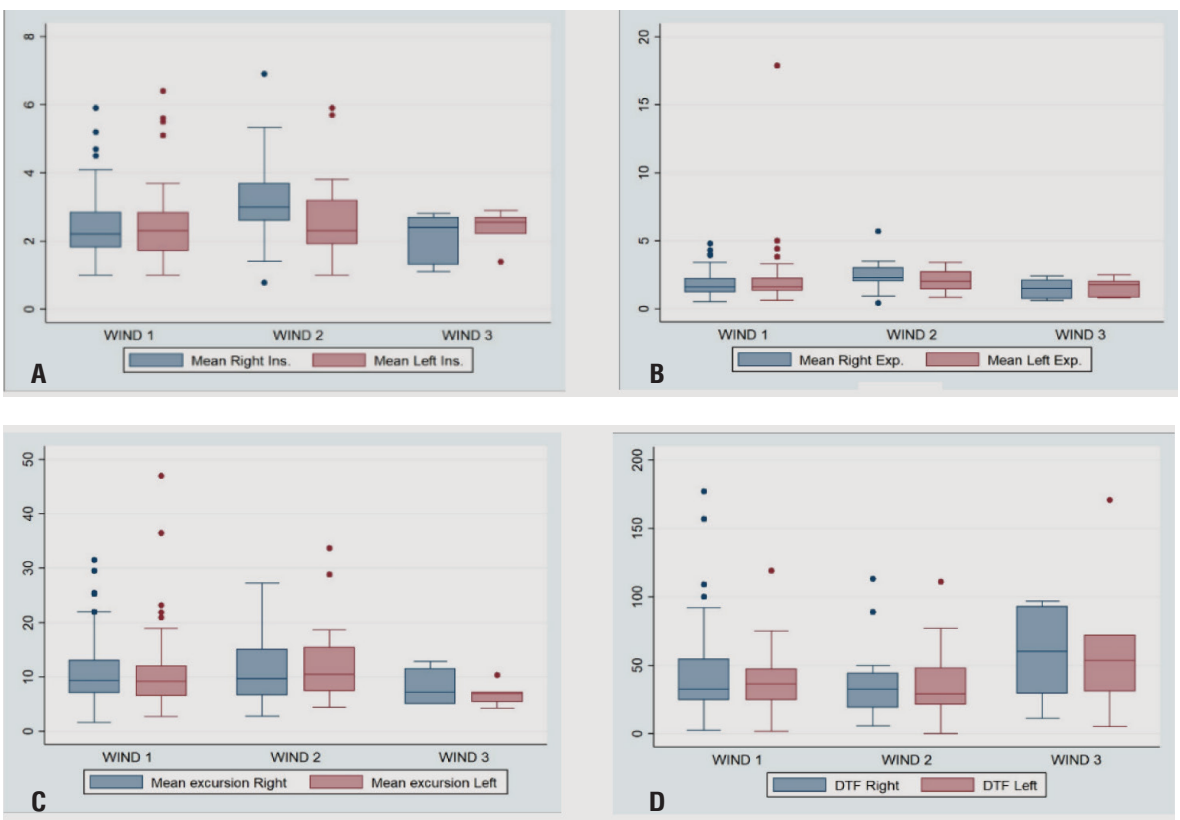

Figure 4 Boxplot of right and left diaphragmatic thickness at inspiration (A) and expiration (B), right and left diaphragmatic excursion (C), and right and left DTF (D): the central line represents the median value, the box boundaries represent the 25th and 75th percentiles, the lines represent the lowest datum within 1.5 inter-quartile range (IQR) of the lower quartile and the highest datum within 1.5 IQR of the upper quartile, and the circles represent outlier values.

Table 3 WIND group, mechanical ventilator outcomes, and LOS association

Characteristic	All	WIND 1	WIND 2	WIND 3	*P*-value
Successful weaning from MV N, %	107 (83.59)	82 (91.11)	20 (83.33)	1 (12.50)	< 0.001
Interval between intubation and first weaning, days (IQR)	1 (1-3)	1 (1-2)	1 (1-4)	7 (1.5-8.5)	0.184
Re-intubation N, %	19 (14.84)	8 (8.89)	4 (16.67)	5 (62.50)	< 0.001
Interval between re-intubation, days (IQR)	2 (1-4)	2 (1-5)	2.5 (1-38.5)	3 (1-4)	0.752
MV days (IQR)	2 (1-4)	2 (1-3)	4 (3-7)	12 (5-16)	< 0.001
LOS in ICU, days (IQR)	5 (3-11.5)	3 (2-8)	6 (5-12.5)	22 (17.5-30)	< 0.001

Discussion

The mean diaphragmatic thickness in previous studies[12-14] has been reported to range from 1.5 to 2 mm. Consistent with these findings, the mean diaphragmatic thickness in this study also fell within this range. Previous research has indicated that the diaphragmatic thickness fraction is a reliable measure for assessing respiratory muscle workload during noninvasive mechanical ventilation and predicting extubation success or failure during a trial of spontaneous breathing. However, this study did not observe any significant difference in the measurement of the thickening fraction, which could be attributed to the intricacies involved in the measurement process.

Measuring diaphragmatic thickness poses several challenges. Firstly, due to the relatively small thickness values (between 1.5 and 2 mm), a high-frequency probe, typically a 10 MHz "vascular" probe, is necessary. Secondly, difficulties may arise when dealing with certain patient populations, such as obese individuals. Thirdly, the majority of ultrasound machines have a minimum detectable distance of 0.1 mm, which constitutes roughly 5-7% of the measurement. Consequently, even slight variations introduced by the operator can influence the precision of the measurement. Fourthly, evaluating the left hemidiaphragm can be particularly challenging in some cases to identify the correct position for measuring diaphragmatic parameters. Lastly, there is a lack of available data regarding the learning curve associated with measuring the thickening fraction. These factors collectively contribute to the potential discrepancies between the findings of this study and those of previous studies.

In conclusion, this study aligns with earlier research by reporting a mean diaphragmatic thickness within the established range. However, it did not find any significant difference in the measurement of the thickening fraction, potentially due to the complexities involved in the measurement process. Challenges associated with measuring diaphragmatic thickness include the need for a high-frequency probe, difficulties with certain patient populations, the impact of operator-induced fluctuations, challenges in evaluating the left hemidiaphragm, and a lack of data on the learning curve for measuring the thickening fraction. These factors may help explain the differences observed between this study and previous research.

On the contrary, measuring diaphragmatic excursion using ultrasound is a relatively straightforward procedure. In this study, although the differences were not statistically significant, the values of diaphragmatic excursion were observed to be higher in both groups 1 and 2 of the WIND population compared to group 3, which represents individuals with normal diaphragmatic function. Notably, group 2 exhibited even higher values than group 1, suggesting the need for further investigation to determine whether this difference may be due to early postoperative diaphragmatic dysfunction. Additionally, conducting studies with larger sample sizes and closely monitoring ultrasonographic parameters during mechanical ventilation in the Surgical Intensive Care Unit (SICU) setting is crucial. These efforts will facilitate a more comprehensive analysis and enhance our understanding of the significance of ultrasound parameters in this specific context.

The study conducted by the WIND group aimed to validate the use of the WIND group classification in predicting the outcomes of mechanical ventilation in patients admitted to the Maharaj Nakorn Chiang Mai SICU. From the Table 3, the results of the study showed that the

WIND group classification was effective in predicting the outcomes of mechanical ventilation. This suggests that the WIND group classification can be a useful tool for clinicians in assessing the prognosis of patients requiring mechanical ventilation. However, it is important to highlight that the study also found no correlation between the WIND group classification and ultrasonic diaphragmatic measures.

One limitation of this study is that although we are concerned with the measurement bias by training the residents every rotation and consultant assistant during measurement, the operator bias might also occur. Another limitation arises from the possibility of post-operative diaphragmatic swelling in patients, which might lead to minimal differences in diaphragmatic thickness and excursion among the groups under investigation. Additionally, as mentioned earlier, the study emphasizes that even slight discrepancies introduced by the operator can significantly affect measurement precision. Therefore, to bolster the reliability of the study findings, it is advisable to carry out an intra-observer validation assessment.

Conclusion

Diaphragmatic ultrasonography lacks the ability to differentiate between the various WIND groups. However, the success of weaning varies among WIND classifications.

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Conflict of interest

The authors disclose no conflict of interest.

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