

# Continence Outcome of Preoperative Pelvic Floor Muscle Training after Robotic-Assisted Laparoscopic Radical Prostatectomy: Randomized Controlled Trial

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**Background:** Incontinence is the second most bothersome outcome after robotic-assisted laparoscopic radical prostatectomy (RARP). Most patients will regain continence at one year, but pelvic floor muscle training (PFMT) may represent a valid treatment to improve postoperative urinary continence.

**Objective:** To determine the relationship between preoperative PFMT functional outcomes in patients undergoing RARP.

**Materials and Methods:** The present study was a randomized controlled trial. Sixty patients with clinically localized adenocarcinoma of the prostate between December 2020 and June 2022 were randomized into two groups: Group A included 30 patients in standard RARP and a pre-operative PFMT program, and Group B included 30 patients in which only standard RARP was performed. The primary outcome was continent status at 1, 3, and 6 months after surgery using the score from the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF). The higher score means poorer incontinence status. The secondary outcomes were continence status at 1, 3, and 6 months after surgery, assessed using the pad test score.

**Results:** The continent status at 1, 3, and 6 months postoperatively was evaluated by ICIQ-UI SF. The total mean score in Group A was better than that in Group B, but it was not statistically significant. The divided ICIQ-SF score by severity level showed a significant improvement in post-prostatectomy urinary incontinence at one month ( $p=0.024$ ). Pad test at one, three, and six months for the PFMT group was better than for the control group, but was not statistically significant.

**Conclusion:** Pre-operative PFMT for men undergoing RARP for prostate cancer may improve postoperative urinary continence.

**Keyword:** Urinary incontinence; Radical prostatectomy; Pelvic floor muscle training

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Prostate cancer is the most common cancer in men. Treatment options for localized disease include radical prostatectomy, radiation therapy, hormonal therapy, and active surveillance<sup>(1,2)</sup>. Robotic-assisted radical prostatectomy (RARP) is a minimally invasive technique that offers more precise prostate removal, reduced blood loss, and faster recovery compared

with open prostatectomy. It is also associated with fewer complications, such as urinary incontinence and erectile dysfunction.

Surgical refinements, including bladder neck preservation, neurovascular bundle sparing, puboprostic ligament preservation, and urethral length maximization, may help enhance postoperative continence recovery. Although most patients regain continence within 6 to 12 months after RARP<sup>(3-5)</sup>, improving early continence recovery remains important for quality of life.

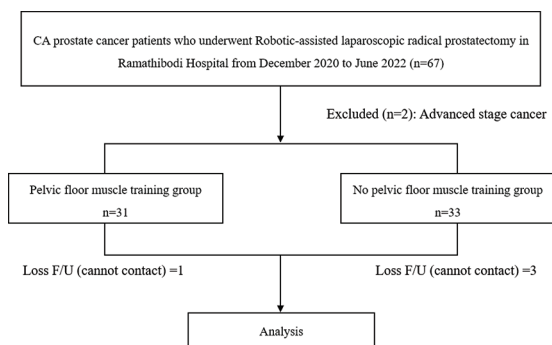
Continence is influenced by both uncontrollable factors (e.g., age and urethral anatomy) and modifiable factors (e.g., surgical technique and pelvic floor muscle strength). Pelvic floor muscles (levator ani, ischiocavernosus, and bulbospongiosus) contribute to urinary control<sup>(6-8)</sup>. Pelvic floor muscle training (PFMT) is a non-invasive intervention designed to strengthen these muscles and is traditionally used

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**Figure 1.** Flow diagram.



**Figure 2.** Lying position of PFMT.

postoperatively. Increasing attention has been given to the role of preoperative PFMT in promoting earlier continence recovery.

The present study aimed to evaluate the effect of preoperative PFMT<sup>(9-11)</sup> on postoperative urinary continence outcomes in patients undergoing RARP through a single-blinded, randomized controlled trial.

### MATERIALS AND METHODS

Sixty patients with localized prostate adenocarcinoma who were scheduled for RARP at Ramathibodi Hospital between December 2020 and June 2022 were prospectively enrolled. Patients with locally advanced disease, metastatic disease, prior urinary incontinence, previous pelvic radiation, neurological disorders, or medications known to affect continence were excluded (Figure 1).

A sample size calculation was performed, and assuming a 25% difference in continence rates between groups at three months, with 80% power and  $\alpha=0.05$ , required 30 participants per group.

Participants were randomized (1:1) using a computer-generated block randomization sequence, with allocation concealed in opaque sealed envelopes. This was a single-blinded study in which outcome assessors were blinded to group allocation.

Patients were assigned to two groups: Group A (PFMT group), receiving PFMT beginning four to six weeks before surgery plus standard RARP (30 patients), and Group B (control group), undergoing standard RARP only (30 patients).

All surgeries were performed by a surgical team with experience exceeding 800 RARP procedures. PFMT<sup>(12)</sup> was delivered under the supervision of a trained physiotherapist. Exercises consisted of three daily 10-minute sessions performed in lying, sitting, and standing positions (Figure 2-4). Adherence was encouraged via exercise logs and telemedicine follow-up. However, objective verification was not



**Figure 3.** Sitting position of PFMT.



**Figure 4.** Standing position of PFMT.

Initial number

ICIQ-UI Short Form  
CONFIDENTIAL DAY MONTH YEAR  
Today's date

Many people leak urine some of the time. We are trying to find out how many people leak urine, and how much this bothers them. We would be grateful if you could answer the following questions, thinking about how you have been, on average, over the PAST FOUR WEEKS.

1 Please write in your date of birth:            
DAY MONTH YEAR

2 Are you (tick one): Female  Male

3 How often do you leak urine? (Tick one box)

never	<input type="checkbox"/>	0
about once a week or less often	<input type="checkbox"/>	1
two or three times a week	<input type="checkbox"/>	2
about once a day	<input type="checkbox"/>	3
several times a day	<input type="checkbox"/>	4
all the time	<input type="checkbox"/>	5

4 We would like to know how much urine you think leaks.  
How much urine do you usually leak (whether you wear protection or not)? (Tick one box)

none	<input type="checkbox"/>	0
a small amount	<input type="checkbox"/>	2
a moderate amount	<input type="checkbox"/>	4
a large amount	<input type="checkbox"/>	6

5 Overall, how much does leaking urine interfere with your everyday life?  
Please ring a number between 0 (not at all) and 10 (a great deal)

0	1	2	3	4	5	6	7	8	9	10
not at all										a great deal

ICIQ score: sum scores 3+4+5

6 When does urine leak? (Please tick all that apply to you)

never – urine does not leak	<input type="checkbox"/>
leaks before you can get to the toilet	<input type="checkbox"/>
leaks when you cough or sneeze	<input type="checkbox"/>
leaks when you are asleep	<input type="checkbox"/>
leaks when you are physically active/exercising	<input type="checkbox"/>
leaks when you have finished urinating and are dressed	<input type="checkbox"/>
leaks for no obvious reason	<input type="checkbox"/>
leaks all the time	<input type="checkbox"/>

Thank you very much for answering these questions.  
Copyright © ICIQ Group

**Figure 5.** International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF).

implemented.

The primary outcome was continence status measured using the International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF) at 1, 3, and 6 months after catheter removal. Secondary outcomes included a standardized 24-hour pad test. Continence was defined as one pad per day or less.

### Statistical analysis

Baseline characteristics were compared using chi-square or Fisher's exact tests for categorical variables. ICIQ-UI SF scores were compared between groups using Student's t-test. Statistical analyses were performed using Stata, version 14 (StataCorp LP, College Station, TX, USA). A p-value of less than 0.05 with 95% confidence intervals (CIs) was considered statistically significant.

### RESULTS

Sixty patients were enrolled, with a mean age of 66.9±5.5 years and a median prostate-specific antigen (PSA) of 9.0 ng/mL (range 6.4 to 14.2 ng/

ส่วนที่ 2 แบบประเมินความรุนแรงของภาวะกลั้นปัสสาวะไม่อยู่  
คำชี้แจง กรุณาทำเครื่องหมาย ✓ ลงใน  หน้าตัวเลขที่ตรงกับอาการของท่านที่ปรากฏว่า  
ท่านมีอาการต่อไปนี้มากน้อยเพียงใด

1. คุณปัสสาวะเล็ดบ่อยแค่ไหน (เลือกหนึ่งข้อ)

ไม่เคย	<input type="checkbox"/>	0
สัปดาห์ละครั้งหรือน้อยกว่า	<input type="checkbox"/>	1
สองถึงสามครั้งต่อสัปดาห์	<input type="checkbox"/>	2
ประมาณวันละครั้ง	<input type="checkbox"/>	3
หลายครั้งต่อวัน	<input type="checkbox"/>	4
ตลอดเวลา	<input type="checkbox"/>	5

2. คุณมีปริมาณปัสสาวะเล็ดมากเท่าไร  
โดยปกติปริมาณปัสสาวะที่คุณกลั้นไม่อยู่มีมากเท่าไร (ไม่ว่าคุณจะไปเล่นรองขับหรือไม่ก็ตาม)  
(เลือกหนึ่งข้อ)

ไม่มี	<input type="checkbox"/>	0
เล็กน้อย	<input type="checkbox"/>	2
ปานกลาง	<input type="checkbox"/>	4
จำนวนมาก	<input type="checkbox"/>	6

3. โดยรวม ภาวะปัสสาวะเล็ดรบกวนต่อชีวิตประจำวันของคุณมากเพียงใด  
โปรดวงกลมตัวเลขระหว่าง 0 (ไม่เลย) และ 10 (มากที่สุด)

0	1	2	3	4	5	6	7	8	9	10
ไม่เลย										มากที่สุด

คะแนนรวมในข้อ 1+2+3

4. ภาวะปัสสาวะเล็ดเกิดขึ้นเมื่อใด (โปรดเลือกทุกข้อที่ตรงกับคุณ)

ไม่เลย – ไม่มีอาการปัสสาวะเล็ด	<input type="checkbox"/>
ปัสสาวะเล็ดก่อนจะถึงห้องน้ำ	<input type="checkbox"/>
ปัสสาวะเล็ดเมื่อมีอาการไอหรือจาม	<input type="checkbox"/>
ปัสสาวะเล็ดขณะนอนหลับ	<input type="checkbox"/>
ปัสสาวะเล็ดเมื่อมีกิจกรรมรีบเร่งหรือกำลังออกกำลังกาย	<input type="checkbox"/>
ปัสสาวะเล็ดหลังเข้าห้องน้ำและใช้เสื่อผ้าอยู่	<input type="checkbox"/>
ปัสสาวะเล็ดโดยไม่ทราบสาเหตุที่ชัดเจน	<input type="checkbox"/>
ปัสสาวะเล็ดตลอดเวลา	<input type="checkbox"/>

**Figure 6.** International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF)-Thai version.

mL). There were no significant differences in baseline characteristics (Table 1), including preoperative PSA, Gleason score, prostate volume, PSAD, and underlying conditions affecting continence.

Perioperative outcomes (Table 2) showed no statistically significant differences between groups. The median length of stay was five days in both groups (p=0.719). Median operative time did not differ significantly (Group A: 115±24 minutes and Group B: 124±33 minutes, p=0.209). Intraoperative blood loss was also not significantly different (Group A: median of 200 mL and Group B: median of 250 mL, p=0.757).

Continence outcomes assessed by the Thai version of the ICIQ-UI SF, which is approved by the ICIQ International group (Figure 5, 6), are shown in Table 3.

- At 1 month, the PFMT group had a lower mean score (14.8±2.7) compared with the control group (15.1±1.7), but the difference was not significant (p=0.574).

- At 3 months, mean scores were 10.1±3.4 versus 10.8±2.4 (p=0.364).

**Table 1.** Baseline characteristics

Variable	Total (n=60)	Control (n=30)	PFMT (n=30)	p-value
Age (years); mean±SD	66.9±5.5	67.8±6.2	66.2±4.7	0.257
BW (kg); mean±SD	70.0±12.2	68.8±12.8	71.3±11.6	0.437
Height (cm); mean±SD	166±8	165±6	167±8	0.453
BMI (kg/m <sup>2</sup> ); mean±SD	25.3±3.7	25.1±4.3	25.5±2.9	0.668
Underlying; n (%)				
HT	43 (71.7)	19 (63.3)	24 (80.0)	0.152
DM	20 (33.3)	10 (33.3)	10 (33.3)	0.999
DLP	31 (51.7)	12 (40.0)	19 (63.3)	0.071
Prostate risk group				
PSA (ng/dL); median (IQR)	9.0 (6.4, 14.2)	8.7 (6.7, 13.6)	9.6 (6.3, 16.5)	0.784
Gleason score 1; n (%)				
• 3	38 (63.3)	21 (70.0)	17 (56.7)	0.438
• 4	19 (31.7)	7 (23.3)	12 (40.0)	
• 5	3 (5.0)	2 (6.7)	1 (3.3)	
Gleason score 2; n (%)				
• 3	36 (60.0)	19 (63.4)	17 (56.7)	0.892
• 4	22 (36.7)	10 (33.3)	12 (40.0)	
• 5	2 (3.3)	1 (3.3)	1 (3.3)	
Positive lobe (n=53); n (%)				
• Right	23 (43.4)	8 (29.6)	15 (57.7)	0.031
• Left	17 (32.1)	13 (48.2)	4 (15.4)	
• Both	13 (24.5)	6 (22.2)	7 (26.9)	
p_vol (n=49); mean±SD	46.4±22.3	49.8±24.4	43.2±20.2	0.303
PSAD (n=49); mean±SD	0.29±0.23	0.25±0.19	0.33±0.27	0.189
Pre ADT; n (%)				
• 0	47 (78.3)	24 (80.0)	23 (76.7)	0.754
• 1	13 (21.7)	6 (20.0)	7 (23.3)	
Pre T; n (%)				
• 1b	1 (1.7)	0 (0.0)	1 (3.3)	0.368
• 1c	58 (96.6)	29 (96.7)	29 (96.7)	
• 3c	1 (1.7)	1 (3.3)	0 (0.0)	
Pre N; n (%)				
• 0	60 (100)	30 (100)	30 (100)	-
Pre M; n (%)				
• 0	60 (100)	30 (100)	30 (100)	-
Pre-operative SF score				
Total score	0 (0.0)	0 (0.0)	0 (0.0)	-

PFMT=pelvic floor muscle training; BW=body weight; BMI=body mass index; HT=hypertension; DM=diabetes mellitus; DLP=dyslipidemia; PSA=prostate-specific antigen; PSAD=prostate-specific antigen density; ADT=androgen deprivation therapy; SF=short form; SD=standard deviation; IQR=interquartile range

**Table 2.** Perioperative data

Peri-operative	Total (n=60)	Control (n=30)	PFMT (n=30)	p-value
Blood loss (mL); median (IQR)	225 (150, 300)	200 (150, 300)	250 (150, 300)	0.757
Operative time (minutes); mean±SD	119±29	115±24	124±33	0.209
Length of stay(days); median (IQR)	5 (4, 5)	5 (4, 6)	5 (4, 5)	0.719

PFMT=pelvic floor muscle training; SD=standard deviation; IQR=interquartile range

**Table 3.** Postoperative ICIQ-SF total mean score (compare control group and PFMT group)

Variable	Control (n=30) Mean±SD	PFMT (n=30) Mean±SD	p-value
Sum ICIQ score (at postoperative)			
At 1 month	15.1±1.7	14.8±2.7	0.574
At 3 months	10.8±2.4	10.1±3.4	0.364
At 6 months	6.9±2.4	6.7±2.9	0.808

PFMT=pelvic floor muscle training; ICIQ=International Consultation on Incontinence Questionnaire; SD=standard deviation

**Table 4.** Postoperative antimuscarinic

Antimuscarinic	Total (n=60) n (%)	Control (n=30) n (%)	PFMT (n=30) n (%)	p-value
No	13 (22.8)	4 (14.8)	9 (30.0)	0.172
Yes	44 (77.2)	23 (85.2)	21 (70.0)	

PFMT=pelvic floor muscle training

- At 6 months, scores were 6.7±2.9 versus 6.9±2.4 (p=0.808).

Severity-level analysis showed:

- At 1 month, PFMT resulted in significantly fewer cases of severe and very severe incontinence compared with controls (p=0.024) (Figure 7).

- At 3 and 6 months, no statistically significant differences were observed (Figure 8, 9).

Subgroup analysis of antimuscarinic drug use demonstrated similar trends, with improved continence in the PFMT group but without statistical significance (Table 4).

Pad test results showed:

- At 1 month, PFMT patients had fewer cases of severe incontinence and more cases of successful continence than controls (Figure 10).

- At 3 months, the PFMT group had a higher continence rate (40% versus 23%) (Figure 11).

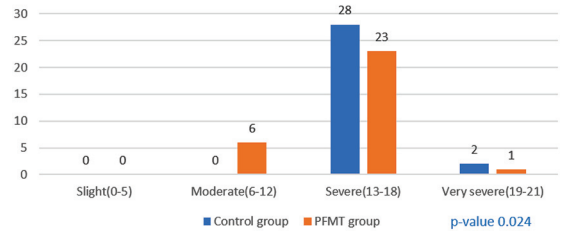
- At 6 months, neither group had moderate-to-severe incontinence (Figure 12).

## DISCUSSION

Radical prostatectomy is a commonly used treatment for localized prostate cancer. RARP has become the preferred approach because it offers improved oncologic and functional outcomes compared with open or laparoscopic surgery. However, postoperative urinary incontinence still occurs in 4% to 31% of patients.

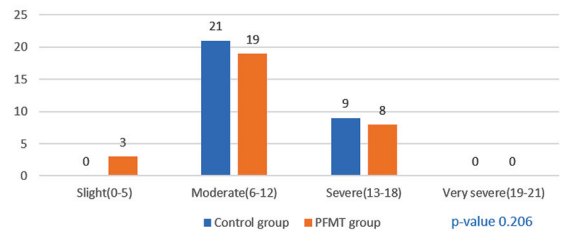
Postoperative urinary continence is influenced by several factors, including patient age, comorbidities, preoperative continence status, surgeon experience,

Subgroup analysis of ICIQ-SF divided by severity level (At 1 month)



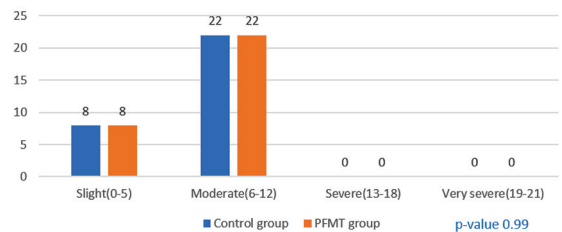
**Figure 7.** Postoperative ICIQ-SF score divided from severity level (at 1 month).

Subgroup analysis of ICIQ-SF divided by severity level (At 3 month)



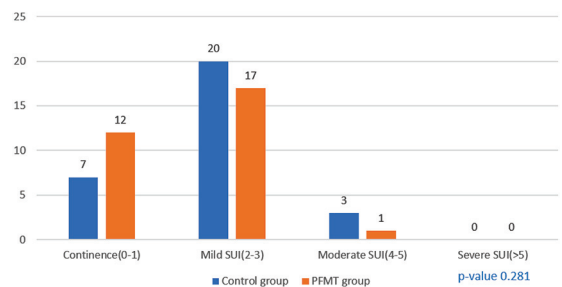
**Figure 8.** Postoperative ICIQ-SF score divided from severity level (at 3 month).

Subgroup analysis of ICIQ-SF divided by severity level (At 6 month)



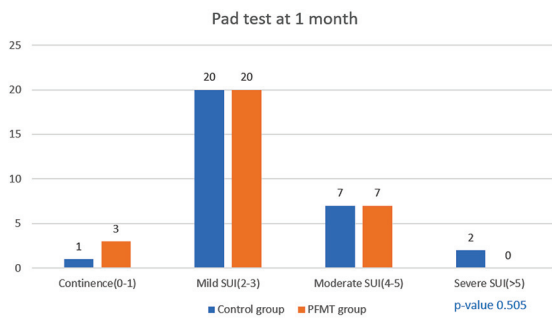
**Figure 9.** Postoperative ICIQ-SF score divided from severity level (at 6 month).

Pad test at 3 months

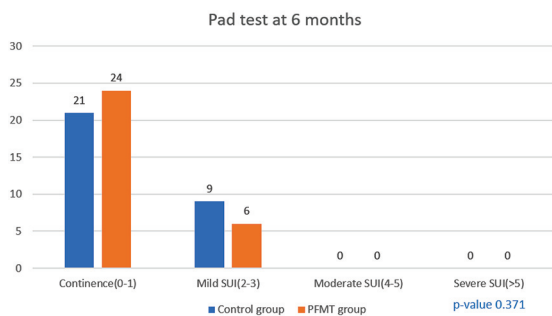


**Figure 10.** Postoperative pad test at 3 months.

operative technique, and postoperative rehabilitation. PFMT<sup>(13)</sup> is a conservative treatment that enhances



**Figure 11.** Postoperative pad test at 1 month.



**Figure 12.** Postoperative pad test at 6 months.

urinary control by improving pelvic floor muscle strength, endurance, coordination, and activation of the external sphincter.

Previous studies have shown that preoperative PFMT can reduce the duration and severity of postoperative incontinence. A meta-analysis by Chang et al. demonstrated reduced risk of incontinence at three months postoperatively in patients who received PFMT. Other studies have shown the benefits of biofeedback-assisted PFMT, particularly in RARP patients.

The results of the present study showed no significant differences in baseline characteristics, including preoperative PSA, Gleason score, prostate volume, PSAD, and underlying conditions that affected continence. Intraoperative outcomes such as blood loss and operative time, postoperative complications, and length of stay were not significantly different.

The primary outcome of the present study is continence status from the ICIQ-SF total score. Group A, the PFMT group, has a total ICIQ-SF score better than group B, the control group, but the difference is not statistically significant at 1, 3, and 6 months. While the ICIQ-SF score was divided by severity level, it showed a significant improvement in post-prostatectomy urinary incontinence at one month, but

no significant improvement at three and six months.

The secondary outcome of the present study is continence status from the pad test<sup>(14)</sup>. For the pad test at one and three months, group A, the PFMT group, can control incontinence more than group B, the control group, but the difference is not statistically significant. At six months, the pad test in both groups had no patients with moderate to severe incontinence.

### LIMITATION

The study period overlapped with the COVID-19 pandemic, limiting physical follow-up, and transitioning PFMT monitoring to telemedicine.

### CONCLUSION

PFMT is responsible for supporting the pelvic organs and controlling urinary continence. PFMT can help to improve the strength and function of these muscles, which can help to reduce incontinence after a RARP. Studies have shown that preoperative PFMT can improve postoperative early continence outcomes in patients undergoing RARP, but there are no statistically significant results. It is a non-invasive and low-risk intervention beneficial for patients.

### WHAT IS ALREADY KNOWN ABOUT THIS TOPIC?

Urinary incontinence is recognized as one of the most distressing complications following RARP, with the majority of patients achieving continence within one year postoperatively. Preoperative PFMT may contribute to improved urinary continence in the early postoperative period, especially within the first month after surgery.

### WHAT DOES THIS STUDY ADD?

This randomized controlled trial demonstrates that preoperative PFMT is associated with a statistically significant improvement in early urinary continence at 1-month post-RARP when analyzed by severity grading on the ICIQ-UI SF scale. These findings suggest that incorporating PFMT into the preoperative regimen may be a beneficial intervention to expedite continence recovery in patients undergoing RARP.

### ACKNOWLEDGEMENT

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### AUTHORS' CONTRIBUTIONS

Writing original, review, and editing by TT.

Investigation and methodology by RA, TA, and PR. Resources by PS, CK, WR, and KS. Supervision and corresponding author by WK.

#### DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article. Raw data that supporting the findings of this study are available from the corresponding author, upon reasonable request.

#### ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This trial was approved by the Ethics Committee of the Faculty of Medicine, Ramathibodi Hospital, Mahidol University (COA. MURA2020/952).

#### CLINICAL TRIAL REGISTRATION

The present study was registered with the Thai Clinical Trials Registry (TCTR20201228001).

#### USE OF ARTIFICIAL INTELLIGENCE

No artificial intelligence tools were used in any part of the research process.

#### FUNDING DISCLOSURE

This research project was supported by the Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

#### CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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