



## Original Research

# Total Knee Arthroplasty With Lateral Parapatellar Approach Results in Less Early Postoperative Skin Numbness Than Medial Approach, but No Difference at Mid-Term Follow-Up: A Randomized Control Trial

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## ABSTRACT

**Background:** Anterior skin numbness is a common complication after total knee arthroplasty (TKA) that may impact postoperative functional outcomes. This study aimed to compare skin numbness area, functional outcomes, and patient satisfaction between patients undergoing TKA with a medial parapatellar approach (medial group) and a lateral parapatellar approach (lateral group).

**Methods:** A prospective randomized study included 68 knees undergoing TKA via the medial parapatellar approach ( $n = 32$ ) and the lateral parapatellar approach ( $n = 32$ ) through the midline skin incision. Anterior skin numbness was assessed as the primary outcome using Semmes-Weinstein monofilaments at 6 postoperative timepoints (2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years). Knee range of motion, Knee Injury and Osteoarthritis Outcome Score (KOOS), and patient satisfaction scores were collected. Fifty-nine patients were retrieved at the 2-year final follow-up. Statistical analysis considered repeated outcome measurements with adjusted  $P$ -values.

**Results:** The lateral group had a significantly smaller area of anterior skin numbness at 2 weeks (11.2 vs 20.2 sq.cm.), 6 weeks (8.2 vs 17.2 sq.cm.), and 3 months (7.8 vs 14.4 sq.cm.) postoperatively compared to the medial group. No difference in the area of numbness was found at 6 months, 1 year, and 2 years. Although the lateral group showed significantly higher satisfaction scores ( $P = .027$ ) and the KOOS symptoms subdomain ( $P = .018$ ), there were no differences in knee range of motion and other components of KOOS in both groups.

**Conclusions:** Compared to the medial approach, the lateral parapatellar approach in TKA demonstrates a reduced area of early postoperative skin numbness and expedited 6-month recovery, along with marginally superior patient satisfaction scores. However, both approaches yield comparable outcomes in terms of postoperative knee motion and overall functional outcomes.

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## Introduction

Anterior skin numbness, a frequently encountered complication of total knee arthroplasty (TKA), often arises from injury to the infrapatellar branch of the saphenous nerve (IPBSN) and can negatively impact recovery [1-5]. While a prospective study found no significant difference in the incidence of anterior numbness

between minimally invasive and conventional TKA techniques [6], the use of an anterolateral skin incision has demonstrated a much smaller area of numbness compared to the traditional anterior midline approach, with this benefit persisting from 6 weeks post-surgery to 1 year [7,8]. Furthermore, research suggests that TKA patients with diabetes mellitus experience a higher rate of global anterior numbness and a slower recovery compared to nondiabetic individuals [9].

While some prior studies have suggested inferior functional outcomes and gait balance control with the lateral parapatellar approach compared to the medial and mid-vastus approaches [10,11], its utility in specific scenarios warrants further

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investigation. Notably, this approach may facilitate balancing of the valgus deformity [12], better patellofemoral tracking [13], and help correcting with shorter operative times [14]. However, it is unknown whether postoperative sensory deficits of anterior knee vary between patients undergoing TKA with the lateral and those with medial parapatellar approaches. We hypothesize that there is a difference in the extent and recovery of postoperative anterior skin numbness between the 2 approaches.

The primary objective of this study was to compare the extent and recovery of anterior skin numbness between these 2 groups. The secondary objectives were to evaluate potential differences in the rate of numbness recovery after TKA and to assess patient satisfaction and functional outcomes using the Knee Injury and Osteoarthritis Outcome Score (KOOS) [15].

## Material and methods

### Study design

This study is a prospective randomized controlled trial registered in the Clinical Trials Registry (TCTR20220228002). The protocol was approved by the institutional review board. Patients with knee osteoarthritis scheduled for unilateral TKA at the arthroplasty center were included in the study. However, patients with osteoarthritis in diabetic patients, prior sensory alterations on the anterior knee skin due to other causes (such as spinal stenosis, prior incision, or chronic skin lesion), and those who declined to participate were excluded from the study. The study was designed to assess the differences in the area of the skin numbness at multiple timepoints (2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years after surgery). The outcome measurement was blindly evaluated by both patients and assessors.

### Patients

Seventy-two consecutive patients were enrolled in the study from June 1, 2017, to December 31, 2021. The patients were randomly and blindly assigned to either the lateral parapatellar group or the medial parapatellar group using a computer-generated randomization code with a block size of 4. The Consolidated Standards of Reporting Trials diagram for the study is demonstrated in Figure 1. The first group (n = 32) was defined by

patients who underwent TKA through the lateral parapatellar approach (lateral group), and the second group (n = 32) was defined by those who underwent TKA through the medial parapatellar approach (medial group).

The study recorded various patient characteristics, including age, gender, body mass index, American Society of Anesthesiologists classification [16], Charlson comorbidity index [17], knee range of motion, and pain visual analog scale (VAS). The primary outcomes of the study were the differences in anterior skin numbness and numbness recovery time between the lateral and medial groups. The secondary outcomes included pain VAS, knee range of motion, patient satisfaction numeric rating scale (1-10) [18], and functional outcome assessed using the KOOS [15] with 5 subscales (pain, symptoms, activity of daily living, sport and recreation function, and knee-related quality of life) at 1 year and 2 years postoperatively.

### Surgical procedure

The TKAs were performed by fellowship-trained adult hip and knee reconstructive surgeons at 2 orthopaedic institutes. The same skin incision in both study groups was done at the patellar bone's midline from the superior pole of the patella to the tibial tubercle after a standard skin preparation. In some cases, it may be extended proximally above the upper pole of the patella with inadequate exposure. For the medial group, the knees were approached through the standard medial parapatellar arthrotomy.

The other group of lateral TKA was performed through the lateral parapatellar approach. The skin incision from the superior pole of the patella to the tibial tubercle was done in the same fashion as the medial group; otherwise, the incision may be extended proximally as needed for exposure. The lateral parapatellar arthrotomy was performed by making a total thickness, longitudinal incision through the lateral retinaculum, and the quadriceps tendon. The split in the quadriceps tendon was extended approximately 5 cm above the superior pole of the patella to avoid patellar tendon avulsion during patellar dislocation. The operated knees were exposed in extension to facilitate patellar mobilization during the exposure, and the patella was medially subluxated by knee flexion and medial traction on the extensor mechanism.

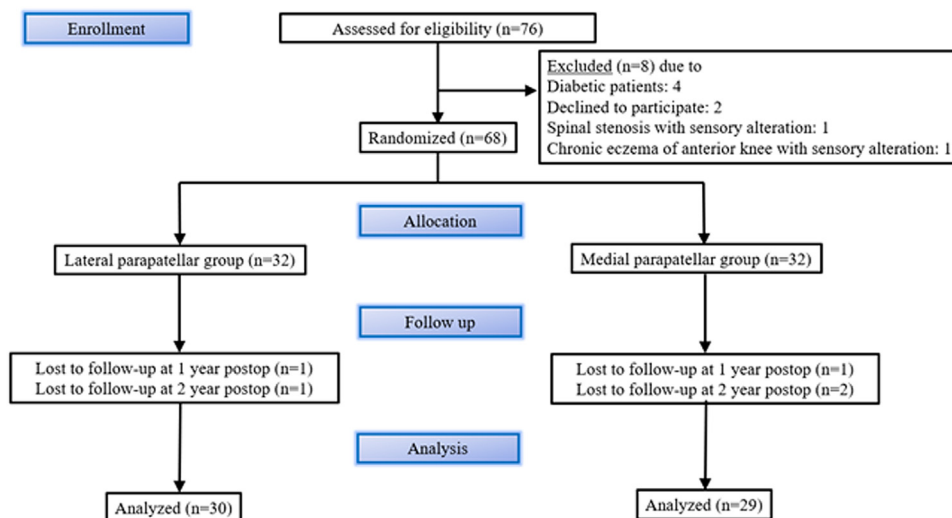


Figure 1. CONSORT diagram for study enrollment. CONSORT, consolidated standards of reporting trials.

Bony preparation in both groups involved manual instrumentation and mechanical axis alignment. The posteriorly stabilized NexGen LPS Fixed Bearing system (ZimmerBiomet, Warsaw, IN) and onlay round patellar components were implanted with bone cement in all cases. Varus-valgus constrained inserts were available as a backup for potential severe imbalanced gaps.

#### Measurement of skin numbness

The area of skin numbness was assessed by using 10 grams Semmes-Weinstein monofilament (a standardized tool commonly used to test the sensory perception of the skin) on the affected knee after TKA with 29 reference points at various time points postoperatively, including 2 weeks, 6 weeks, 3 months, 6 months, 1 year, and 2 years [14]. To assess the area of anterior skin numbness, 2 assessors who were not involved in the surgery used the Semmes-Weinstein monofilament, a ruler scale as a validation tool, and marking pen. SketchAndCalc software [19] was used to accurately calculate the total area of anterior knee numbness (in square centimeters; sq.cm.) based on the data obtained from Semmes-Weinstein monofilament measurements (Fig. 2). The patient follow-up and assessment of anterior skin numbness were performed periodically, ensuring that the data collection and evaluation continued for at least 2 years after the surgery.

#### Statistical analysis

The sample size was calculated based on the primary outcome (the difference in the area of anterior skin numbness at postoperative 6 weeks). Based on a previous study by Laffosse et al. [8], the mean difference in area of the anterior skin numbness between anterolateral and midline incisions was  $-43.6$  squared centimeters with a standard error of  $44.1$ . A type I error risk was set at 5% with a 90% power, which gave the sample size of 22 patients for each group. The statistical analyses were performed by predefined intention-to-treat and per protocol analyses. To account for a 20% potential loss of follow-up patients, a total of 64 patients were recruited.

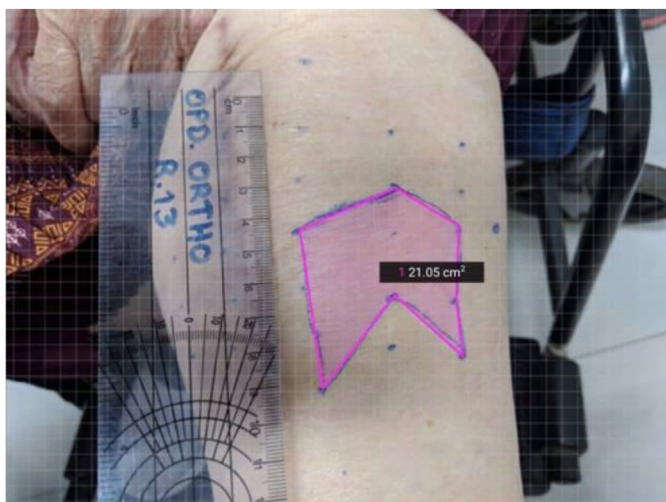
Descriptive analysis of patient characteristics consisted of means and ranges for continuous variables. Frequencies and percentages were reported for discrete variables. Comparisons

between the baseline characteristics were analyzed using a chi-square test or Fisher's exact test for categorical data and an independent t-test or Mann-Whitney U test for continuous data. The differences in area of the skin numbness, numbness recovery time, pain VAS, knee range of motion, patient satisfaction score, and KOOS were compared by independent t-test, Mann-Whitney U test, or 2-way repeated measure analysis of variance for between-group comparisons using SPSS Statistics version 19.0.2 for Windows (STATA Corp, College Station, Texas). Statistical significance was defined as  $P$ -value  $< .05$ .

#### Results

The baseline patient characteristics, including age, gender, and other relevant factors, were similar and comparable in both groups. The amount of intraoperative blood loss and preoperative radiographic knee parameters did not significantly differ between the 2 approaches; however, the lateral group had a longer operative time compared to the medial group (mean difference 24.1 minutes, 95% confidence interval (CI) 16.4-31.8) (Table 1). The lateral group showed a significantly smaller area of postoperative anterior skin numbness compared to those in the medial group at postoperative 2 weeks (11.2 vs 20.2,  $P < .001$ ), 6 weeks (8.2 vs 17.2,  $P < .001$ ), and 3 months (7.8 vs 14.4 sq.cm.,  $P < .001$ ). However, the area of skin numbness did not significantly differ between the groups at postoperative 6 months (5.6 vs 8.9), 1 year (1.7 vs 4.7), and 2 years (0.0 vs 1.0 sq.cm.), respectively. The lateral group showed a higher rate of complete recovery of skin numbness at postoperative 3 months (31.3% vs 0.0%,  $P < .001$ ) and 6 months (50.0% vs 15.6%,  $P = .004$ ) compared to the medial group (Table 2).

The lateral group had a higher satisfaction score compared to those in the medial group at postoperative 1 year (mean difference 0.6, 95% CI 0.1-1.2,  $P = .027$ ) (Table 3). The pain VAS and the knee range of motion did not differ between the groups at preoperative evaluation and postoperative follow-up (Table 3). In terms of functional outcomes, the KOOS symptoms subdomain score was significantly higher in the lateral group at postoperative 2 years (mean difference 6.5, 95% CI 1.2-11.8,  $P = .018$ ) (Table 4). However, there were no significant differences between the 2 groups in other KOOS subdomain outcomes, including pain, activity of daily living, sport and recreation function, and quality of life at postoperative 1 and 2 years (Table 4).



**Figure 2.** The irregular shaped area of anterior knee hypesthesia was sketched and marked by an assessor and SketchAndCalc software was used to calculate the area of skin numbness.

**Table 1**  
Demographic characteristics.

Variables	Lateral group (n = 32) n (%), mean $\pm$ SD	Medial group (n = 32) n (%), mean $\pm$ SD	P-value
<b>Baseline characteristics</b>			
Age (year)	66.41 $\pm$ 12.77	68 $\pm$ 7.20	.542
Gender: Female	24 (75.0)	22 (68.8)	.578
Side: Right	20 (62.5)	15 (46.9)	
Body mass index (kg/m <sup>2</sup> )			.148
Overweight/obese (>25)	25 (78.1)	30 (93.8)	
Normal weight (18-25)	7 (21.9)	2 (6.2)	
<b>Comorbidity</b>			
American Society of Anesthesiologists class			<b>.042</b>
I	17 (53.1)	9 (28.1)	
II	15 (46.9)	23 (71.9)	
Charlson comorbidity index	2.25 $\pm$ 1.30	2.44 $\pm$ 0.80	.489
<b>Surgical parameters</b>			
Operative time (minutes)	116.1 $\pm$ 16.4	92.0 $\pm$ 14.5	<b>&lt;.001</b>
Operative blood loss (milliliters)	78.1 $\pm$ 33.5	76.6 $\pm$ 33.6	.827

Bold indicates statistical significance of factor ( $P < .05$ ).

**Table 2**  
The area of anterior knee skin numbness and rate of complete recovery.

Characteristics	Lateral group (n = 32) n (%), mean ± SD	Medial group (n = 32) n (%), mean ± SD	Adjusted P-value	Test
Patients with skin numbness				
Preoperative	0 (0)	0 (0)	NA	Independent t-test
At 72 h postoperative	31 (96.9)	32 (100.0)	>.999	
Area of skin numbness (in square centimeters), mean ± SD				
2 wk	11.2 ± 6.3	20.2 ± 7.9	<b>&lt;.001</b>	Repeated measure analysis of variance
6 wk	8.2 ± 6.8	17.2 ± 9.1	<b>&lt;.001</b>	
3 mo	7.8 ± 7.0	14.4 ± 9.8	<b>.007</b>	
6 mo	5.6 ± 5.2	8.9 ± 6.6	.097	
1 y	1.7 ± 0.8	4.7 ± 5.1	.117	
2 y	0.8 ± 0.4	1.0 ± 0.5	.082	
Rate of complete recovery of skin numbness, n (%)				
2 wk	0 (0.0)	0 (0.0)	NA	Repeated measure analysis of variance
6 wk	2 (6.3)	0 (0.0)	.152	
3 mo	10 (31.3)	0 (0.0)	<b>&lt;.001</b>	
6 mo	16 (50.0)	5 (15.6)	<b>.004</b>	
1 y	20 (62.5)	19 (59.4)	.801	
2 y	29 (90.6)	28 (87.5)	.694	

Bold indicates statistical significance of factor ( $P < .05$ ).

There were a few observed complications in the study, including one patient with periprosthetic knee infection that required 2-stage revision surgery in the lateral group, and one patient in each group experienced prolonged surgical wound drainage. One patient had an acute kidney injury, which resolved completely after medial approach TKA (Table 5). However, the sample size in the study was underpowered to draw definitive conclusions regarding surgical-related complications.

**Discussion**

Anterior skin numbness is a common minor complication after TKA; otherwise, it could lead to a significant patient concern (7.0%-24.5%) [2,3]. Although previous studies have investigated the association between postoperative skin numbness and outcomes, the skin numbness after different surgical approaches in TKA remains unclear. We found 96.9%-100% prevalence of postoperative skin numbness, which was similar to the previous studies in which

**Table 3**  
Pain visual analog scale, knee range of motion, and patient satisfaction score.

Characteristics	Lateral group (n = 32) Mean ± SD	Medial group (n = 32) Mean ± SD	P-value
Pain visual analog scale			
Preoperative	7.78 ± 1.29	7.75 ± 1.27	.923
Postoperative 1 y	1.47 ± 1.14	1.47 ± 1.11	.895
Knee range of motion			
Preoperative arc of motion	106.1 ± 13.1	109.2 ± 13.9	.359
Flexion	106.7 ± 12.3	110.3 ± 12.8	.257
Extension	0.6 ± 2.5	1.1 ± 3.0	.410
1-y postoperative arc of motion	116.7 ± 14.8	111.3 ± 14.3	.139
Flexion	117.0 ± 14.3	111.9 ± 13.8	.147
Extension	0.3 ± 1.2	0.6 ± 1.7	.395
2-y postoperative arc of motion	117.5 ± 14.4	111.4 ± 14.5	.096
Flexion	117.8 ± 13.8	112.0 ± 14.0	.101
Extension	0.3 ± 1.2	0.6 ± 1.7	.395
Patient satisfaction			
numeric rating scale (1-10)			
1-y postoperative	8.9 ± 1.0	8.3 ± 1.2	<b>.027</b>

Bold indicates statistical significance of factor ( $P < .05$ ).

**Table 4**  
Postoperative functional outcomes of Knee Injury and Osteoarthritis Outcome Score (KOOS).

Components/ subdomains	Lateral approach (n = 32) mean ± SD	Medial approach (n = 32) mean ± SD	P-value
Pain			
1-y postoperative	83.3 ± 10.4	80.6 ± 15.1	.408
2-y postoperative	87.1 ± 5.2	84.5 ± 7.0	.105
Symptoms			
1-y postoperative	80.8 ± 13.0	76.4 ± 18.2	.266
2-y postoperative	86.8 ± 7.1	80.3 ± 13.3	<b>.018</b>
Activity of daily living			
1-y postoperative	80.9 ± 17.2	76.8 ± 17.6	.349
2-y postoperative	84.1 ± 12.9	82.7 ± 12.1	.672
Sport and recreation function			
1-y postoperative	80.5 ± 18.7	82.3 ± 15.7	.684
2-y postoperative	80.5 ± 11.1	77.68 ± 13.9	.369
Knee-related quality of life			
1-y postoperative	84.4 ± 12.5	83.4 ± 14.2	.778
2-y postoperative	86.9 ± 8.2	85.4 ± 10.3	.495

Independent t-test was applied in all comparisons.  
Bold indicates statistical significance of factor ( $P < .05$ ).

anterior skin numbness was a common complication reported after TKA (68.9%-100%) [1-4,9]. In addition, Tanavalee et al. [6] identified the course and distribution of the IPBSN relative to anatomical landmarks commonly used for skin incisions in TKA. Importantly, the recommended reference line for the medial parapatellar incision, traditionally used, runs between the superomedial border of the patella and a point just medial to the tibial tubercle. This anatomical proximity explains why the medial parapatellar approach carries a higher risk of IPBSN injury. In contrast, our study explored the potential benefits of the lateral parapatellar approach. Our results demonstrated a significantly smaller area of anterior skin numbness in those who underwent lateral parapatellar TKA compared to the medial approach group at all timepoints evaluated: 2 weeks, 6 weeks, and 3 months postoperatively. Furthermore, those in the lateral parapatellar group experienced significantly faster recovery of clinical numbness, reaching normal sensation at both 3 and 6 months after surgery.

These findings support our hypothesis that the lateral parapatellar approach offers a lower risk of injury to both the IPBSN and the anterior-inferior branch of the femoral cutaneous nerve. This advantage translates to a faster recovery of skin numbness following TKA, suggesting the potential benefits of utilizing the lateral approach over the traditional medial approach in certain situations.

The higher patient satisfaction observed in those who underwent the lateral parapatellar approach reflected the benefit of their smaller area of skin numbness at 1 year postoperatively. However, it is unlikely that this difference would reach the minimally clinically important difference [18].

Lyman et al. proposed 16 scores (with 95% CI) of the minimal detectable change and 7-9 scores (based on anchor or distribution approach) of the minimal clinically important change of the KOOS symptoms component in a cohort study of validity of estimates [20]. In our study, the KOOS symptoms subdomain demonstrated

**Table 5**  
Complications (related to the total knee arthroplasty).

Complications	Lateral group n (%)	Medial group n (%)
Periprosthetic knee infection	1 (3.1)	0 (0)
Prolonged surgical wound drainage	1 (3.1)	1 (3.1)
Acute kidney injury	0 (0)	1 (3.1)
Total	2 (6.3)	2 (6.3)

statistically higher in patients who had the lateral approach at postoperative 2 years; otherwise, it was still debatable whether this met the minimal clinically important difference between the groups due to the small samples in our study [21,22]. In addition, we found no significant difference between the groups in terms of knee range of motion and pain intensity at 2 years postoperatively.

The lateral parapatellar approach is an alternative choice of TKA, which may facilitate balancing of the valgus knee and may result in better patellar tracking. By entering the joint lateral to the patella, there was no destabilization of complex medial structures and good functional results in the previous literature [14,23,24]. However, the previous studies reported a longer operative time, which is less familiar to most surgeons, and peroneal nerve palsy as postoperative complications.

We also observed significantly longer operative time in the lateral group (mean difference 24.1 minutes, 95% CI 16.4–31.8) compared to the medial group and this was consistent with some previous reports. We hypothesized that surgeon unfamiliarity, more difficulty in medial patella mobilization, and necessity of tight closure of lateral arthrotomy were the factors associated with the longer operative time in the lateral group.

Approximately 10% of osteoarthritis patients undergoing TKA have a valgus knee [25] using the lateral parapatellar approach in other common causes of valgus knee arthritis, for example, post-traumatic arthritis, inflammatory joint diseases, rickets, and renal osteodystrophy [26]. However, surgeons uncommonly prefer the lateral parapatellar approach technique, and they are familiar with the medial parapatellar approach rather than the severity of the valgus knee.

This study had several strengths. Firstly, they came from a randomized controlled trial process. Secondly, all patients were measured for the area of skin numbness by SketchAndCalc software, which was more accurate than previous studies [5–9]. Thirdly, we included the patient satisfaction score at 1-year follow-up in the outpatient department. However, this study had some limitations. Even though the lateral parapatellar approach showed higher satisfaction scores ( $P$ -value = .027), the result may not represent the clinical meaningful difference because all patients were assessed on the satisfaction score only at 1 year, and the absolute difference was only 0.6 between the 2 groups (8.9 and 8.3). Additionally, the patient-reported outcome of the KOOS symptom subdomain at 2 years may be underpowered to adequately assess a clinically meaningful difference. This is because the sample size calculation was based on detecting a difference in skin numbness, which may not be an accurate proxy for overall symptom improvement. Therefore, the observed results could be due to chance (statistical error) rather than a true effect of the intervention.

## Conclusions

While the lateral parapatellar approach in TKA exhibits advantages like less early postoperative skin numbness and quicker recovery by 6 months, its patient satisfaction scores are marginally higher than the medial approach. Nevertheless, both approaches yield comparable results in postoperative knee motion and overall functionality.

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## Conflicts of interest

O. Phruetthiphat is an international member of AAHKS and a board member of the Royal College of Orthopaedic Surgeons of Thailand (RCOST). K. Mokmongkolkul is a member of the Royal College of Orthopaedic Surgeons of Thailand (RCOST). R. Apinyankul is a member of the Royal College of Orthopaedic Surgeons of Thailand (RCOST).

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## CRediT authorship contribution statement

**Ong-art Phruetthiphat:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Data curation, Conceptualization. **Krissada Mokmongkolkul:** Writing – original draft, Resources, Methodology, Investigation, Formal analysis, Data curation. **Rit Apinyankul:** Writing – review & editing, Writing – original draft, Resources, Methodology, Data curation, Conceptualization.

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