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Factors predicting the use of the backward upward rightward pressure maneuver in thyroid surgery: a single-center retrospective cohort study

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Abstract

Background The purpose of this study was to evaluate the predictability of utilizing the backward upward rightward pressure (BURP) maneuver and the efficacy of related tests in patients with a challenging airway and a Mallampati score of 2 or higher who underwent scheduled elective thyroid surgery.

Methods Patient files were scanned for 300 adult patients who had undergone thyroid surgery under general anesthesia. The information included their medical history of thyroid disease, previous thyroid surgery, and evaluation tests for difficult intubation such as Mallampati score, maximum mouth opening, ease of intubation, thyroid goitre grade, and whether the BURP maneuver was performed. Patients who had a history of difficult intubation or a Cormack Lehane score less than 2 were excluded. Additionally, the patients were divided into two groups: one group underwent the BURP maneuver ($n = 78$) and the other did not ($n = 56$).

Results Statistically significant differences in the maximum mouth openings and thyroid goitre grade were observed between the groups according to the preoperative evaluation. Furthermore, significant differences were noted between the groups in terms of the ease of intubation, intubation time, Cormack–Lehane score, and number of intubation attempts.

Conclusion There may be a correlation between the maximum mouth opening and thyroid goitre grade in predicting the use of the BURP maneuver. It is important to keep in mind, however, that difficult intubation may occur in some uncommon types of goiter, such as retrosternal goiter, even if the thyroid gland size is small. Therefore, it may be useful to consider performing the BURP maneuver.

Keywords Anesthesia, BURP maneuver, Goitre, Prediction

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Background

Every year, many people undergo surgical procedures that require endotracheal intubation under general anesthesia. The primary responsibility of an anesthetist is to maintain the patient's airway. The American Society of Anesthesiologists (ASA) defines difficult laryngoscopy as the inability to visualize any part of the vocal cords using direct laryngoscopy [1].

If a difficult airway can be accurately predicted during preoperative evaluation, unexpected difficulties and associated morbidity can be minimized. Parameters such as the modified Mallampati score, thyromental distance, neck extension, and interincisor distance are commonly used for this purpose. To manage an unexpectedly challenging airway, anesthetists can employ various maneuvers, including the backward upward rightward pressure (BURP) maneuver [2].

The BURP maneuver involves applying pressure to the thyroid and cricoid cartilage, moving them backward, upward, and to the right. Currently, there are insufficient data to determine whether the BURP maneuver is effective in predicting difficult laryngoscopy when compared to widely used clinical indicators such as thyromental distance, modified Mallampati score, and interincisor distance [2]. There are no known tests predicting the applicability of the BURP maneuver to improve glottic visualization in patients undergoing thyroid surgery.

The objective of this study was to assess the efficacy of tests used to predict the need for the BURP maneuver in patients who were scheduled for elective thyroid surgery, who had a Mallampati score ≥ 2 , and who experienced a difficult airway. Additionally, we aimed to compare the impact of the BURP maneuver on the success rate of intubation in cases of unexpected difficult intubation, especially in patients who were treated for such situations.

Methods

This retrospective cohort study received approval from the Clinical Research Ethics Committee of Süleyman Demirel University (decision number 2017/116). Between January 2011 and December 2016, 300 ASA I-II patients underwent thyroid surgery under general anesthesia at our hospital. Demographic data, history of thyroid disease, medication history, history of previous thyroid surgery, history of dyspnea, dysphagia, and hoarseness were recorded from the preoperative and intraoperative anesthesia observation records in the patient files. Mallampati score, maximum mouth opening, upper lip bite test, and intubation were used to evaluate difficult intubation. Data were collected on ease of use, thyroid grade, Cormack-Lehane Score (CLS), and whether the BURP maneuver was performed.

The Mallampati score was determined with the patient sitting, with the mouth wide open, and with the tongue

maximally protruding without phonation. In the Mallampati score Class 1 complete visualization of the soft palate, Class 2 complete visualization of the uvula, Class 3 visualization of only the base of the uvula, Class 4 soft palate is not visible at all [3]. The maximum opening of the mouth is defined as the greatest distance between the incisal edge of the maxillary central incisor and the incisal edge of the mandibular central incisor, when the mouth is opened as wide as possible without causing pain, or as the interincisor distance plus the overbite [4]. Normal values for maximum mouth opening are between 35 and 60 mm [5]. The upper Lip Bite Test was graded as follows: Class 1 lower incisors can bite the upper lip above the vermilion line. Class 2 lower incisors can bite the upper lip below the vermilion line. Class 3 the lower incisors can not bite the upper lip [6]. To assess the ease of intubation, we used a visual rating scale (VRS) ranging from 0 (easy) to 100 (difficult). Preoperative thyroid goiter was graded according to the World Health Organization (WHO) Goitre Grading System criteria as follows: Ia-goitre not observed from a distance, Ib-goitre observed on swallowing, and II-goitre observed from a distance. During preoperative evaluation, the presence of dyspnea, dysphagia, and hoarseness was considered indicative of invasion or compression [7]. In the Cormack-Lehane Score grading system was used to evaluate the laryngeal view as follows: grade 1-complete visualization of the vocal cords; grade 2-visualization of the inferior portion of the glottis; grade 3-visualization of only the epiglottis; and grade 4-no visualization of the epiglottis [8]. Patients with a history of difficult intubation, a Cormack-Lehane score < 2 or missing data were excluded from the study. A total of 134 patients were included in the study. The patients were divided into two groups: those who underwent the BURP maneuver ($n=78$) and those who did not ($n=56$) (Fig. 1).

Anesthesia records in the patient files confirmed that the protocol employed was the standard protocol applied to all patients who underwent thyroid surgery under general anesthesia. This protocol includes the administration of premedication with midazolam. Standard monitoring procedures include noninvasive blood pressure measurement, pulse oximetry, electrocardiogram monitoring, and end-tidal carbon dioxide measurement. A tube with neuromonitoring sensors was prepared in advance of the procedure. The neuromonitoring device was calibrated and controlled. All patients routinely received intravenous dexketoprofen trometamol. As part of the routine anesthesia induction process, lidocaine and propofol were administered. For neuromuscular blockade during tracheal intubation, intravenous rocuronium was administered. The patient was intubated with a neuromonitoring tube. Following intubation, neuromonitoring was employed to enable the functional evaluation of

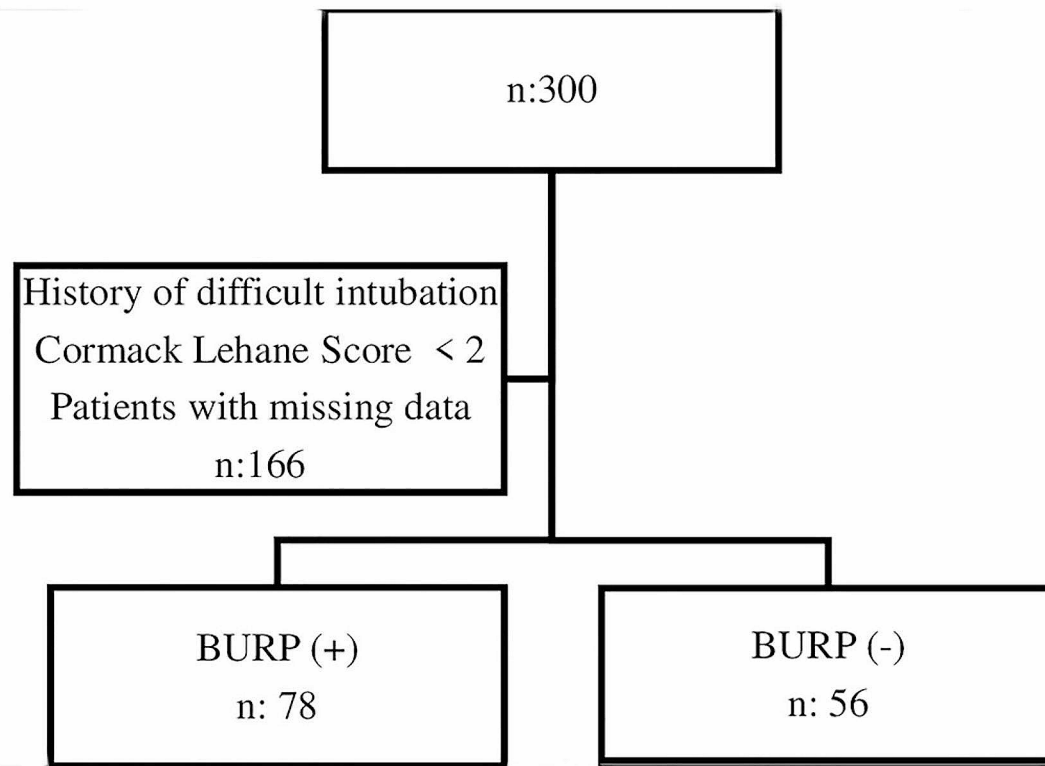


Fig. 1 Study flow chart and outcomes of the included patients

the relevant nerves, specifically the recurrent laryngeal nerve and the external branch of the superior laryngeal nerve. It was found that stimulation was received from all nerves intraoperatively. Subsequently, tracheal intubation was performed by a final-year anesthesia assistant using a Macintosh laryngoscope. The quality of the laryngeal view was assessed using the CLS and documented in the anesthesia records, which served as the source of information for this study.

The intubation time (from first contact of the laryngoscope to successful endotracheal intubation), ease of intubation, and number of intubation attempts were recorded according to the information on the anesthesia observation forms. Anesthesia was maintained using a gas mixture consisting of 40% oxygen and 60% air combined with sevoflurane at a minimum alveolar concentration (MAC) of 2. Thyroidectomy procedures were conducted with the patient's head in a slightly hyperextended position. Following extubation, the vocal cords were examined with a laryngoscope.

Statistical analysis

The data obtained in the study were subjected to statistical analysis using SPSS version 15.0 software (SPSS Inc., Chicago, IL, USA). Prior to commencing the study,

a power analysis was conducted. Demographic data and determinants of difficult intubation are presented as the mean \pm standard deviation (SD) and the number of patients. Certain parameters used to assess associations with the BURP maneuver were reported as correlation analysis results (r' -correlation coefficient) and corresponding p values. Receiver operating characteristic (ROC) analysis was performed to establish cut-off values for correlated data.

The patient population was divided into two groups based on the use of the BURP maneuver. Comparisons involving thyroid medication usage, type of thyroid disease, history of thyroid surgery, thyroid goitre grade, preoperative clinical findings, Mallampati and Cormack Lehane scores, and the number of intubation attempts were conducted using Student's t -test, the Mann-Whitney U test, and the chi-square test as appropriate. A significance level of $p < 0.05$ was considered to indicate statistical significance.

Results

No statistically significant differences were found among the patients regarding their demographic data ($p > 0.05$).

No statistically significant differences were detected between the patient groups concerning thyroid disease,

Table 1 Preoperative evaluation criteria and intubation findings of patients

Variables	BURP (+)	BURP (-)	P
	n=78	n=56	
Toxic multinodular goitre	8	9	
Simple multinodular goitre	57	36	
Thyroiditis	0	2	0.193*
Grave's disease	2	0	
Malign goitre	10	6	
Other	1	3	
Thyroid medication	12	6	
Antithyroid medication	13	12	0.630*
No medication	53	38	
Thyroid surgery (Yes/No)	7/71	1/55	0.191*
Thyroid goitre grade Ia	34	11	
Ib	23	22	0.014*
II	21	23	
Dyspnea	8	6	
Dysphagia	6	4	0.232*
Hoarseness	5	10	
No	58	36	
Mallampati classification I	24	20	0.799*
II	29	21	
III	22	13	
IV	3	1	
Maximum mouth opening (cm)	5.31 ± 1.28	5.88 ± 1.58	0.009*
Cormack Lehane Score 2	45	56	<0.001*
3	28	0	
4	5	0	
Upper lip bite test 1	38	26	0.595*
2	37	27	
3	3	2	
Ease of intubation (VRS:0 Easy, VRS: 100 Difficult)	45.00 ± 24.86	12.58 ± 17.70	<0.001[‡]
Intubation time (sn)	22.61 ± 23.59	9.74 ± 8.44	<0.001[‡]
Number of intubation attempts	1.39 ± 0.93	1.01 ± 0.133	0.003[‡]
Thyromental distance	8.20 ± 3.21	7.90 ± 1.74	0.300 [‡]
Sternomental distance	14.34 ± 2.38	14.34 ± 2.84	0.800 [‡]
Neck extension	111.65 ± 11.93	111.34 ± 15.34	0.929 [‡]

BURP: backward, upward, and rightward pressure, VRS: visual rating scale, * chi-square test, [‡]Mann-Whitney U test

history of drug use, history of thyroid surgery, history of dyspnea, dysphagia, hoarseness or Mallampati scores ($p > 0.05$). However, statistically significant differences were found in the maximum mouth opening test and thyroid grade. Categorical data were assessed using chi-square analysis regarding the presence of laryngeal manipulation. A significant difference was observed in CLS ($p < 0.001$), while no significant difference was found in the results of the upper lip bite test ($p = 0.595$) (Table 1).

Statistically significant differences were observed between the groups in terms of the ease of intubation,

Table 2 Logistic regression analysis results of the predictors of the BURP maneuver

	Odds Ratio	95% CI		P*
		lower	upper	
Ease of intubation	1.050	1.020	1.080	0.001
Number of intubation attempts	4.328	0.284	65.983	0.292
Intubation time	1.060	1.013	1.110	0.013
Cormack Lehane score	1			
Cormack Lehane score (1)	0	0	0	0.999
Cormack Lehane score (2)	1.749	0	0	1.000
Maximum mouth opening	1.074	0.649	1.777	0.782

*Logistic Regression

intubation time, CLS, and number of intubation attempts ($p < 0.05$). However, when examining the relationships of sternomental distance, thyromental distance, and neck extension with laryngeal manipulation using the Mann-Whitney U test, no significant differences were found (Table 1).

When examining the relationships between ease of intubation and thyromental distance, sternomental distance, maximum mouth opening, neck extension, body mass index (BMI), and the number of intubation attempts, we found a moderate negative correlation with maximum mouth opening ($r = -0.413$; $p < 0.001$), a moderate positive correlation with the number of intubation attempts ($r = 0.464$; $p < 0.001$), and a moderate positive correlation with intubation time ($r = 0.385$; $p < 0.001$).

We observed a statistically significant negative correlation between BURP status and maximum number of mouth openings at a low level ($r = 0.228$; $p < 0.001$), as well as between BURP status and the number of intubation attempts and intubation time at a moderate level ($r = -0.346$; $p < 0.001$; and $r = -0.411$; $p < 0.001$, respectively).

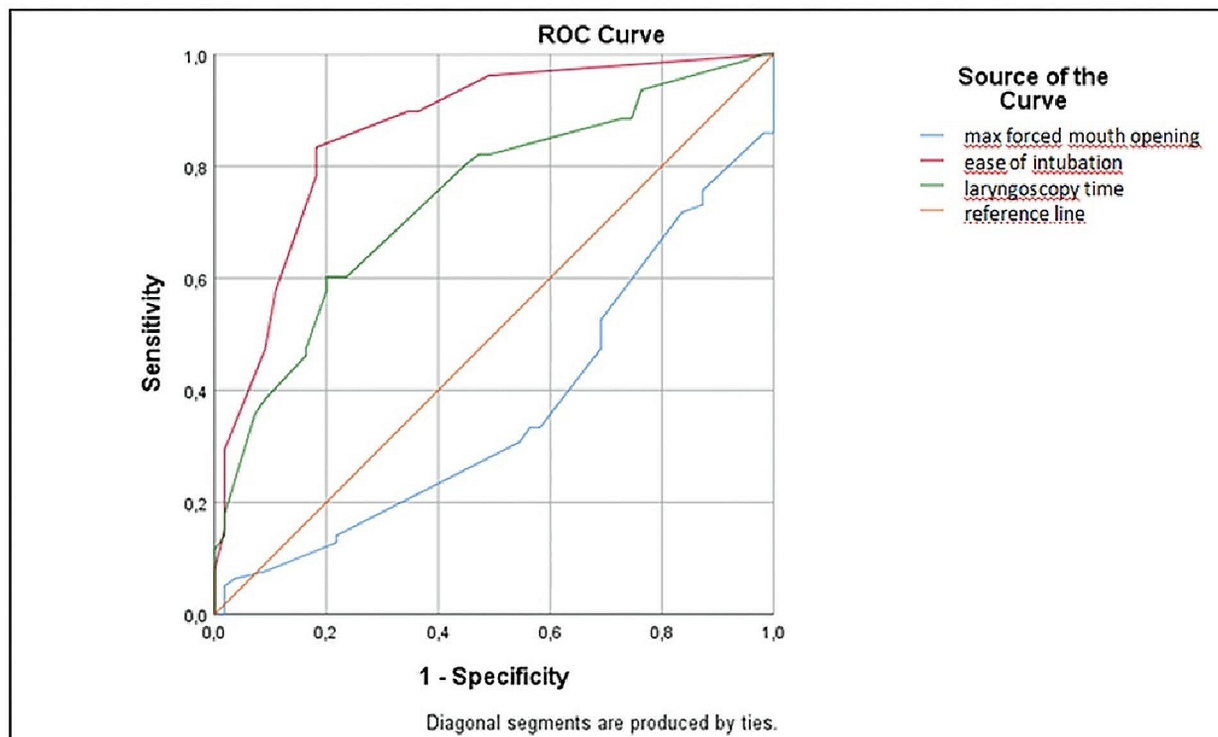
The results of the logistic regression analysis, which was conducted using the enter method to identify predictive factors for the application of the BURP maneuver in patient groups based on significant values, are presented in Table 2.

The results of the regression analysis revealed that intubation time and ease of intubation could serve as predictive factors for the likelihood of the BURP maneuver being performed. Specifically, an increase of 1 unit in the ease-of-intubation score was found to significantly increase the probability of performing BURP by 1.050-fold, while a 1-unit increase in intubation time increased the probability by 1.060-fold. Although these factors were statistically significant in the univariate analysis, the maximum mouth opening distance, CLS, and number of attempts did not significantly increase the probability of performing BURP (Table 3).

We conducted ROC analysis to establish cutoff values for the ease of intubation score and intubation time, both of which were identified as predictive factors in the

Table 3 Sensitivity and specificity values of values related to the BURP maneuver according to ROC curve analysis

Risk Factor	AUC (95%)	cut off	P	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)
Ease of intubation	0.865 (0.81–0.92)	22.5	<0.001	83.3	82.2	76.5
Intubation time	0.742 (0.67–0.92)	8.5	<0.001	80.8	53.6	54.8
Max mouth opening	0.368 (0.29–0.45)	5.5	0.002	66.7	58.2	28.8

**Fig. 2** ROC analysis of ease of intubation score, intubation time and maximum degree of mouth opening

regression analysis, as well as for the maximum degree of mouth opening, which showed significance in the univariate analysis but not in the regression analysis (Fig. 2).

Patients meeting these specified values were identified as individuals on whom the BURP maneuver was performed. The established cut-off values for predicting whether BURP would be performed were 22.5 for the ease of intubation score, 8.5 s for intubation time, and 5.5 cm for the maximum mouth opening distance.

Discussion

The objective of this study was to assess the predictability of the use of the BURP maneuver in patients with a Mallampati score of ≥ 2 who were undergoing planned elective thyroid surgery due to a difficult airway. Additionally, we aimed to compare the impact of the BURP maneuver on the success of intubation in cases of unexpected difficult intubation. The study's findings revealed correlations between thyroid goitre grade and the maximum mouth opening test and the likelihood of performing the BURP

maneuver. Moreover, this maneuver was associated with ease of intubation, intubation time, number of intubation attempts, and Cormack-Lehane score.

In a study involving 308 patients in West Africa, the most effective predictors of difficult laryngoscopy were identified as the modified Mallampati test, thyromental distance, and interincisor distance [1]. Another study involving 500 patients reported that, among factors such as the modified Mallampati test, thyromental distance, anatomic defects, and cervical mobility (utilizing the M-TAC scoring system), the Mallampati classification provided superior predictive value [9]. Interestingly, there was no significant relationship between the Mallampati score and the use of the BURP maneuver.

In a study focused on identifying predictors of difficult intubation in thyroid surgery, potential risk factors were identified, such as female sex, BMI, thyromental distance, neck mobility, CLS, and the presence of cancerous goitre or tracheal deviation [10]. Additionally, neck circumference has emerged as an independent predictor of

difficult intubation in goitre surgery [11]. Predictors such as the presence of tracheal stenosis (>30%) and reduced mouth opening (<4.4 cm) were also associated with difficult intubation in patients with goitre [12]. In this study, we observed that the thyroid goitre grade, particularly in patients classified as Ia, and the use of the BURP maneuver in individuals with a maximum mouth opening of less than 5.5 cm could serve as indicators of difficult intubation in patients undergoing thyroid surgery. It is noteworthy that even when the thyroid gland appears small externally, the thyroid tissue may extend posteriorly toward the sternum, making it less visible from the outside. Therefore, it is essential to recognize that a low thyroid goitre grade does not necessarily imply the absence of potentially difficult intubation in these patients.

In a study evaluating the impact of goitre on intubation, data from 4742 patients were analyzed, and no significant differences were observed between the two groups, namely mask ventilation and intubation, with respect to the presence or absence of goitre [13]. In a separate study involving 324 patients who underwent thyroid surgery, no significant differences were identified between the groups with clinically palpable goitre and those with impalpable goitre regarding the frequency of difficult intubation [14]. In line with these findings and consistent with other studies, the current study also did not establish a significant relationship between goitre type and the use of the BURP maneuver.

In a study that investigated the correlation between the ultrasonographic volume of the thyroid and difficult intubation, no significant correlation was found between thyroid volume and the intubation difficulty score (IDS) [15]. Additionally, it has been reported that the BURP maneuver offers improved glottic visualization when using the GlideScope in pediatric patients [16].

In a clinical study that compared the BURP maneuver with the BACK maneuver (which involves moving the larynx posteriorly by applying pressure to the thyroid and cricoid cartilage), superior larynx visualization was achieved with the BURP maneuver [2]. It should be noted that using the BURP maneuver in conjunction with the Sellick maneuver during rapid sequence intubation may deteriorate glottic visualization; therefore, it has been suggested that this combination should not be employed routinely [17].

In a comparison of the use of the BURP maneuver by anesthesia assistants in the first and third months, it was observed that laryngoscopic imaging improved over time [18]. In a previous study, the modified jaw thrust maneuver, the BURP maneuver, and the conventional method were compared via videolaryngoscopy, and it was found that the BURP maneuver led to a deterioration in laryngoscopic imaging [19].

This study had several limitations. This was a retrospective study conducted in a single center, the sample size was small and follow-up was limited.

Conclusion

Preoperative evaluation tests conducted to assess difficult intubation suggest a potential relationship between the maximum mouth opening and thyroid goitre grade in predicting the use of the BURP maneuver. Nonetheless, difficult intubation may still occur in certain uncommon types of goitre, such as retrosternal goitre. Consequently, it remains advisable to consider the utilization of the BURP maneuver in such cases.

Abbreviations

ASA	American Society of Anesthesiologists
BURP	Backward upward rightward pressure
CLS	Cormack-Lehane score
VRS	Visual rating scale
WHO	World Health Organization
MAC	Minimum alveolar concentration
SPSS	Statistical package for the social sciences
SD	Standard deviation
ROC	Receiver operating characteristic
BMI	Body mass index
M-TAC	Modified Mallampati test, thyromental distance, anatomic defects, cervical mobility
IDS	Intubation difficulty score
BACK	Backward pressure on the thyroid or cricoid cartilage

Author contributions

F.A.S.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Validation, Visualization, Writing – original draft. E.S.O.: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Data availability

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

This retrospective cohort study received approval from the Clinical Research Ethics Committee of Süleyman Demirel University (decision number 2017/116). The informed consent was also waived by the Ethics Committee of the Süleyman Demirel University, because of the retrospective nature of the study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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