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Comparison of Effects of Extubation in Prone and Supine Positions in Patients Operated for Lumbar Disk Herniation

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ABSTRACT

AIM: To observe the effects of prone position extubation on respiratory side effects and hemodynamic parameters in patients who underwent lumbar spinal surgery.

MATERIAL and METHODS: This prospective observational study included 60 patients extubated in either the prone (n=30) or supine (n=30) positions. Heart rate, noninvasive arterial blood pressure, peripheral oxygen saturation, train of four values, and bispectral index values were measured and recorded in all patients during operation and at the time of anesthetic agent discontinuation, before and after extubation. The Aldrete recovery score was recorded together with the severity of cough during emergence and recovery. Sore throat visual analog scale (VAS) score was recorded at the first and sixth hours after extubation. Incidents such as nausea, vomiting, respiratory failure, uncontrolled airway, and decreased saturation were also recorded.

RESULTS: The number and severity of cough ($p<0.05$) and sore throat VAS ($p<0.001$) were lower in the prone group. Postextubation breath holding was more frequent in the supine group ($p < 0.001$). Aldrete recovery scores were higher in the prone group ($p<0.05$). Heart rate and mean arterial pressure values were not significantly different in the prone group during the emergence and recovery period as compared with the supine group ($p>0.05$).

CONCLUSION: Extubation in the prone position after lumbar spinal surgery provides more comfortable emergence and recovery periods with less alteration of respiratory status and a better recovery profile.

KEYWORDS: Spinal surgery, Prone extubation, Anesthesia recovery

INTRODUCTION

When positioning patients undergoing surgery from the prone position to the supine position for recovery and extubation, hemodynamic changes such as tachycardia and hypertension, cough, and loss of monitoring can occur (14). Lifting and turning the head when transitioning from the prone to supine position can cause tracheal irritation due to the presence of the endotracheal tube. This might accelerate cough and bronchospasm and cause hemodynamic changes. These changes can result in increased surgical hemorrhage, myocardial ischemia, and abdominal and intracranial pressure (2,7,8,27). Various medications such as intravenous (IV) esmolol, intratracheal and IV lidocaine, and alpha agonist dexmedetomidine are included among medication alternatives that may be used to suppress circulation during extubation in the supine position and unwanted reflexes that may occur in the airway (7,9,24,26). Numerous articles have been published comparing the respiratory and hemodynamic parameters after extubation in the prone position; however, the superiority of each technique remains unclear (2,19,23,28).

The hypothesis of this study is that extubation in the prone position will lead to more stable hemodynamics and a higher-quality recovery profile with fewer respiratory complications for patients. To test this hypothesis, the primary outcome in our study was determined as the incidence and severity of cough after extubation. Secondary outcomes were to

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compare extubation and recovery duration, sore throat, and hemodynamic changes in patients extubated in either the prone or supine position.

MATERIAL and METHODS

After receiving permission from the ethics committee (24.02.2020/5298-GOA) and written informed consent from patients, the study included American Society of Anesthesiologists (ASA) I-II patients aged 18–65 years undergoing elective lumbar surgery at the neurosurgery clinic at Dokuz Eylul University Faculty of Medicine central operating rooms.

Patients were divided into two groups: supine and prone. Patient allocation was determined using the block randomization method. Patients included in the supine group (n=30) were extubated in the supine position, whereas patients included in the prone group (n=30) were extubated in the prone position.

Exclusion Criteria

We excluded cases considered to have, or with a history of, difficult intubation; with more than two intubation attempts; with airway hyperactivity such as upper respiratory tract infection; asthma; bronchitis; uncontrolled hypertension; obstructive sleep apnea; and morbid obesity (body mass index > 35 kg/m^2) (28).

Anesthesia Method

All patients underwent routine monitoring and anesthesia methods used in our clinic. Routine monitoring consisted of electrocardiogram, pulse oximetry, noninvasive blood pressure measurement, end-tidal CO_2, axillary skin temperature probe, bispectral index (BIS), and train of four (TOF). For preoperative sedation, 0.02 mg/kg IV midazolam was administered.

Anesthesia induction was performed with a 2-minute infusion of 0.2 µg/kg/min remifentanil and IV 2% lidocaine 1 mg/kg, followed by IV 2 mg/kg propofol and IV 0.5 mg/kg rocuronium. After induction, patients were ventilated with 6 L/min 100% oxygen through a face mask for 2 minutes until intubation. Anesthesia maintenance was provided by 1 MAC (2%) sevoflurane and 50% O_2/air mixture and 0.1–0.4 µg/kg/min remifentanil (25).

All patients had anesthesia depth standardized with BIS monitoring (ASPECT A-2000 BIS XP monitor). BIS values were held between 40 and 60 (15). The BIS value was set by regulating the sevoflurane dose. All patients had neuromuscular junction monitoring with TOF guard (TOF GUARD, Biometer International A.S., Denmark), and an endotracheal tube (ETT) was inserted when the TOF was zero. During the surgical procedure, a neuromuscular blocker agent was administered when TOF > 1 twitch was displayed (11). After endotracheal intubation, the ETT cuff pressure was measured with a manometer (cuff pressure manometer, Rüsch, Germany) and inflated with air when it was below 20 cm H_2O (6). Patients were turned to the prone position on the operating table with their heads in the neutral position, and a donut cushion was used to prevent pressure on the face. Minute ventilation of patients was set to end-tidal CO_2 35–40 mmHg.

In the supine group, the administration of anesthetic agent was stopped without stopping monitoring after patients were turned to the supine position from the prone position. The patient group in the prone position had the anesthetic agent administration stopped after skin suturing. To reverse the neuromuscular block, a dose of 2.0 mg/kg sugammadex was used if the neuromuscular block reverse TOF value was less than 90%. After extubation, all patients were administered 4 L/min oxygen through a face mask. Patients were extubated and monitored by the same anesthesiologist.

With the aim of providing postoperative analgesia to patients, tramadol 1 mg/kg and paracetamol 1000 mg were administered toward the end of the operation.

The anesthesia duration (duration from induction until anesthetic agents were stopped), surgery duration (from surgical incision until skin closure), emergence duration (duration from completion of surgical suturing until extubation), and extubation duration (duration from cessation of anesthetic agents until extubation) were recorded for patients.

Heart rate and mean blood pressure were recorded before anesthesia induction and before extubation. Heart rate and mean blood pressure were recorded again every minute until 5 minutes after extubation and in the 10th, 15th, and 30th minutes after extubation. If SpO_2 was <90% for more than 30 seconds, desaturation was recorded (28).

The number of coughs by the patient every minute in the first 4 minutes after extubation and in the 10th, 15th, and 30th minutes was recorded. Cough severity was classified as none–mild (only a single cough), moderate (more than one, short-duration cough), and severe (more than one cough lasting longer than 5 seconds) (10). If patients had cessation of respiration for longer than 20 seconds, breath holding was assessed and recorded (28).

Patients were examined for sore throat in the first and sixth hours by a physician blind to the groups. Patients were asked whether they had sore throat, and if so, the visual analog scale (VAS) value was recorded (28). Respiratory (laryngospasm, bronchospasm) and cardiac (arrhythmia, bradycardia, hypotension, hypertension, etc.) complications occurring during extubation were recorded. Patients were determined to be out of recovery when the Aldrete score was >8. Aldrete scores and duration in recovery were recorded (1).

Power Analysis

The primary outcome was determined as the incidence of cough after the extubation. With this aim, we used the study by Yorukoglu et al. (28). In this study, they found that the incidence of cough at 1 minute after extubation in the supine position was 40%, whereas the incidence of cough at 1 minute after extubation in the prone position was 8.5%. Using the incidence of cough at 1 minute after extubation values obtained in this study, with alpha error 5%, beta error 20%, and 80% power, we calculated that both groups needed to include 28 patients. Accepting a patient loss rate of 10% due to various reasons, with the addition of this rate, the plan was to include 30 patients in each of the two groups.

Statistical Analysis

Study data were entered into and analyzed with the Statistical Package for the Social Sciences (SPSS Inc, Chicago, IL, USA) 24.0 program. Continuous values are given as mean ± standard deviation (mean ± SD), whereas categorical data are given as number (n) and percentage (%). Data with continuous values were first assessed using the Kolmogorov–Smirnov test for fit to normal distribution. According to group numbers, two-way groups with normally distributed data were analyzed using the independent samples *t*-test (Student *t*-test), whereas the Mann–Whitney *U* test was used for two-way groups without normally distributed data. The paired sample *t*-test was used for in-group analysis. Variables denoting frequency were analyzed with the chi-square test and Fisher's exact test. p values less than 0.05 were accepted as statistically different.

RESULTS

The study included patients aged 18–65 years of age with ASA I-II undergoing elective lumbar surgery at the neurosurgery clinic in the central operating rooms of Dokuz Eylul University Faculty of Medicine. The study included 60 patients, with 30 in the prone position and 30 in the supine position. All patients completed the study.

There were no statistically significant differences in gender, ASA risk distribution, smoking rates, mean age, mean height, mean weight, or mean body mass index between patients in the supine group and those in the prone group ($p>0.05$; Table I).

Except for emergence ($p<0.001$) and recovery durations ($p<0.05$), there were no significant differences between the operational durations within the groups ($p>0.05$; Table II).

Aside from one parameter, there were no significant differences in systolic pressure, diastolic blood pressure, mean blood pressure, or heart rate between patients extubated in the prone and supine positions ($p>0.05$). A significant difference was found only for systolic blood pressure in the 30th minute after extubation ($p<0.05$; Figure 1).

Patients extubated in the prone position after extubation and in the first minute after extubation had significantly lower cough count and severity as compared with patients extubated in the supine position ($p<0.05$). There were no significant differences between the groups at any other measurement times ($p>0.05$; Table III).

One patient in the prone group and ten patients in the supine group were observed to hold their breath for longer than 20 seconds. There was a significant difference identified between the supine and prone groups in terms of holding breath for longer than 20 seconds ($p<0.001$). Desaturation after extubation was observed in three patients in the supine group. There was no significant difference in the development of desaturation after extubation ($p>0.05$; Table IV).

Table I: Demographic Characteristics of Patients

	Group P (n=30)	Group S (n=30)	All patients (n=60)
Woman n (%)	10 (33.3)	10 (33.3)	20 (33.3)
Male n (%)	20 (66.7)	20 (66.7)	40 (66.7)
ASA 1 n (%)	3 (10)	5 (16.7)	8 (13.3)
ASA 2 n (%)	27 (90)	25 (83.3)	52 (86.7)
Smoker n (%)	16 (53.3)	15 (50)	31 (51.7)
Non-smoker n (%)	14 (46.7)	15 (50)	29 (48.3)
Mean age (mean ± SD, years)	56.6 ± 8.3	52.6 ± 13	54 ± 11.16
Mean height (mean ± SD, cm)	164.7 ± 9.1	165.7 ± 8.8	165 ± 9.1
Mean weight (mean ± SD, kg)	73.4 ± 11	77.1 ± 12.9	75.3 ± 12
Mean BMI (mean ± SD, kg/m^2)	27.1 ± 3.4	28.04 ± 3.7	27.57 ± 3.6

Table II: Operational Durations for Patients (mean ± SD)

	Surgery duration (min)	Anesthesia duration (min)	Emergence duration (min)	Extubation duration (min)	Recovery duration (min)
Group P	152 ± 49	176 ± 50	9 ± 4	9 ± 4	5 ± 5
Group S	168 ± 86	201 ± 85	18 ± 6*	10 ± 5	7.5 ± 5*
All patients	160 ± 70	188 ± 70	13 ± 6	9.6 ± 3.5	6.25 ± 5

***** *p<0.05, between Group P and Group S, Student t test.*

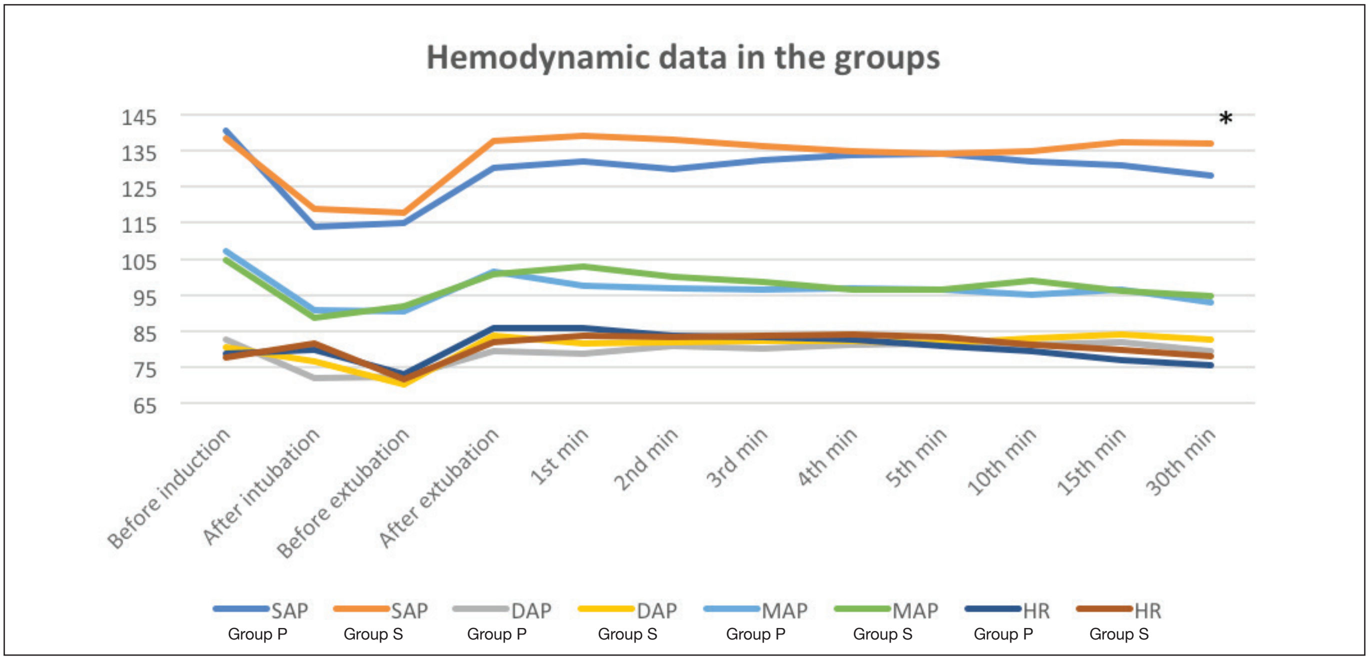

Figure 1: Hemodynamic data in the groups. **SAP:** Systolic arterial pressure (mmHg), **DAP:** Diastolic arterial pressure (mmHg), **MAP:** Mean arterial pressure (mmHg), **HR:** Heart rate (beats/min). *p<0,05; between Group P and Group S, Student t Test.

Table III: Cough Severity and Count for Patients

		After extubation*	1st min*	2nd min	3rd min	4th min	5th min	10th min	15th min	30th min
Group P (n=30), n (%)	Low	1 (3.3)	1 (3.3)	0 (0)	0 (0)	2 (6.7)	2 (6.7)	1 (3.3)	0 (0)	0 (0)
	Moderate	0 (0)	0 (0)	0 (0)	1 (3.3)	0 (0)	1 (3.3)	2 (6.7)	0 (0)	0 (0)
	High	0 (0)	0 (0)	0 (0)	1 (3.3)	0 (0)	0 (0)	0 (0)	0 (0)	1 (3.3)
	Total	**1** (3.3)	**1** (3.3)	**0** (0)	**2** (6.7)	**2** (6.7)	**3** (10)	**3** (10)	**0** (0)	**1** (3.3)
Group S (n=30), n (%)	Low	6 (20)	4 (13.3)	3 (10)	0 (0)	2 (6.7)	1 (3.3)	1 (3.3)	3 (10)	1 (3.3)
	Moderate	5 (16.7)	5 (16.7)	1 (3.3)	0 (0)	1 (3.3)	2 (6.7)	1 (3.3)	0 (0)	0 (0)
	High	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Total	11 (36.7)	9 (30)	4 (13.3)	0 (0)	3 (10)	3 (10)	2 (6.7)	3 (10)	1 (3.3)
All patients (n=60), n (%)		12 (20)	10 (16.7)	4 (6.7)	2 (3.3)	5 (8.3)	6 (10)	5 (8.3)	3 (5)	2(3.3)

**p<0.05, between Group P and Group S, Chi-Square Test.*

We found significant between-group differences in sore throat VAS scores in the first and sixth hours (p<0.001; Table IV).

DISCUSSION

In this study, we demonstrated that patients extubated in the prone position had a significantly shorter duration of emergence and recovery duration as compared with patients extubated in the supine position. Patients undergoing extubation in the prone position were determined to have significantly lower cough frequency up to the second minute after extubation, frequency of breath holding after extubation, and mean sore throat scores in the first and sixth hours as compared with patients who underwent extubation in the supine position.

Respiratory events such as cough, breath holding, and laryngospasm in the extubation and recovery period are linked to irritation of the airway during removal of the orotracheal tube and aspiration (2,5,16,17,20,21,28). Cough in the emergence period may cause hypertension, cardiac dysrhythmia, myocardial infarctus, postoperative surgical hemorrhage, laryngospasm, and elevations in abdominal, ocular, and intracranial pressure (5,16,17,20,21,28). Deep extubation (removing the endotracheal tube when the patient is in deep anesthesia);

Table IV: VAS Scores for Sore Throat in 1st and 6th Hours in the Groups

1st hour VAS sore throat score*				6th hour VAS sore throat score*			
VAS	**Group P (n=30) n (%)**	**Group S (n=30) n (%)**	**All patients (n=60) n (%)**	**VAS**	**Group P (n=30) n (%)**	**Group S (n=30) n (%)**	**All patients (n=60) n (%)**
0	25 (83.3)	15 (50)	40 (66.7)	0	22 (73.3)	15 (50)	37 (61.7)
1	1 (3.3)	0 (0)	1 (1.67)	1	2 (6.7)	0 (0)	2 (3.3)
2	0 (0%	3 (10)	3 (5)	2	0 (0)	1 (3.3)	1 (1.67)
3	1 (3.3)	6 (20)	7 (11.7)	3	3 (10)	0 (0)	3 (5)
4	2 (6.7)	3 (10)	5 (8.3)	4	0 (0)	4 (13.3)	4 (6.7)
5	1 (3.3)	1 (3.3)	2 (3.3)	5	0 (0)	4 (13.3)	4 (6.7)
6	0 (0)	1 (3.3)	1 (1.7)	6	2 (6.7)	3 (10)	5 (8.3)
7	0 (0)	1 (3.3)	1 (1.7)	7	1 (3.3)	2 (6.7)	3 (5)
8	0 (0)	0 (0)	0 (0)	8	0 (0)	1 (3.3)	1 (1.7)

***** *p<0.05, between Group P and Group S, Chi-Square Test.*

topical, IV, or endotracheal lidocaine administration; acupuncture; and IV magnesium administration were shown to have positive effects on extubation complications (2,28). However, the significance and effects of different extubation techniques on airway reactivity are little studied (28).

For patients undergoing spinal surgery in the prone position, a variety of studies have found that those extubated in the prone position have a lower incidence of cough as compared with those extubated in the supine position (4,12,13,18,19,23,28). Airway reactivity and cough upon emergence from anesthesia are considered to be linked to excessive tracheal irritation from the endotracheal tube. A study by Yörükoğlu et al. compared prone and supine extubation after spinal surgery and reported that patients undergoing prone extubation both with and without IV lidocaine had lower cough numbers in the first 4 minutes after extubation as compared with the supine groups (28). In their study, Ozden et al. emphasized that smokers have more frequent respiratory complications linked to airway irritation during extubation (19). Olympio et al. (18), and Yorukoglu et al. (28) included smokers and patients with reactive airway in their study groups, whereas Goyal et al. (12), and Srivastava et al. (23) excluded smokers. In our study, we researched the severity of cough during both extubation and recovery periods. The group extubated in the supine position was observed to have more pronounced severity of cough as compared with the prone group, which is similar to the findings of previous reports.

Positioning patients from the prone position to the supine position increases the incidence of this tracheal irritation and hence cough (18). Olympio et al. did not observe a significant difference between the two groups in terms of the presence of sore throat (18). However, when they compared sore throat incidence in the supine extubation with IV lidocaine, Yörükoğlu et al. observed sore throat less frequently in the prone position (28). Patients extubated in the prone position were observed to a reduced incidence of sore throat. The results of sore throat incidence in our study are in parallel with the findings of Yorukoglu et al. (28) but in contrast with that of Olympio et al. (18). The discrepancy in these results might be the result of differences in study designs or the low number of patients in the groups.

Although our patients extubated in the supine position had their anesthetic agents discontinued after turning to the supine position and beginning the emergence process, ten of these patients were observed to have straining and breath holding linked to irritation of the intubation tube. It is considered that these patients had anesthetic depth permitting to surgical stimuli, which was insufficient for turning from the supine to prone position. That might be reason why patients extubated in the supine position were observed to have more breath holding.

The most important limiting factor about prone extubation is ensuring safety of the airway. Olympio et al. stated that reliable extubation in the prone position could be provided for limited numbers of patients (18). They emphasized that they excluded from their study patients with difficult airway and obesity. In our study, we excluded patients with morbid obesity, difficult airway, and airway hyperactivity, which increase the risk for emergence of airway problems. The results of our study should be interpreted by considering this exclusion factor.

In our study, the operational durations of anesthesia, surgery, emergence, and extubation were noted. Similar to the study by Yorukoglu et al. (28), there was no significant time difference observed in our study, except for the durations of emergence and extubation. Shortening these durations will reduce the total duration of surgery and may provide benefits of more efficient use of the operating room. Similar to a study by Ozden et al. (19), we found a significant difference among our patients in the time needed to reach an Aldrete score of >8.

After lumbar spinal surgery, significant respiratory changes are observed when moving the patient from the prone position to the supine position during the recovery period (3). This situation is more pronounced for patients with cardiac and/or pulmonary disease (22). More stable hemodynamics were observed during the emergence of patents extubated in the prone position after surgery (4,12,18,19,28). In studies that compared the extubation methods among two groups undergoing spinal surgery and evaluates the hemodynamic results, Srivasta et al found that hypertensive patients extubated in the prone position were as hemodynamically stable as normotensive patients were (23). Ozden et al. stated that heart rate and mean arterial pressure values were more stable in the extubation and recovery periods in the prone group (19). Different from other researchers, Kumar et al. revealed no differences in hemodynamic parameters of patients extubated in the prone or supine position in a randomized controlled study of 60 ASA I-II patients aged from 18–65 years (13). Similar to these previous reports, we have also observed hemodynamic stability in prone-extubated patients; however, this difference did not reach statistical significance. This hemodynamic stability in our study might be related to the method of analgesia used.

During emergence from surgeries performed in the prone position, patient monitoring is disrupted when turning the patient from the prone position to the supine position, and this cessation is more frequently observed when patients are extubated in the supine position (4,12,13,18,23,28). Olympio et al. noted the duration of demonitoring in patients with monitoring disruption due to positioning (18). In a group of 21 patients with extubation in the prone position, 19 did not experience monitoring loss; however, all 24 patients with extubation in the supine position had monitoring loss. As a result, they emphasized that patients extubated in the supine position experienced more monitoring loss. Chanabassappa and Shankarnarayana noted loss of monitoring in patients extubated in both the prone and supine positions (4). One of 30 patients extubated in the prone position and 30 of 30 patients extubated in the supine position experienced monitoring loss. Hemodynamic changes are most commonly observed during the time when patients are turned from the prone position to the supine position. In our study, monitoring continued in all patients throughout the emergence process while turning from the prone to supine position, and monitoring was not interrupted in any patient.

Limitations

Our results should be interpreted while keeping in mind that the study was designed as a prospective observational study with a limited number of patients. We lacked a control group that did not receive IV lidocaine, and postoperative analgesia was satisfactory in both groups. Thus, any differences in hemodynamics and pain might be obscured by these factors.

CONCLUSION

The technique of prone extubation results in less cough after extubation and a reduced incidence of sore throat. These findings prove the necessity of considering prone emergence and extubation as an alternative approach for a selected group of patients. In patients with hyperactive airways, the results of prone extubation remain to be determined. In addition, prone extubation may ensure more ergonomic use of the operating room by reducing the duration of emergence and recovery.

AUTHORSHIP CONTRIBUTION

Study conception and design: FSG

Data collection: MS, SO

Analysis and interpretation of results: VH, MS

Draft manuscript preparation: FSG, SO

All authors (FSG, MS, SO, VH) reviewed the results and approved the final version of the manuscript.

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