



## Evaluation of perioperative serum sodium and potassium changes in patients undergoing transurethral resection of the prostate under subarachnoid block—an observational cross-sectional study.

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### Abstract

#### Background:

Transurethral resection of the prostate (TURP) may cause fluid and electrolyte disturbances due to absorption of irrigation fluid. This study evaluated changes in serum sodium and potassium in relation to the duration of TURP.

#### Methods:

This prospective observational study included 104 patients undergoing elective TURP under subarachnoid block from August 2025 to July 2026. Patients were divided according to resection duration into Group 1 (<45 minutes; n=52) and Group 2 (>45 minutes; n=52). Serum sodium and potassium were measured preoperatively, intraoperatively at 40 minutes, and postoperatively. Operative and hemodynamic parameters were also assessed.

#### Results:

Patients undergoing TURP for more than 45 minutes had significantly greater irrigation-fluid use ( $15.8 \pm 2.7$  vs.  $10.9 \pm 2.1$  L;  $P < 0.001$ ) and tissue resection ( $45.7 \pm 8.1$  vs.  $30.2 \pm 6.4$  g;  $P < 0.001$ ). The postoperative serum sodium level was significantly lower in Group 2 than in Group 1 ( $134.8 \pm 3.7$  vs.  $137.6 \pm 3.1$  mEq/L;  $P < 0.001$ ), with a greater reduction from baseline ( $4.1 \pm 1.8$  vs.  $1.6 \pm 1.2$  mEq/L;  $P < 0.001$ ). Postoperative serum potassium was significantly higher in Group 2 ( $4.46 \pm 0.38$  vs.  $4.28 \pm 0.33$  mEq/L;  $P = 0.011$ ). No significant between-group differences in heart rate or mean arterial pressure were observed at the assessed time points, and no clinically evident TURP syndrome was reported.

#### Conclusion:

Prolonged TURP was associated with greater sodium reduction and potassium elevation, emphasizing the importance of perioperative electrolyte monitoring.

#### Recommendation:

Perioperative electrolyte monitoring should be considered, particularly during prolonged TURP procedures, to facilitate early detection and management of electrolyte disturbances.

**Keywords:** Transurethral resection of prostate; Serum sodium; Serum potassium; Glycine irrigation; Electrolyte imbalance; Transurethral Resection of the Prostate syndrome.

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### Introduction

Benign prostatic hyperplasia (BPH) is a common condition in ageing men and may produce progressive lower urinary tract symptoms requiring surgical intervention when medical therapy is inadequate [1, 2]. Transurethral resection

of the prostate (TURP) remains an established surgical treatment for symptomatic BPH and is frequently performed under spinal or other neuraxial anaesthetic techniques. Despite advances in surgical and anaesthetic practice, TURP is associated with important perioperative physiological changes, largely related to absorption of irrigation fluid into



the systemic circulation. The extent of these changes depends on factors such as the type and volume of irrigation fluid, duration of surgery, amount of prostatic tissue resected, and the pressure at which irrigation is delivered [3-5].

Electrolyte disturbances, particularly hyponatremia, are among the major concerns during TURP and may contribute to the development of TURP syndrome. Systemic absorption of irrigation fluid can produce dilutional changes in serum sodium and osmolality, while substantial fluid absorption may also cause intravascular volume expansion and cardiovascular disturbances [5-7]. Earlier studies have demonstrated that reductions in serum sodium may become more pronounced with increasing operative duration and irrigation-fluid absorption. Changes in serum potassium have also been reported during TURP, with some studies demonstrating postoperative potassium elevation associated with the volume of irrigation fluid used, duration of resection, and amount of prostate tissue removed [8-11]. However, the pattern of electrolyte changes may vary with the type of irrigation solution; studies using isotonic saline have reported reductions in both sodium and potassium without clinically significant consequences [12, 13].

Because spinal anaesthesia permits continuous assessment of the patient's clinical and hemodynamic status during TURP, monitoring of serum electrolytes together with operative and cardiovascular parameters may help identify early physiological alterations associated with irrigation-fluid absorption. Previous investigations have shown associations between electrolyte changes and factors such as operative duration, volume of irrigation fluid, and prostate tissue resected, while hemodynamic changes may reflect evolving intravascular fluid shifts [9, 10]. Therefore, the present study was undertaken to evaluate changes in serum sodium and potassium levels in patients undergoing TURP under subarachnoid block and to assess their relationship with the volume of irrigation fluid absorbed, duration of resection, amount of prostate tissue resected, and concurrent hemodynamic changes.

## Methods

### Study Design and Duration

This study was designed as a prospective observational study to evaluate changes in serum sodium and potassium concentrations in relation to the duration of transurethral resection of the prostate (TURP). The study was conducted from August 2025 to July 2026 among patients undergoing elective TURP under subarachnoid block.

### Study Setting

The study was conducted in the Department of Anaesthesiology, Pt. B. D. Sharma Postgraduate Institute of Medical Sciences (PGIMS), Rohtak, Haryana, India. The study was carried out in the operating theatres among patients undergoing elective transurethral resection of the prostate (TURP) under subarachnoid block. Preoperative assessment, intraoperative monitoring, and postoperative observation were performed according to the institutional protocol.

### Sample Size

A total of 104 patients scheduled for elective TURP were included in the study. Patients were categorized into two groups according to the duration of prostate resection: Group 1, with a resection time of less than 45 minutes, and Group 2, with a resection time of more than 45 minutes. Assuming a mean difference of 2.0 mEq/L, a standard deviation of 3.0 mEq/L, a two-sided significance level of 5%, and a statistical power of 80%, the estimated sample size was approximately 36 patients per group. Allowing for approximately 15% attrition, at least 42 patients per group were required. Therefore, 104 patients (52 per group) were included in the study.

### Study Population and Selection Criteria

Patients aged 41-80 years with benign prostatic hyperplasia (BPH), classified as ASA physical status I, II, or III, and scheduled for elective TURP under subarachnoid block were eligible for inclusion. Written informed consent was obtained from all participants.

Patients younger than 41 or older than 80 years, those with ASA physical status IV, undergoing TURP under general anaesthesia, receiving diuretic therapy, or having pre-existing electrolyte abnormalities were excluded. Patients with advanced cardiac, pulmonary or renal disease, lumbar spine metastasis or spinal deformity were also excluded.

### Preoperative Preparation

All patients underwent routine preanaesthetic assessment at least 24 hours before surgery, including relevant history, physical examination and laboratory investigations. On arrival in the operating room, standard multiparameter monitoring was established, and baseline heart rate, blood pressure and oxygen saturation were recorded. Peripheral intravenous access was secured, and Ringer's lactate 10 mL/kg was administered for preloading. Intravenous



pantoprazole 40 mg and ondansetron 0.15 mg/kg were administered as premedication.

### Anaesthetic Technique

A subarachnoid block was performed at the L3–L4 or L4–L5 interspace using 3–3.5 mL of 0.5% hyperbaric bupivacaine. Supplemental oxygen at 4 L/min through a Venturi mask was provided when required. Heart rate, blood pressure, and oxygen saturation were monitored at 5-minute intervals throughout the procedure.

### Study Parameters

The primary outcomes were changes in serum sodium and potassium concentrations. Secondary parameters included duration of prostate resection, weight of prostate tissue resected, total volume of irrigation fluid used, volume of irrigation fluid absorbed, heart rate, and mean arterial pressure. These parameters were compared between patients with resection times below and above 45 minutes.

### Irrigation Fluid and Assessment of Absorption

Glycine 1.5% was used as the irrigation solution and was delivered from a cylindrical glass container maintained at a height of 60 cm above the patient's pubic symphysis. The volume of irrigation fluid used was recorded during the procedure. Fluid absorption was estimated according to the study protocol using changes in serum sodium and estimated extracellular fluid volume.

### Laboratory and Hemodynamic Assessment

Blood samples were obtained at three time points: preoperatively, intraoperatively at 40 minutes after commencement of prostate resection, and 30 minutes after completion of surgery. Serum sodium and potassium concentrations were measured at each assessment point. Heart rate and mean arterial pressure were also recorded at the corresponding time points for comparison between the groups.

### Postoperative Monitoring

Following surgery, patients were observed in the post-anaesthesia care unit for at least 2 hours. Postoperative vital signs and complications related to subarachnoid block, including hypotension and vomiting, were monitored and managed appropriately.

### Bias

Potential bias was minimized by applying predefined inclusion and exclusion criteria, using standardized assessment procedures, and measuring serum electrolytes at predefined time points. However, confounding factors related to patient characteristics and operative duration may have influenced the outcomes.

### Statistical Analysis

Data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean  $\pm$  standard deviation, while categorical variables were presented as frequencies and percentages. Continuous variables were compared between the two groups using the independent Student's t-test. Categorical variables were analysed using the chi-square test or Fisher's exact test, as appropriate. A P-value  $<0.05$  was considered statistically significant.

### Results

During the study period from August 2025 to July 2026, 120 patients scheduled for elective transurethral resection of the prostate (TURP) were assessed for eligibility. Of these, 108 met the eligibility criteria and were enrolled, while 12 were excluded due to pre-existing electrolyte abnormalities ( $n = 5$ ), diuretic use ( $n = 4$ ), or failure to meet other eligibility criteria ( $n = 3$ ). Four enrolled participants did not complete the study due to withdrawal of consent ( $n = 2$ ) and incomplete data collection ( $n = 2$ ). The final analysis included 104 patients, divided into two groups according to resection duration: Group 1 (less than 45 minutes;  $n = 52$ ) and Group 2 (more than 45 minutes;  $n = 52$ ).

The demographic characteristics of the two groups were comparable, with no statistically significant differences in age, body weight, ASA physical status, or the prevalence of smoking, diabetes mellitus, hypertension, and COPD ( $P > 0.05$ ). As expected, the mean procedure duration was significantly longer in Group 2 than in Group 1 ( $56.8 \pm 6.2$  vs.  $39.7 \pm 3.9$  minutes;  $P < 0.001$ ). Group 2 also had a significantly greater amount of prostate tissue resected ( $45.7 \pm 8.1$  vs.  $30.2 \pm 6.4$  g;  $P < 0.001$ ) and a higher volume of irrigation fluid used ( $15.8 \pm 2.7$  vs.  $10.9 \pm 2.1$  L;  $P < 0.001$ ). However, the volume of irrigation fluid absorbed was comparable between the groups ( $71.2 \pm 7.1$  vs.  $69.4 \pm 6.0$  mL;  $P = 0.156$ ) (Table 1).



**Table 1: Comparison of Demographic and Operative Characteristics Between the Study Groups**

| Variable                               | Group 1: Resection < 45 min (n = 52) | Group 2: Resection > 45 min (n = 52) | p     |
|----------------------------------------|--------------------------------------|--------------------------------------|-------|
| Age (years), M ± SD                    | 61.8 ± 6.1                           | 63.2 ± 5.8                           | .231  |
| Weight (kg), M ± SD                    | 66.8 ± 5.2                           | 67.9 ± 5.7                           | .312  |
| ASA physical status                    |                                      |                                      | .647  |
| ASA I, n (%)                           | 13 (25.0)                            | 11 (21.2)                            |       |
| ASA II, n (%)                          | 34 (65.4)                            | 33 (63.5)                            |       |
| ASA III, n (%)                         | 5 (9.6)                              | 8 (15.4)                             |       |
| Smoking, n (%)                         | 23 (44.2)                            | 21 (40.4)                            | .697  |
| Diabetes mellitus, n (%)               | 10 (19.2)                            | 11 (21.2)                            | .800  |
| Hypertension, n (%)                    | 14 (26.9)                            | 15 (28.8)                            | .829  |
| COPD, n (%)                            | 8 (15.4)                             | 10 (19.2)                            | .611  |
| Procedure duration (min), M ± SD       | 39.7 ± 3.9                           | 56.8 ± 6.2                           | <.001 |
| Prostate tissue resected (g), M ± SD   | 30.2 ± 6.4                           | 45.7 ± 8.1                           | <.001 |
| Irrigation fluid used (L), M ± SD      | 10.9 ± 2.1                           | 15.8 ± 2.7                           | <.001 |
| Irrigation fluid absorbed (mL), M ± SD | 69.4 ± 6.0                           | 71.2 ± 7.1                           | .156  |

Note. M = mean; SD = standard deviation; ASA = American Society of Anesthesiologists; COPD = chronic obstructive pulmonary disease; kg = kilogram; min = minute; g = gram; L = litre; mL = millilitre. Percentages are calculated within each group.

Serum sodium levels were comparable between the groups before surgery ( $139.2 \pm 2.8$  vs.  $138.9 \pm 2.7$  mEq/L;  $P=0.582$ ). Following the procedure, sodium levels decreased in both groups, with a significantly greater reduction observed in Group 2. Intraoperative sodium was  $135.9 \pm 3.5$  mEq/L in Group 2 compared with  $138.1 \pm 3.0$

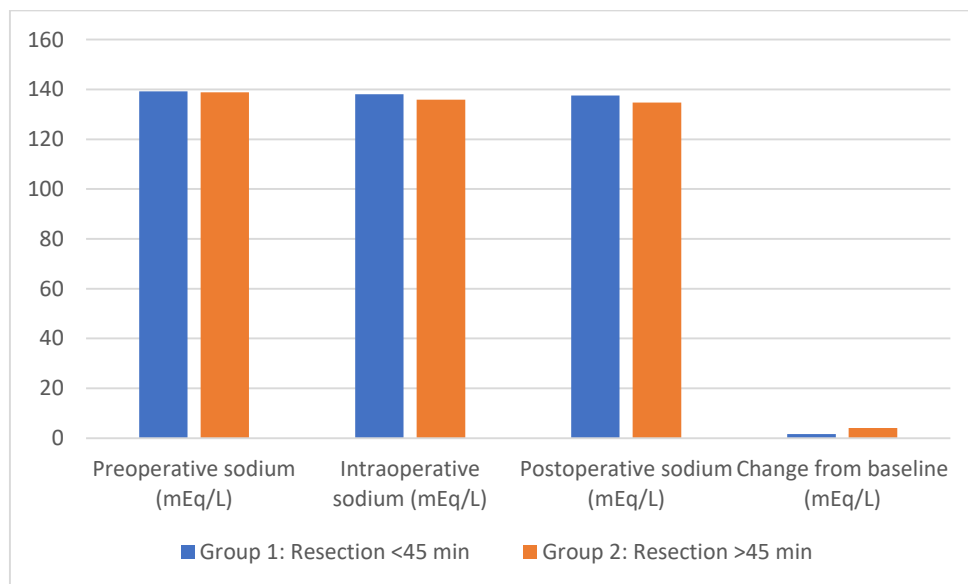
mEq/L in Group 1 ( $P<0.001$ ), while postoperative levels were  $134.8 \pm 3.7$  and  $137.6 \pm 3.1$  mEq/L, respectively ( $P<0.001$ ). The overall fall from baseline was also significantly greater in Group 2 ( $P<0.001$ ) (Table 2 and Figure 1).

**Table 2: Comparison of Serum Sodium Levels at Different Time Points Between the Study Groups**

| Time point                   |        | Group 1: Resection < 45 min (n = 52),<br>M ± SD | Group 2: Resection > 45 min (n = 52),<br>M ± SD | p     |
|------------------------------|--------|-------------------------------------------------|-------------------------------------------------|-------|
| Preoperative (mEq/L)         | sodium | $139.2 \pm 2.8$                                 | $138.9 \pm 2.7$                                 | .582  |
| Intraoperative (mEq/L)       | sodium | $138.1 \pm 3.0$                                 | $135.9 \pm 3.5$                                 | <.001 |
| Postoperative (mEq/L)        | sodium | $137.6 \pm 3.1$                                 | $134.8 \pm 3.7$                                 | <.001 |
| Change from baseline (mEq/L) |        | $1.6 \pm 1.2$                                   | $4.1 \pm 1.8$                                   | <.001 |

Note. M = mean; SD = standard deviation; mEq/L = milliequivalents per litre.

**Figure 1. Comparison of Serum Sodium Levels at Different Time Points Between the Study Groups**



Serum potassium levels were similar at baseline between the two groups ( $P=0.641$ ). A modest increase was observed during and after surgery, with significantly higher intraoperative potassium levels in Group 2 compared with Group 1 ( $4.39 \pm 0.36$  vs.  $4.25 \pm 0.31$  mEq/L;  $P=0.036$ ). Postoperatively, potassium remained significantly higher in

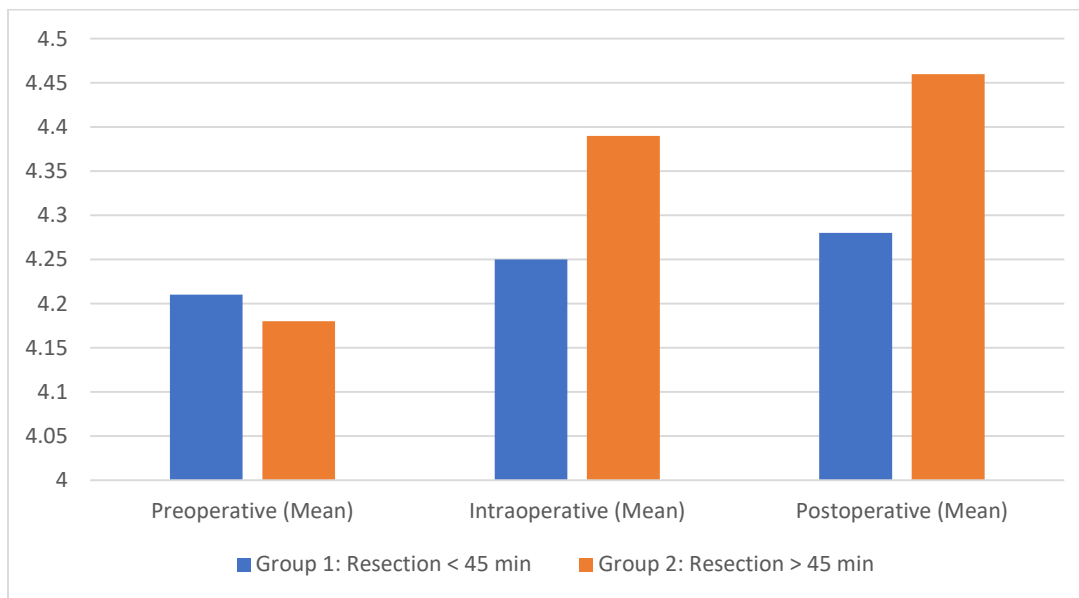
Group 2 ( $4.46 \pm 0.38$  vs.  $4.28 \pm 0.33$  mEq/L;  $P=0.011$ ). Heart rate and mean arterial pressure were comparable between the groups at all assessed time points, with no statistically significant differences observed preoperatively, intraoperatively, or postoperatively ( $P>0.05$ ) (Table 3 and Figure 2)

**Table 3: Comparison of Serum Potassium and Hemodynamic Parameters Between the Study Groups**

| Variable                      | Group 1: Resection < 45 min (n = 52),<br>M $\pm$ SD | Group 2: Resection > 45 min (n = 52),<br>M $\pm$ SD | p    |
|-------------------------------|-----------------------------------------------------|-----------------------------------------------------|------|
| Serum potassium (mEq/L)       |                                                     |                                                     |      |
| Preoperative                  | 4.21 $\pm$ 0.32                                     | 4.18 $\pm$ 0.34                                     | .641 |
| Intraoperative                | 4.25 $\pm$ 0.31                                     | 4.39 $\pm$ 0.36                                     | .036 |
| Postoperative                 | 4.28 $\pm$ 0.33                                     | 4.46 $\pm$ 0.38                                     | .011 |
| Heart rate (beats/min)        |                                                     |                                                     |      |
| Preoperative                  | 76.8 $\pm$ 7.4                                      | 77.5 $\pm$ 7.8                                      | .641 |
| Intraoperative                | 78.2 $\pm$ 7.6                                      | 80.4 $\pm$ 8.1                                      | .154 |
| Postoperative                 | 77.4 $\pm$ 7.3                                      | 79.6 $\pm$ 7.9                                      | .145 |
| Mean arterial pressure (mmHg) |                                                     |                                                     |      |
| Preoperative                  | 92.1 $\pm$ 6.8                                      | 93.0 $\pm$ 7.1                                      | .509 |
| Intraoperative                | 88.7 $\pm$ 6.5                                      | 87.1 $\pm$ 7.0                                      | .225 |
| Postoperative                 | 90.2 $\pm$ 6.7                                      | 88.4 $\pm$ 7.2                                      | .180 |

Note. M = mean; SD = standard deviation; mEq/L = milliequivalents per litre; beats/min = beats per minute; mmHg = millimetres of mercury.

**Figure 2. Comparison of Serum Potassium Levels at Different Time Points Between the Study Groups**



## Discussion

The present study demonstrated that longer TURP procedures were associated with greater operative requirements and more pronounced electrolyte changes. Patients with a resection duration of more than 45 minutes had significantly longer procedures, greater prostate tissue resection, and higher irrigation-fluid use than those with shorter procedures. Irrigation-fluid use increased from  $10.9 \pm 2.1$  L in Group 1 to  $15.8 \pm 2.7$  L in Group 2 ( $P < 0.001$ ), whereas the estimated volume of fluid absorbed was comparable between the groups. These findings suggest that prolonged resection is associated with increased irrigation requirements and more extensive tissue removal, which may contribute to perioperative fluid and electrolyte disturbances.

Serum sodium levels were comparable preoperatively but declined significantly more in the longer-duration group during the intraoperative and postoperative periods. Postoperative sodium was  $134.8 \pm 3.7$  mEq/L in Group 2 compared with  $137.6 \pm 3.1$  mEq/L in Group 1 ( $P < 0.001$ ). This reduction is consistent with the dilutional effect of irrigation-fluid absorption during TURP, particularly with prolonged procedures and greater irrigation requirements. Gupta et al. reported that postoperative sodium reduction

was associated with resection duration, irrigation-fluid volume, and the amount of prostate tissue removed [9]. Similarly, another study demonstrated a significant postoperative reduction in serum sodium with the use of 1.5% glycine irrigation [14]. Despite this decline, no clinically evident TURP syndrome was observed in the present study, suggesting that the electrolyte disturbances remained relatively mild.

Serum potassium showed a gradual increase during and after surgery. Although baseline values were comparable, postoperative potassium was significantly higher in Group 2 than in Group 1 ( $4.46 \pm 0.38$  vs.  $4.28 \pm 0.33$  mEq/L;  $P = 0.011$ ). Gupta et al. reported that postoperative hyperkalemia was associated with operative duration, irrigation-fluid volume, and the amount of prostate tissue resected [9]. Similarly, another study demonstrated a significant postoperative increase in serum potassium and a positive relationship between operative duration and potassium levels [15]. The observed potassium changes therefore support the need to monitor electrolyte status during prolonged TURP, particularly when glycine irrigation is used.

Overall, prolonged TURP was associated with increased irrigation-fluid use and greater changes in serum sodium and



potassium. These findings highlight the importance of perioperative electrolyte monitoring when resection extends beyond 45 minutes, even in the absence of clinically apparent TURP syndrome. The study was limited by its single-centre observational design, and direct correlations between electrolyte changes and individual operative factors were not assessed. Larger prospective studies with correlation-based analysis are warranted to further clarify the determinants of electrolyte disturbances during TURP.

### Generalizability

The findings may apply to patients undergoing TURP under subarachnoid block in similar clinical settings, although validation in larger, multicentre studies is needed.

### Conclusion

The present study demonstrated that prolonged TURP was associated with greater irrigation-fluid use, more extensive prostate tissue resection, and significant changes in serum electrolytes. Patients with a resection duration of more than 45 minutes showed a greater decline in serum sodium and a significant rise in serum potassium compared with those undergoing shorter procedures. Although no clinical features of TURP syndrome were observed, these biochemical changes highlight the importance of close perioperative monitoring of serum electrolytes, particularly during prolonged TURP using glycine irrigation. Early recognition of electrolyte disturbances may help prevent progression to clinically significant complications.

### Limitations

The single-centre observational design, relatively small sample size, potential confounding factors, and limited follow-up may restrict the interpretation and generalizability of the findings.

### Recommendation

Routine perioperative monitoring of serum sodium and potassium should be considered, particularly during prolonged TURP procedures.

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### List of Abbreviations

- **TURP:** Transurethral Resection of the Prostate
- **BPH:** Benign Prostatic Hyperplasia
- **ASA:** American Society of Anesthesiologists
- **HR:** Heart Rate
- **MAP:** Mean Arterial Pressure
- **SD:** Standard Deviation

### Conflict of Interest

The authors declare no conflicts of interest related to this study.

### Author Contribution

All authors contributed to the study conception and design, data collection, analysis and interpretation, manuscript preparation, critical revision, and approval of the final version.

### Data Availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to institutional policies and applicable ethical restrictions.

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Original Article

Page | 8

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