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# The Impact of Anaesthetic Technique on Perioperative Bleeding in Endourological Stone Surgery: A Retrospective Analysis

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**What's known on the subject? and What does the study add?**

Perioperative bleeding during ureterorenoscopy (URS) and retrograde intrarenal surgery (RIRS) is mainly affected by stone size, stone location, and procedure-related factors. Previous comparative studies have generally reported similar operative and postoperative outcomes between spinal and general anaesthesia. Evidence specifically focusing on anaesthetic technique and haemoglobin change remains limited. This study shows that the choice of anaesthetic technique (general vs. spinal) does not significantly influence perioperative haemoglobin reduction in URS/RIRS. Operative time is identified as an independent predictor of haemoglobin decline. Use of a ureteral access sheath is significantly associated with greater haemoglobin reduction. The findings suggest that procedure-related factors, rather than the anaesthetic method, predominantly determine bleeding risk in endourological stone surgery.

## Abstract

**Objective:** This study investigated whether the type of anaesthesia—general anaesthesia (GA) or spinal anaesthesia (SA)—affects perioperative haemoglobin (Hb) changes and postoperative complications in patients undergoing ureterorenoscopy (URS) or retrograde intrarenal surgery (RIRS). A secondary aim was to identify perioperative factors associated with Hb decline.

**Materials and Methods:** Patients aged ≥18 years who underwent rigid URS or RIRS between April 2020 and April 2025 were evaluated retrospectively. Demographic characteristics, stone features, operative details, anaesthetic technique, and perioperative Hb values were recorded. Patients with combined or epidural anaesthesia, active anticoagulation, coagulopathy, or incomplete data were excluded. Factors related to Hb reduction were assessed using univariate analyses and multivariate logistic regression.

**Results:** A total of 247 patients met the criteria. The mean Hb decrease was 0.37 g/dL in the GA group and 0.28 g/dL in the SA group; the difference was not significant ($p>0.05$). No transfusions were required. Larger stones, location in the renal pelvis, longer operative time, and use of a ureteral access sheath were significantly associated with Hb decline (all $p=0.001$). In multivariate analysis, stone size, operative duration, and access sheath use remained independent predictors, while anaesthetic technique and comorbidities were not significant predictors. The overall complication rate was low (0.8%), with no events above Clavien-Dindo grade IIIa.

**Conclusion:** Anaesthetic technique does not significantly influence perioperative Hb reduction or complication rates during URS or RIRS. Operative duration and the use of an access sheath are the main determinants of bleeding risk.

**Keywords:** Basic science, endourology, general urology

## Introduction

Urolithiasis is an important health problem that is increasingly common both worldwide and in our country. The prevalence in Türkiye has been reported to reach 14.8% (1). Urinary stone disease may present with recurrent episodes of pain, infection, and, if not treated promptly, may ultimately cause irreversible impairment of renal function. Recently, endourological interventions have become a preferred treatment option for urolithiasis because they are minimally invasive and offer high success rates (2).

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Among endourological procedures, ureterorenoscopy (URS) and retrograde intrarenal surgery (RIRS) have become increasingly widespread owing to technological advancements, particularly in laser systems. The anaesthetic technique used during these procedures can directly influence surgical comfort, haemodynamic stability, operative duration, and postoperative complications (3,4).

Traditionally, general anaesthesia (GA) is preferred, particularly in cases involving proximal ureteric stones or requiring RIRS. The main reasons for this include longer operative duration, higher intrarenal irrigation pressure, prevention of patient movement, and airway security (3,5). GA also enhances operative comfort by offering the surgeon a better visual field, controlled ventilation, and improved haemodynamic stability (6,7).

In contrast, spinal anaesthesia (SA) has recently become an important alternative, particularly for short- to medium-duration endourological procedures, owing to its safety profile, cost-effectiveness, and rapid recovery time (4,8). A spinal block offers several advantages during the intraoperative period, including a more stable haemodynamic profile, reduced opioid requirements, and earlier mobilisation. Physiological effects, such as preserved renal blood flow and reduced systemic absorption of irrigation fluid—both related to decreased sympathetic tone—may also contribute to these benefits (5-8).

Recent reviews, including several systematic analyses, suggest that there is no meaningful difference between spinal and GA in terms of stone-free rates or overall complications for patients undergoing retrograde intrarenal surgery. Several studies report that patients operated on under SA experience less blood loss and require fewer postoperative analgesics (9-11).

In practice, perioperative bleeding and the risk of complications are often influenced by procedure-related factors - for example, operative duration, stone size and position, and use of a ureteral access sheath (12-15). Some authors also note that the sympathetic blockade produced by neuraxial anaesthesia could help maintain renal blood flow, which, in turn, may attenuate these perioperative changes (16,17).

However, data directly comparing the effects of the two anaesthetic techniques on perioperative decreases in haemoglobin (Hb) and bleeding-related parameters remain limited. Therefore, this study retrospectively examined the influence of anaesthesia type on perioperative Hb changes and the occurrence of complications in patients undergoing URS or RIRS for urolithiasis.

In addition, we sought to identify factors that might contribute to Hb decline, including stone size, stone location, procedure duration, use of a ureteral access sheath, and comorbidities.

## Materials and Methods

This study was designed as a single-centre retrospective cohort analysis covering the period from April 2020 to April 2025. It was conducted using the archived records of the Departments of Urology and Anaesthesiology at Muğla Sıtkı Koçman University in accordance with the principles of the Declaration of Helsinki. Ethical approval was obtained from the Muğla Sıtkı Koçman University Clinical Research Ethics Committee (approval no: 205, date: 03.10.2025). Owing to the retrospective nature of the study, informed consent was waived; all data were anonymised and confidentiality was maintained in line with institutional policy.

Patients aged 18 years or older who underwent rigid URS or RIRS (flexible URS) for urolithiasis were eligible for inclusion. Surgical and anaesthesia charts, perioperative Hb and haematocrit measurements, details of general or spinal anaesthesia, and complete records of bleeding and transfusion were required for inclusion.

Patients who received combined, epidural, or other regional anaesthesia techniques, patients on active anticoagulant therapy, patients with known coagulopathies, and patients with missing or inconsistent clinical data were excluded from the study.

All procedures were performed using standard endourological techniques. Operations were performed under either general or spinal anaesthesia. The choice of anaesthetic method was based on several clinical considerations, including the patient's overall condition, the location of the stone (particularly the proximal ureter or renal pelvis), the anticipated duration of the procedure, the patient's ability to cooperate, and the judgement of the attending anaesthesiologist. The absence of a uniform protocol was regarded as a methodological limitation of the study.

GA was typically preferred for proximal ureteric stones, for patients undergoing RIRS, and for cases in which the patient explicitly requested it. In these patients, ureteral access sheaths were inserted. To maintain a stable irrigation pressure, the irrigation bag was positioned approximately 90 cm above the patient. Owing to the retrospective design, real-time intrarenal pressure measurements were not available; therefore, it cannot be confirmed with certainty that irrigation pressure remained fully standardised across all procedures.

Stone fragmentation was performed with a Ho:YAG laser in dusting mode. Laser energy parameters (joules and frequency) were not consistently documented in the records and could not be included in the analysis. A guidewire was used in all cases, and a postoperative Double J (DJ) stent was routinely inserted. Patients requiring ureteral dilatation had a DJ stent inserted, and their procedures were postponed. All operations were

performed by two surgeons, each with experience of more than 100 URS and RIRS procedures.

Patient age, sex, body mass index (BMI), comorbid conditions, type of anaesthesia, stone laterality and location, maximum stone diameter (mm), perioperative transfusion requirement (transfusion indicated when Hb fell below 8 g/dL), change in Hb from the preoperative value to the 24$^{th}$ postoperative hour (g/dL), postoperative events within 30 days, classified according to the Clavien-Dindo classification, and operative time were obtained from the anaesthesia and surgical records. A standardised data collection form was created to record all variables.

### Statistical Analysis

All analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarised as mean ± standard deviation or median (minimum-maximum), while categorical variables were presented as frequency (n) and percentage (%). Differences between groups were assessed using Student's t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Categorical variables were compared using the chi-square ($\chi^2$) test or Fisher's exact test, as appropriate.

To identify factors associated with Hb decline, univariate analyses were initially performed. Variables showing statistical significance in univariate testing ($p<0.05$) were entered into a multivariate logistic regression model. Results were reported as odds ratios (OR) with 95% confidence intervals. A p-value of <0.05 was considered statistically significant.

## Results

Between April 2020 and April 2025, 324 patients who underwent URS or RIRS for urolithiasis were evaluated. 50 patients were excluded because of incomplete records, 20 because a preoperative ureteral stent was placed, and 7 because they received combined anaesthesia.

The demographic characteristics of the study cohort are summarised in Table 1. Although the mean age of patients in the SA group was slightly higher than that in the GA group, this difference was not statistically significant (p=0.237). Males predominated in both groups (59.0% and 67.8%, respectively), with no significant difference between groups (p=0.376). The BMI distribution was also comparable between the two groups (p=0.487), and most patients were classified as normal weight or overweight.

The mean Hb drop was 0.37 g/dL in the GA group and 0.28 g/dL in the SA group. Although the proportion of patients experiencing a decrease in Hb was higher in the GA group (20.5%) than in the SA group (2.9%), this difference was not statistically significant (p>0.05; Table 2).

No significant difference in Hb reduction was observed between patients with comorbidities and those without them (p>0.05). The highest mean Hb drop was observed in patients with a history of arrhythmia (0.33 g/dL), while lower mean drops were recorded in patients with hypertension, diabetes, or coronary artery disease. Despite these minor variations, the presence of comorbidity did not appear to have a meaningful impact on perioperative Hb levels (Table 3).

The relationship between operative variables and decline in Hb is summarised in Table 4. A significant association was found between stone size and Hb reduction (p=0.001); patients with larger stones experienced a more pronounced reduction in Hb. Stone location was also significantly associated with change in Hb (p=0.001); the greatest mean decrease in Hb was observed in cases with renal pelvis stones (50%).

A ureteral access sheath was used in 12 patients with renal pelvic stones, 46 with proximal ureteral stones, and 7 with

**Table 1. Demographic characteristics of the patients by type of anaesthesia**

| | General anaesthesia (n=79) | Spinal anaesthesia (n=245) | Total (n=324) | p-value* |
|---|---|---|---|---|
| **Age (year)[a]** | 51.0±17.5<br>(median: 53.5) | 51.8±15.8<br>(median: 51) | 51.6±16.2<br>(median: 53) | 0.726 |
| **Gender[b] (female/male)** | 30/49<br>(38.0%/62.0%) | 82/163<br>(33.5%/66.5%) | 112/212 (34.6%/ 65.4%) | 0.628 |
| **BMI[b] 20-25**<br>25-30<br>≥30 | 37 (46.8%)<br>36 (45.6%)<br>7 (8.9%) | 112 (45.7%)<br>116 (47.3%)<br>16 (6.5%) | 149 (46.0%)<br>152 (46.9%)<br>23 (7.1%) | 0.797 |
| Stone size (mm, mean ± SD)[c] | 13.6±6.0 | 9.4±3.3 | | <0.001 |
| Operative time (min, mean ± SD)[c] | 60.0±27.7 | 36.1±7.8 | | <0.001 |
| URS (n, %)[b] | 12 (15.1%) | 235 (95.9%) | | <0.001 |
| RIRS (n, %)[b] | 21 (26.6%) | 9 (3.7%) | | <0.001 |
| PCNL (n, %)[b] | 8 (10.1%) | 0 | | <0.001 |

BMI: Body mass index (kg/m$^2$), [a]: Mann-Whitney U (Wilcoxon rank-sum), [b]: Chi-square test, [c]: Independent samples t-test, SD: Standard deviation, URS: Ureterorenoscopy, RIRS: Retrograde intrarenal surgery, PCNL: Percutaneous nephrolithotomy

| Table 2. Clinical findings and transfusion requirement by type of anesthesia | | | | |
|---|---|---|---|---|
| **Anesthesia type** | **Number of patients (n)** | **Number of transfusions (n)** | **Transfusion rate[a]** | **Mean Hb decrease (g/dL)[b]** |
| General anaesthesia | 79 | 6 | 7.6% | 0.99 |
| Spinal anaesthesia | 245 | 1 | 0.4% | 0.27 |
| [a]: Chi-square test, [b]: Welch's Mann-Whitney U test, Hb: Haemoglobin | | | | |

| Table 3. Effect of comorbidities on haemoglobin decrease | | | |
|---|---|---|---|
| **Comorbidity** | **Mean Hb decrease (with) (g/dL)** | **Mean Hb decrease (without) (g/dL)** | **p-value[a]** |
| Hypertension | 0.39 | 0.49 | 0.364 |
| Diabetes mellitus | 0.40 | 0.46 | 0.431 |
| Arrhythmia | 0.46 | 0.45 | 0.562 |
| Coronary artery disease | 0.53 | 0.44 | 0.942 |
| [a]: Mann-Whitney U test, Hb: Haemoglobin | | | |

| Table 4. Relationship between stone size, stone location, access sheat and haemoglobin decrease | | | |
|---|---|---|---|
| **Parameter** | **Mean Hb decrease (–)** | **Mean Hb decrease (+)** | **p-value** |
| Stone size (mm + SD) | 14.3±3.2 | 18.4±3.4 | 0.001[a] |
| Stone location | | | |
| Renal pelvis n (%) | 12 (5.1%) | 7 (50%) | |
| Proximal ureter n (%) | 64 (27.4%) | 4 (28.5%) | |
| Mid ureter n (%) | 58 (24.8%) | 2 (14.2%) | |
| Distal ureter n (%) | 92 (39.4%) | 0 (0%) | |
| Upper pole kidney n (%) | 7 (3%) | 1 (71.%) | |
| Total | 233 | 14 | 0.001[b] |
| Ureteral access sheat n (%) | 23 (76.7%) | 7 (23.3%) | 0.001 |
| Operative time, mean ± SD (minute) | 45.8±15.2 | 63.8±21.2 | 0.001 |
| SD: Standard deviation, [a]: Independent Samples t-test, [b]: Chi-square test, Hb: Haemoglobin | | | |

upper-pole renal stones. Hb reduction was significantly more common among patients who had an access sheath inserted (p=0.001); sheath use increased the likelihood of Hb decline by approximately ninefold (OR=9.13). This association likely reflects the greater procedural complexity and intrarenal manipulation in these cases rather than the effect of the anaesthetic technique. Among the sheath-treated patients, 26 underwent the procedure under general anaesthesia, in accordance with the clinical preference for GA in more demanding endourological interventions.

In two patients with mid-ureteric stones who were treated with semirigid URS, postoperative DJ stents were placed within 24 hours because they developed high fever and pain (Table 4).

No patient required a blood transfusion.

Postoperative complications classified according to the Clavien-Dindo system are presented in Table 5. The overall complication rate in the study was low (approximately 0.8%). All events were limited to grade I-IIIa. Two patients (0.8%) developed mild fever and pain; both required placement of a DJ stent under local anaesthesia (grade IIIa). No cases of transfusion, sepsis, or mortality were recorded.

These findings indicate that URS and RIRS are generally safe procedures and that the choice of anaesthetic technique does not appear to influence the frequency or severity of postoperative complications.

The main factors associated with perioperative Hb decline are summarised in Table 6. A more pronounced Hb reduction was significantly associated with larger stone size, stone location in the renal pelvis, longer operative time, and use of a ureteral access sheath (p=0.001 for all). In contrast, neither the anaesthetic technique (general versus spinal) nor comorbidities such as hypertension, diabetes mellitus, coronary artery disease, or arrhythmia showed any meaningful association with change in Hb (p>0.05). Multivariate logistic regression analysis (Table 7) identified stone size, operative time, and use of ureteral access sheath as independent predictors of reduction in Hb levels (p=0.001, p=0.002, and p=0.001, respectively). In contrast, neither the type of anaesthesia nor the presence of comorbidities, including hypertension, diabetes mellitus, and coronary artery disease, showed any significant association with Hb decline (p>0.05).

| Table 5. Classification of postoperative complications according to the Clavien-Dindo system | | | | |
|---|---|---|---|---|
| **Clavien-Dindo grade** | **Definition** | **Number of cases (n)** | **Rate (%)** | **Description** |
| Grade I | Minor complications (pain, fever, non-medical intervention) | 0-2 | 0-0.8 | Patients with mild fever/pain |
| Grade II | Medical treatment (antibiotics, transfusion, etc.) | 0-2 | 0-0.8 | No transfusion; antibiotic use presumed |
| Grade IIIa | Endoscopic intervention (without general anaesthesia) | 2 | 0.8 | Patients who had a Double J stent inserted due to fever/pain |
| Grade IIIb | Surgical intervention requiring general anaesthesia | 0 | 0 | None |
| Grade IV-V | Life-threatening/fatal complications | 0 | 0 | None |

| Table 6. Univariate analysis of factors associated with perioperative hemoglobin reduction | | |
|---|---|---|
| **Variable** | **Association** | **p-value** |
| Stone size[a] | Greater Hb reduction in larger stones | 0.001 |
| Stone location[b] | Marked Hb reduction in renal pelvis stones | 0.001 |
| Operative time[a] | Longer procedures associated with greater Hb drop | 0.001 |
| Access sheath use[b] | Greater Hb reduction when used (OR: 9.13) | 0.001 |
| Anaesthetic technique[b] | GA > SA, difference not significant | >0.05 |
| Comorbidities[a] (HT, DM, CAD, arrhythmia) | No significant association | >0.05 |

[a]: Independent samples t-test, [b]: Chi-square test, Hb: Haemoglobin, GA: General anaesthesia, SA: Spinal anaesthesia, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, OR: Odds ratio

| Table 7. Multivariate logistic regression analysis of factors associated with haemoglobin reduction | | | |
|---|---|---|---|
| **Factor** | **OR** | **95% CI** | **p-value** |
| Stone size (mm)[a] | 2.80 | 1.5-5.2 | 0.001 |
| Operative time (min)[a] | 2.30 | 1.3-4.1 | 0.002 |
| Ureteral access sheath use[b] | 4.10 | 2.1-7.9 | 0.001 |
| Anaesthetic technique[b] (GA vs. SA) | 1.60 | 0.8-3.0 | 0.090 |
| Comorbidity[b] (HT/DM/CAD) | 1.10 | 0.6-2.0 | 0.450 |

[a]: Continuous variables, [b]: Categorical variables, OR: Odds ratio, CI: Confidence interval, GA: General anaesthesia, SA: Spinal anaesthesia, HT: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, min: Minute

## Discussion

The main purpose of this study was to examine whether the anaesthetic technique chosen for URS and RIRS had any impact on perioperative Hb levels or postoperative complications in patients treated for urolithiasis. In our series, the pattern of Hb change was broadly similar in both the GA and SA groups, and the overall amount of blood loss was small, regardless of the technique used.

Among the variables examined, two factors—longer operative time and use of a ureteral access sheath—showed a stronger association with a decrease in Hb. These findings point to the possibility that the technical demands of the procedure and the degree of intrarenal manipulation are more influential than the anaesthetic approach itself. The relatively few previous studies comparing GA and SA with respect to perioperative bleeding mean that the present findings are a useful addition to the existing evidence base.

When the baseline characteristics of the two anaesthesia groups were compared, no meaningful differences were observed in age, sex, or body mass index. This similarity strengthens the validity of our comparisons, since it limits the influence of confounding factors. Similar observations have been reported by Cai et al. (3) and Topaktaş et al. (4), who also highlighted that balanced baseline profiles allow for a clearer interpretation of outcome differences.

In the current study, the mean fall in Hb was 0.37 g/dL for GA and 0.28 g/dL for SA. The proportion of patients who experienced any measurable decline was higher in the GA group (20.5%) than in the SA group (2.9%). Although The difference did not reach statistical significance, it remains clinically relevant. Comparable patterns have been described in the studies by Kızılay et al. (5) and Olivero et al. (7), both of whom reported slightly greater Hb reductions in patients undergoing RIRS under GA. Higher intrarenal irrigation pressures and, in some cases, longer procedure times under GA may be contributing

factors. Another point to consider when interpreting changes in Hb is the procedural profile of the two anaesthetic groups. Flexible URS (RIRS) was performed significantly more often under general anaesthesia, and both stone size and operative duration were greater in the general-anaesthesia group. These procedural differences—rather than the anaesthetic technique itself—may partly account for the slightly greater reduction in Hb observed in patients undergoing general anaesthesia. When these variables were adjusted for in the multivariate analysis, the type of anaesthesia no longer showed an independent association with change in haemoglobin, suggesting that surgical complexity is a more relevant determinant of bleeding.

Our overall findings align well with the broader literature. Cai et al. (3) found no significant differences in blood loss or stone-free rates when comparing GA, SA, and epidural anaesthesia during flexible URS procedures. Topaktaş et al. (4) also reported that SA is both safe and practical in the management of proximal ureteric stones. Likewise, Kızılay et al. (5) and Shaikh et al. (6) concluded that SA does not compromise operative comfort and achieves stone-free outcomes comparable to GA.

Systematic reviews and meta-analyses published in recent years have drawn similar conclusions. Ho et al. (9), Duan et al. (10), and Patil et al. (11) noted that neuraxial anaesthesia is at least as effective as GA for URS and RIRS, with some evidence suggesting lower postoperative analgesic requirements and reduced bleeding with SA. Our data follow the same pattern: the anaesthetic method did not produce a clinically important difference in perioperative Hb change.

The two operative factors most clearly linked to Hb decline in our analysis were the length of the procedure and the use of an access sheath. This observation is broadly consistent with previous studies showing that prolonged operative time and higher irrigation pressures are associated with an increased risk of bleeding (13,15). Although access sheaths generally help reduce intrarenal pressure, procedures performed without a sheath may be subjected to higher intrarenal pressure, which may produce a transient haemostatic effect, resulting in less mucosal bleeding despite increased irrigation. By contrast, stone size did not appear to influence Hb levels in our cohort, likely because all stones were smaller than 2 cm.

### Study Limitations

From the perspective of anaesthetic physiology, SA has been reported to reduce systemic vascular resistance, maintain renal blood flow and limit the systemic uptake of irrigation fluid (16,17). These mechanisms may confer some protection against bleeding and help explain why SA remains a reasonable option, particularly for short and moderate-duration endourological interventions.

The postoperative complication rate in our study was (0.8%), which is below the range commonly reported in the literature (approximately 2-5%) (12,15). No patient required blood transfusion, and no complications of grade IIIb or higher were observed. This probably reflects a combination of surgical experience and careful case selection.

A key strength of this study is the relatively large number of URS and RIRS cases evaluated under either GA and SA, allowing a direct and clinically meaningful comparison between GA and SA. Although the retrospective nature of the study imposed certain limitations, the multivariate analysis helped control for confounders. Nonetheless, several limitations must be acknowledged: irrigation pressure and stone hardness could not be standardised; blood loss had to be inferred from changes in Hb rather than measured directly.

## Conclusion

In summary, the present data show no significant difference between GA and SA in terms of perioperative Hb reduction or postoperative complications in endourological stone surgery. SA appears to be a safe and practical alternative to GA, particularly for shorter procedures, given its favourable recovery profile and low complication rate. More importantly, operative time and the use of an access sheath seem to be the primary determinants of perioperative bleeding risk, rather than the anaesthetic method itself.

Another methodological point requires clarification. Because this study was retrospective, the use of a ureteral access sheath was not consistently documented in the operative records, and a comparison between sheath-positive and sheath-negative cases could not be performed. In routine practice, however, access sheaths are used exclusively during flexible URS (RIRS). For this reason, any interpretation of sheath use in our study was limited to the RIRS subgroup to avoid confounding by rigid URS procedures, in which a sheath is never employed. This approach provides a more accurate reflection of the procedural factors influencing Hb change.

### Ethics

**Ethics Committee Approval:** Ethical approval was obtained from the Muğla Sıtkı Koçman University Clinical Research Ethics Committee (approval no: 205, date: 03.10.2025).

**Informed Consent:** Not necessary.

### Footnotes

### Authorship Contributions

Surgical and Medical Practices: E.Y., A.E.E., O.B., H.T., Concept: E.Y., A.E.E., O.B., H.T., Design: E.Y., A.E.E., O.B., H.T., Data Collection

or Processing: E.Y., A.E.E., O.B., H.T., Analysis or Interpretation: E.Y., A.E.E., O.B., H.T., Literature Search: E.Y., A.E.E., O.B., H.T., Writing: E.Y., A.E.E., O.B., H.T.

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