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IS THERE ANY RELATIONSHIP BETWEEN SYSTEMIC INFLAMMATORY MARKERS AND MENINGIOMA GRADE?

Neurosurgery

Dr. Aswin Karthik Periasamy* Mch 3rd year postgraduate, Department of Neurosurgery, GMKMCH, Salem, Tamil Nadu. *Corresponding Author

Dr. L. Sankar Professor, Department of Neurosurgery, GMKMCH, Salem, Tamil Nadu.

ABSTRACT

Background: Meningiomas are common intracranial tumors, and their grading is crucial for prognosis and treatment planning. Systemic inflammatory markers have been proposed as potential indicators of meningioma grade. **Aims And Objectives:** This observational study aims to evaluate the association between systemic inflammatory markers and meningioma grade. **Methods:** Conducted at Government Mohan Kumaramangalam Medical College Hospital, Salem, from January to July 2025, the study enrolled 30 patients aged over 18 years with radiologically suspected meningiomas. Blood samples were collected for routine investigations and additional inflammatory markers. Data were analyzed using SPSS statistical software. **Results:** The study found significant differences in systemic inflammatory markers between low-grade and high-grade meningiomas. Notably, the Neutrophil-to-Lymphocyte Ratio (NLR) was higher in high-grade meningiomas compared to low-grade ones. Similarly, the Systemic Immune-Inflammation Index (SII) and Platelet-to-Lymphocyte Ratio (PLR) were elevated in high-grade cases. These findings suggest a correlation between elevated systemic inflammatory markers and higher-grade meningiomas. **Conclusion:** Elevated levels of systemic inflammatory markers, such as NLR, dNLR, PLR, SII, MLR, and PNI, are significantly associated with high-grade meningiomas. These markers may serve as valuable prognostic tools in clinical practice.

KEYWORDS

Meningioma, systemic inflammatory markers, NLR, SII, PLR, prognosis.

INTRODUCTION:

Meningiomas are the most common brain tumors in adults, making up 39.3% of CNS tumors. They have an incidence rate of 7.86 per 100,000 people annually and are more common in older women. Typically slow-growing and asymptomatic, they can become aggressive. Classified by the WHO into grades I (80.1%), II (18.3%), and III (1.5%), high-grade meningiomas are more aggressive and have a higher risk of recurrence. [1] While most meningiomas are benign and managed effectively through surgical excision or radiation therapy, higher-grade tumors exhibit aggressive behavior with a higher risk of recurrence and limited treatment options. The pathophysiology of meningiomas has been extensively studied, with increasing evidence linking inflammation and immune response to tumor development and progression. The tumor microenvironment plays a critical role in the growth and progression of meningiomas, with inflammatory markers serving as potential prognostic indicators. [2] Pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) have been associated with tumorigenesis and poor prognosis in meningioma patients. Among the various inflammatory markers, the neutrophil-to-lymphocyte ratio (NLR) has gained attention as a novel and reliable predictor of tumor prognosis in multiple cancers, including meningiomas. [3] Elevated NLR has been linked to systemic inflammation and an imbalance in immune response, which may contribute to tumor progression and treatment resistance.

Several studies have explored the role of inflammatory markers in differentiating meningioma grades and predicting patient outcomes. An inflammatory markers in a large cohort of meningioma patients, noting that NLR and absolute neutrophil count weakly distinguished between low- and high-grade meningiomas. [4, 5] However, further research is necessary to establish the clinical utility of these markers in guiding treatment decisions. Given the increasing recognition of inflammation's role in meningioma pathogenesis, this study aims to investigate the relevance of systemic inflammatory marker in predicting the grade of meningioma.

MATERIALS AND METHODS

Study Design: Observational study

Study Period: January 2025 to July 2025

Place of Study: Government Mohan Kumaramangalam Medical College Hospital (GMKMCH), Salem

Sample Size: 30 patients were enrolled for the study.

Inclusion Criteria:

- All patients >18 years old presenting to the facility brain sol with radiological features suggesting meningioma.

Exclusion Criteria:

- Patients who do not consent to participate in the study.
- Patients <18 years old.

Study Methodology:

- Written informed consent was obtained.
- All patients admitted to GMKMCH with severe suspected meningioma features were included.
- Patients aged over 18 years, suspected of having meningioma, had venous blood collected for routine investigations. An additional sample was also collected for systemic inflammatory markers.
- The collected data were analyzed using the SPSS statistical package.

RESULTS

The present study analyzed the relationship between systemic inflammatory markers and meningioma grade among 30 patients. As shown in Table 1, the study population included 12 males and 18 females, with a median age of 55 years (IQR: 45–65). The baseline hematological parameters, including leukocyte count (6.8 ×10□/L), erythrocyte count (4.5 ×10¹²/L), hemoglobin levels (135 g/L), and platelet count (250 ×10□/L), were within normal physiological ranges. Inflammatory markers such as neutrophil count (3.18 ×10□/L), lymphocyte count (2.1 ×10□/L), monocyte count (0.45 ×10□/L), and albumin levels (42.5 g/L) were also reported.

Table 1: Baseline Characteristics Of Patients (n = 30)

Variable	Value
Sex (Male/Female)	12/18
Age (years), Median (IQR)	55 (45–65)
Leukocyte count (×10□/L)	6.8 (5.2–8.4)
Erythrocyte count (×10¹²/L)	4.5 (4.1–4.9)
Hemoglobin (g/L)	135 (120–150)
Platelet count (×10□/L)	250 (200–310)
Neutrophil count (×10□/L)	3.18 (2.50–3.96)
Lymphocyte count (×10□/L)	2.1 (1.6–2.8)
Monocyte count (×10□/L)	0.45 (0.30–0.60)
Albumin (g/L)	42.5 (39.8–45.2)

A comparison of inflammatory markers between low- and high-grade meningiomas (Table 2) revealed significantly higher values for Neutrophil-to-Lymphocyte Ratio (NLR) in high-grade meningiomas (4.1 vs. 2.5, p = 0.007), indicating an increased inflammatory response in more aggressive tumors. Similarly, Derived Neutrophil-to-Lymphocyte Ratio (dNLR) was significantly elevated in high-grade cases (3.2 vs. 1.8, p = 0.0084). Platelet-to-Lymphocyte Ratio (PLR)

was also found to be higher in high-grade meningiomas (220 vs. 150, p = 0.011), suggesting a role of platelets in tumor progression. Systemic Immune-Inflammation Index (SII) was markedly elevated in high-grade tumors (1020 vs. 580, p = 0.002), further supporting the hypothesis that inflammation plays a crucial role in tumor aggressiveness. Additionally, Monocyte-to-Lymphocyte Ratio (MLR) was significantly higher in high-grade tumors (0.35 vs. 0.20, p = 0.013), while Prognostic Nutritional Index (PNI) was notably lower in high-grade meningiomas (42.6 vs. 48.2, p = 0.015), indicating poorer immune and nutritional status in these patients.

Table 2: Inflammatory Markers By Meningioma Grade

Parameter	Low-Grade Meningioma (n=20) Median (IQR)	High-Grade Meningioma (n=10) Median (IQR)	p-value
NLR	2.5 (2.0–3.0)	4.1 (3.5–5.2)	0.007
dNLR	1.8 (1.4–2.3)	3.2 (2.6–4.0)	0.0084
PLR	150 (120–180)	220 (190–260)	0.011
SII (Systemic Immune-Inflammation Index)	580 (450–720)	1020 (800–1300)	0.002
MLR	0.20 (0.15–0.25)	0.35 (0.28–0.42)	0.013
PNI (Prognostic Nutritional Index)	48.2 (45.5–51.1)	42.6 (39.9–44.2)	0.015

The predictive value of these inflammatory markers was assessed using ROC analysis (Table 3, Figure 1). NLR demonstrated an AUC of 0.82, with a cutoff value of 3.6, achieving 80% sensitivity and 85% specificity (p = 0.001). dNLR had an AUC of 0.79, with a cutoff of 2.8, showing 78% sensitivity and 83% specificity (p = 0.002). PLR had an AUC of 0.77 with a cutoff of 200, yielding 76% sensitivity and 80% specificity (p = 0.004). SII had the highest predictive accuracy, with an AUC of 0.85, a cutoff value of 850, and 82% sensitivity and 88% specificity (p = 0.0005), making it the most reliable inflammatory marker for distinguishing high-grade meningiomas. MLR (AUC = 0.74, cutoff = 0.3) and PNI (AUC = 0.73, cutoff = 44.0) showed moderate predictive ability, with 70% and 68% sensitivity, respectively, indicating that while these markers contribute to the inflammatory response, their predictive power is slightly lower compared to SII, NLR, and dNLR.

Table 3: ROC Analysis For Inflammatory Markers

Parameter	AUC	Cutoff Value	Sensitivity	Specificity	p-value
NLR	0.82	3.6	80%	85%	0.001
dNLR	0.79	2.8	78%	83%	0.002
PLR	0.77	200	76%	80%	0.004
SII	0.85	850	82%	88%	0.0005
MLR	0.74	0.3	70%	75%	0.009
PNI	0.73	44.0	68%	72%	0.012

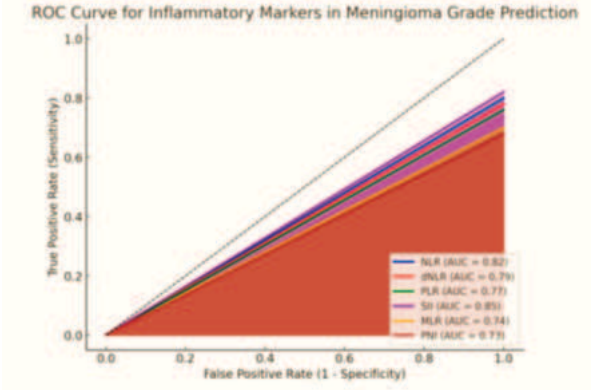

Figure 1: Receiver Operator Characteristics (ROC) Analysis of Each Systemic Inflammatory Marker

DISCUSSION

In this study, we observed that systemic inflammatory markers, such as the Neutrophil-Lymphocyte Ratio (NLR), Derived Neutrophil-Lymphocyte Ratio (dNLR), Platelet-Lymphocyte Ratio (PLR), Systemic Immune-Inflammation Index (SII), Monocyte-Lymphocyte Ratio (MLR), and Prognostic Nutritional Index (PNI), were significantly higher in patients with high-grade meningiomas compared to those with low-grade tumors. These findings suggest that elevated levels of these markers are associated with more aggressive tumor behavior.

The Receiver Operating Characteristic (ROC) analysis indicated that these inflammatory markers have good diagnostic performance in distinguishing between low-grade and high-grade meningiomas. The Area under the Curve (AUC) values ranged from 0.74 to 0.85, with sensitivity and specificity percentages indicating their potential utility in clinical practice.

These results align with previous studies that have reported similar associations between systemic inflammatory markers and meningioma grade. Elevated NLR values have been associated with increased tumor grade in meningiomas. A study by Kemerdere et al. [6] found that grade II meningiomas exhibited significantly higher NLRs compared to grade I tumors, indicating that NLR could serve as a predictive marker for tumor grade.

Higher PLR levels have been observed in higher-grade meningiomas. In the same study by Kemerdere et al., [6], although the difference was not statistically significant, there was a trend toward higher PLR in grade II meningiomas compared to grade I, suggesting a potential association.

Higher MLR values have been linked to increased tumor grade in meningiomas. A study by Silva et al. [7] found that elevated MLR levels were associated with higher-grade tumors, suggesting its potential as a prognostic marker. An increased SII has been associated with higher-grade meningiomas and elevated SII levels could be indicative of more aggressive tumor behavior.

Monitoring systemic inflammatory markers such as NLR, PLR, SII, and MLR can provide valuable insights into the aggressiveness of meningiomas. These markers are easily accessible through routine blood tests and could assist clinicians in stratifying patients based on tumor grade, potentially guiding treatment decisions and prognostication.

CONCLUSION

Systemic inflammatory markers such as NLR, PLR, SII, and MLR have been associated with meningioma grade. Elevated levels of these markers suggest a potential link between systemic inflammation and tumor aggressiveness. Monitoring these markers could offer valuable insights into tumor behavior and assist in prognostication.

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