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Assessment of C-Reactive Protein to Albumin Ratio as Prognostic Marker in Bell's Palsy

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Abstract

Bell's palsy is an acute facial nerve paralysis with uncertain prognosis and no early diagnostic methods. The House-Brackmann system assesses severity but lacks prognostic value. This study explores the CRP-to-albumin ratio (CAR) as a potential prognostic biomarker, which could aid early intervention with targeted therapies like corticosteroids or antivirals. 63 study subjects with ages ranging from 18-60 years with untreated Bell's palsy (Grade 3 or more) presenting within five days of symptom onset were included in this prospective observational study. Informed consent was obtained, and their clinical histories were recorded. A general examination, including facial nerve assessment, was performed. CRP and Albumin levels were measured, and the data was analyzed using SPSS version 25, with a p-value ≤ 0.05 considered statistically significant. The median age of the 63 study subjects was found to be 33 years, with a female predominance in the study subjects (57.1%, F:M ratio 1.33:1). Patients with House-Brackmann Scale (HBS) Grade III or higher were analyzed (39.7% in Grade III, 41.3% in Grade IV, and 19% in Grade V). A CAR cut-off of 0.28 was used, with 44.4% having an abnormal CAR. At the 15-day follow-up, 71.4% showed improvement, with the highest recovery among those with HBS Grade V (83.3%). Overall, Bell's Palsy resolved in 57.1% of patients, significantly higher in those with a normal CAR (94.3%) compared to abnormal CAR (10.7%, $P < 0.001$). CAR showed high diagnostic accuracy (92.6% sensitivity, 91.7% specificity, AUC: 0.949). The median CAR was significantly higher in the "Not Resolved" group (0.470 vs. 0.220, $P < 0.001$). The study concludes that CRP-Albumin Ratio is a reliable prognostic biomarker in Bell's Palsy. A normal CAR predicts recovery, while an abnormal CAR indicates a higher risk of unresolved symptoms.

Keywords: Bell's Palsy, CRP-To-Albumin Ratio, Facial Nerve, House-Brackmann Scale, Prognostic Biomarker.

Introduction

Bell's palsy is a sudden and often temporary weakness or paralysis of the muscles on one side of the face, caused by damage to the facial nerve (cranial nerve VII).[1] This condition usually affects only one side of the face, leading to a drooping of the mouth, eyelid, and sometimes the eyebrow on the affected side. In some cases, the sense of taste may be impaired, and there may be pain or discomfort around the jaw or behind the ear.[2]

As the most common form of facial nerve paralysis, it accounts for 60–75% of acute peripheral facial palsy (APFP) cases.[3] Its annual incidence ranges from 15 to 40 cases per 100,000 people, with a recurrence rate of approximately 10%.[2] In India, the incidence is estimated at 20–30 cases per 100,000, constituting nearly 70% of unilateral peripheral facial palsy cases. Although most patients experience spontaneous recovery within weeks to months, a significant proportion suffer from persistent facial dysfunction, impacting their quality of life.

The aetiology of Idiopathic facial nerve palsy is still not fully understood, although current ideas link it to either a viral infection or an inflammatory response.[4] Bell's palsy has been linked to genetic, immunological, vascular, and infectious causes.[1] Idiopathic facial nerve palsy manifests clinically as decreased function in the innervated area of the facial nerve on one side of the face, resulting in asymmetrical mouth corners, reduced forehead creases, and incomplete eyelid closure.[5] Accurate prognosis is crucial in Bell's palsy management, enabling clinicians to identify patients at higher risk of incomplete recovery and tailor treatment strategies accordingly. Currently, clinical evaluation and electrodiagnostic studies are employed to assess the severity of nerve damage and predict outcomes. However, these methods have limitations in their predictive accuracy, highlighting the need for reliable biomarkers that can enhance prognosis and guide therapeutic interventions.[6]

Inflammation plays a pivotal role in the pathogenesis of Bell's palsy, and markers of systemic inflammation have emerged as potential prognostic indicators.[7] C-reactive protein, an acute- phase reactant produced by the liver in response to inflammation, has been investigated in assessment of response to treatment of severe bloodstream infection.[8] Studies have also demonstrated elevated CRP/albumin levels in patients with Bell's palsy, suggesting a correlation with disease severity and prognosis.[7] Albumin, the most abundant protein in serum, exerts anti-inflammatory and antioxidant effects.[8] Hypoalbuminemia, or low serum albumin levels, has been associated with increased inflammation and poorer outcomes in several diseases.[9] The C-reactive protein to albumin ratio, a novel inflammatory marker, combines the pro-inflammatory effects of CRP with the anti-inflammatory properties of albumin, providing a comprehensive assessment of the inflammatory status. Emerging evidence suggests that CAR may serve as a valuable prognostic marker in various medical conditions, including cardiovascular disease, cancer, and infections.[10] However, its role in Bell's palsy remains largely unexplored. This study has the potential to identify CAR as a novel prognostic marker in Bell's palsy, providing clinicians with a valuable tool to predict patient outcomes and guide treatment decisions. If CAR proves to be a reliable predictor, it could facilitate early intervention with targeted therapies, such as corticosteroids or antiviral agents, in patients at high risk of incomplete recovery.

Hence, this study was conducted to evaluate the correlation between the C-reactive protein to albumin ratio (CAR) and the prognosis of Bell’s palsy, and to determine its prognostic performance by estimating sensitivity, specificity, positive predictive value, and negative predictive value.

Materials & Methods

A prospective observational study was conducted in the Department of Otorhinolaryngology at Deen Dayal Upadhyay Hospital, New Delhi, from April 2023 to December 2024 to evaluate the prognostic utility of the C-reactive protein-to-albumin ratio (CAR) in patients with Bell’s palsy. Sample size for the study was calculated based on study conducted in 2020 by Cayir S

et al. (3) A total of 63 patients aged 18–60 years, presenting within five days of onset of untreated unilateral facial paralysis of House–Brackmann (HBS) grade III or higher, were enrolled based on predefined inclusion and exclusion criteria. Patients with central causes of facial palsy, Ramsay Hunt syndrome, traumatic facial nerve injury, recurrent episodes, significant otologic disease, or systemic inflammatory and nutritional disorders affecting serum biomarkers were excluded. After obtaining informed consent, detailed clinical evaluation and facial nerve grading were performed at baseline. The clinical diagnosis of Bell's palsy was established based on the sudden onset of paralysis or paresis involving all muscle groups on one side of the face, in the absence of signs indicative of central nervous system disease, ear pathology, or cerebellopontine angle disorders. Serum CRP levels were analyzed using the Transasia Bio-Medicals EM 360 fully automated biochemistry analyzer through a quantitative turbidimetric method, while serum albumin levels were determined using the Beckman Coulter AU 480 automated biochemistry analyzer via a photometric method. The CAR was calculated by dividing the CRP value by the serum albumin level, with a CAR cutoff value of 0–0.28; values exceeding this threshold were considered abnormal. Patients received corticosteroid therapy at a dose of 1 mg/kg/day with a gradual tapering over two weeks. Follow up assessments were conducted on the 15th day using the HBS to evaluate treatment response. Patients were categorized into recovery (HBS Grade 1 or 2) and non-recovery groups based on their clinical outcomes after treatment. The collected data were compiled using Microsoft Excel and subsequently analyzed using SPSS software version 25. The normality of each variable was assessed using the Kolmogorov-Smirnov test. Quantitative data were presented as mean ± standard deviation or median with interquartile range, depending on the normality of the distribution. Differences between two groups were analyzed using either the Student's t- test or the Mann-Whitney U test, as appropriate. Qualitative data were expressed as percentages, and differences in proportions were evaluated using the Chi-square test or Fisher's exact test. Receiver Operating Characteristic (ROC) curve analysis was performed to evaluate the predictive utility of the C-reactive protein-to-albumin ratio for poor prognosis in patients with Bell's palsy. The cutoff value was determined, and sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated based on this cutoff. A p-value ≤ 0.05 was considered statistically significant. All patient data were handled with strict confidentiality in accordance with institutional ethical guidelines.

Results

Table 1: Baseline characteristics of study subjects

Variable	Category	Frequency (n)	Percentage (%)
Age group (in years)	≤20	10	15.9
	21-30	18	28.6
	31-40	16	25.4
	41-50	10	15.9
	51-60	9	14.3
Gender	Female	36	57.1

	Male	27	42.9
House Brackmann Stage	III	25	39.7
	IV	26	41.3
	V	12	19.0
CRP-Albumin Ratio	Normal (≤ 0.28)	35	55.6
	Abnormal (> 0.28)	28	44.4

A total of sixty-three patients with untreated Bell's Palsy were enrolled in the study. For the purpose of analysis, the patients were classified into distinct categories to assess various parameters.

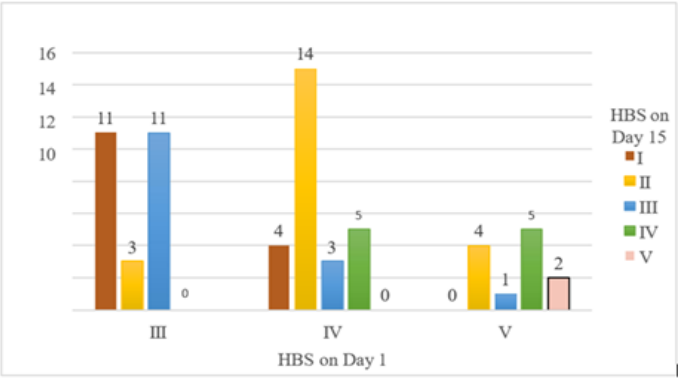
The age of the participants ranged from 18 to 59 years, with median age of 33 years. Majority of the participants were between the age group of 21- 30 years (28.6%), followed by those aged 31 to 40 years (25.4%), 41 to 50 years (15.9%), and 51 to 60 years (14.3%). Additionally, 15.9% were below the age of 20 years . Among the 63 patients enrolled in the study, 57.1% were females, while 42.9% were males, resulting in a female- to-male ratio of 1.33:1.

The study included only patients with HBS Grade III or higher. As presented in Table 1 among 63 patients, 39.7% (n=25) were classified as HBS Grade III, 41.3% (n=26) were classified as HBS Grade IV, and 19.0% (n=12) as HBS Grade V. A cut-off value of 0.28 was established, with values exceeding 0.28 considered abnormal. Based on this threshold, 44.4% (n=28) of participants exhibited an abnormal CAR, while 55.6% (n=35) had a normal CAR as shown in Table 1.

Table 2: Clinical picture on followup after 15 days

Variable	Category	Frequency (n)	Percentage (%)
House Brackmann Stage On Day 15	I	15	23.8
	II	21	33.3
	III	15	23.8
	IV	10	15.9
	V	2	3.2
Clinical outcome	Resolved	36	57.1
	Not Resolved	27	42.9

Figure 1: Comparison of HBS grades on Day 1 and Day 15



At the 15-day follow-up, 21 patients (33.3%) had HBS Grade II, while 15 patients (23.8%) were classified in both Grade I and Grade III. 10 patients (15.9%) had HBS Grade IV. Only two patients (3.2%) were in Grade V. (Table No.2)

Out of 25 patients who presented with HBS grade III on Day 1 of the study,14 (56.0 %) of them showed improvement with 11 patients in Grade I and 3 patients in Grade II on 15th day follow- up.

Similarly, out of 26 patients with HBS Grade IV on Day 1, 4 patients were in Garde I, 14 patients were in Grade II, 3 patients were in Grade III (80.8 % showed improvement) and 5 patients (19.2%) were in Grade IV on 15th follow-up day without showing any improvement. Likewise, out of 12 patients with HBS Grade V on Day 1, 4 patients were in Grade II, 1 patient was in Grade III, 5 patients were in Grade IV (83.3 % showed improvement) and 2 patients were in Grade V on 15th follow-up day (16.7 % without any improvement). (Figure No.1) Of the 63 patients enrolled in the study, Bell's palsy resolved in 57.1% (n=36) of cases, while 42.9% (n=27) of cases not resolved following treatment (Table 2).

Table 3: Association between CRP-Albumin Ratio and Clinical outcome

CRP-Albumin Ratio	Outcome		TOTAL
	Not Resolved	Resolved	
Abnormal	25 (89.3%)	3 (10.7%)	28 (44.4%)
Normal	2 (5.7%)	33 (94.3%)	35 (55.6%)
TOTAL	27 (42.9%)	36 (57.1%)	63 (100.0%)
Significance: $\chi 2 = 44.4$; $P < 0.001$.			

As shown in Table No. 3 out of 63 patients, 55.6% (n=35) had normal CAR while 44.4% (n=28) had abnormal CAR. Among 28 patients with abnormal CAR, only 10.7% (n=3) had recovery while 89.3% (n=25) had no recovery. In contrast among 35 patients with normal CAR, 94.3% (n=33) had recovery and only 5.7% (n=2) had no recovery. A significant association was observed between CAR and Outcome ($P < 0.001$).

The median CRP-Albumin Ratio was higher in the "Not Resolved" group (0.470) compared to the "Resolved" group (0.220), with a notable interquartile range (IQR) of 0.265 in the "Not Resolved" group and 0.06 in the "Resolved" group. The values in the "Not Resolved" group ranged from a minimum of 0.130 to a maximum of 0.790, while the "Resolved" group showed values between 0.130 and 0.330. The total cohort of 63 patients demonstrated a median ratio of 0.260, with an IQR of 0.215.

The comparison between the two groups, as determined by the Mann-Whitney U test, yielded a significant result (Mann-Whitney U = 49.5; $P < 0.001$), indicating that the CRP-Albumin Ratio is significantly associated with clinical resolution status.

Table 4: Measures of Predictive Accuracy of CRP-Albumin Ration for recovery from Bell's Palsy by Day 15

Decision Statistics	Estimate	95% Confidence Interval	
		Lower	Upper
Test sensitivity	92.6 %	75.7 %	99.1 %
Test specificity	91.7 %	77.5 %	98.2 %
Diagnostic accuracy	92.1 %	82.4 %	97.4 %
Positive predictive value	89.3 %	71.8 %	97.7 %
Negative predictive value	94.3 %	80.8 %	99.3 %

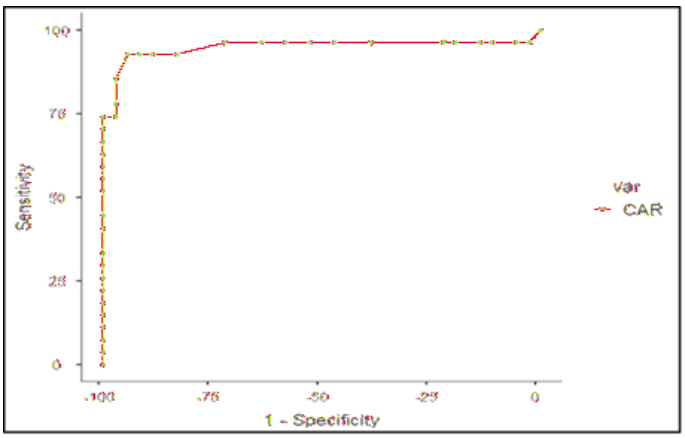


Figure 2: ROC Curve for CRP-Albumin Ratio in predicting recovery from Bell's Palsy.

In this study, the CAR demonstrated a sensitivity of 92.6% and a specificity of 91.7% in predicting recovery from Bell's Palsy. The predictive accuracy of CAR was 92.1%. Furthermore, the positive and negative predictive values of CAR were found to be 89.3% and 94.3%, respectively. These predictive values are influenced by the recovery rate observed in the Bell's Palsy patient population. The Receiver Operating Characteristic (ROC) curve was plotted to evaluate the diagnostic performance of the CRP-Albumin Ratio, with an optimal cut- off value of 0.28. The Area Under the Curve (AUC) was 0.949, indicating a high discriminative ability. (Table No. 4 & Figure No. 2)

Discussion

Bell's palsy is a common cause of acute facial paralysis with generally favorable recovery, although some patients experience incomplete resolution. This variability highlights the need for reliable prognostic markers. The C-reactive protein to albumin ratio (CAR) reflects both systemic inflammation and nutritional status, integrating the effects of elevated C-reactive protein and reduced albumin, and may serve as a useful prognostic indicator. The present study was designed to study the correlation of C- Reactive protein to albumin ratio as prognostic marker in patients with Bell's palsy.

In this study, we observed female (57.1%) dominance as compared to males (42.9%). Possible contributing factors include hormonal fluctuations, particularly during pregnancy, and the higher prevalence of certain autoimmune conditions in women. These results align with Ragaban A et al, who also reported female dominance (53.7%) when compared to males (46.3%).(11) Similarly, Alanazi WL et al also reported higher female (61%) enrolment as compared to males (39%).[12] Another study conducted by Ibekwe et al reported higher females (57.9%) than males (42.1%).[13]

The majority of our cases were in the 21–30 age group (28.6%), followed by the 31–40 age group (25.4%). The lowest frequency was observed in the 51–60 age group (14.3%), with equal representation representation in the <20 and 41–50 age groups (15.9%). This distribution suggests that Bell's palsy primarily affects individuals in the younger to middle-aged demographic, particularly those in their 20s and 30s. The predominance of cases in younger adults may be attributed to their higher exposure to certain risk factors, such as viral infections (e.g., herpes simplex virus) and stress, which are commonly implicated in the etiology of Bell's palsy. Alanazi F et al. also observed that people between the ages of 21 and 30 years were the most affected (44.4%).[14] Similarly, Lamina S et al also reported that facial palsy was more prevalent among 20–34 years age group with a percentage of (40.3%).[15] Another study conducted by Ragaban A et al reported that individuals aged 20-29 years were the most affected (24.8%).[11]

The House-Brackmann Scale (HBS) serves as a cornerstone for the clinical assessment of facial nerve dysfunction, offering a standardized and reliable method to evaluate the severity and progression of facial nerve

disorders. In the current analysis, the distribution of cases according to HBS grades highlights the predominance of moderate to severe facial nerve dysfunction. Grade IV emerged as the most frequent stage, representing 41.3% of cases, followed closely by Grade III at 39.7%, while Grade V accounted for 19.0%. This distribution underscores the clinical burden posed by intermediate to advanced stages of facial nerve dysfunction, which often require intensive therapeutic interventions and prolonged rehabilitation. The significant proportion of cases in Grades III and IV suggests a critical need for timely and targeted interventions to optimize recovery outcomes. In our study we have observed 56.0% improvement among grade III cases and 80.8% improvement among grade IV cases. Early initiation of corticosteroids, antiviral therapy (if indicated), and physical rehabilitation are particularly crucial for patients presenting with moderate dysfunction, as these measures can mitigate the progression to more severe stages. Additionally, the presence of Grade V cases, although less frequent, underscores the importance of specialized care and possible surgical interventions in cases with profound dysfunction. We have observed 83.3% improvement among Grade V cases. Gupta S et al reported that 16 (37.5%) patients were grade II, 9 (14.6%) were grade III, 11 (31.3%) were grade IV, 7 (14.6%) were grade V and 1 (2.0%) patient was grade VI at onset.(4) Another study conducted by Xu L et al reported that the number of patients from II to VI of H-B grading were 8, 32, 38, 19, and 7, respectively.(5) Similarly, Shang W et al reported that 88 (28.3%) were diagnosed as grade 4, 111 (35.7%) as grade 5, 112 (36.0%) as grade 6.[9]

Facial nerve dysfunction often results from inflammation, which can be evaluated using biomarkers such as C-reactive protein (CRP) and albumin. The CRP-albumin ratio (CAR) provides a comprehensive measure of systemic inflammation and nutritional status, which can offer valuable insights into prognosis. In our study, 44.4% of participants had an abnormal CAR, indicating heightened systemic inflammation, while 55.6% had a normal ratio, suggesting a more stable inflammatory and nutritional state. Among the unresolved cases, 89.3% had an abnormal CAR, whereas only 10.7% of those who had resolved their condition exhibited abnormal CAR values. Conversely, 94.3% of resolved cases had a normal CAR, confirming the ratio's role as a strong predictor of recovery. These findings highlight the importance of CAR as a reliable indicator of the body's inflammatory response and its association with recovery. Cayir S et al reported that extremely increased levels of CAR might be an indicator of poor prognosis in patients with Bell's palsy.[3] Another study conducted by Sevil E et al also reported that the CRP/albumin ratio was statistically significantly higher in the patient group than in the control group.[7] The CRP-albumin ratio's diagnostic accuracy in our study was high, with a sensitivity of 92.6%, specificity of 91.7%, and overall diagnostic accuracy of 92.1%. The high sensitivity ensures that most patients who will recover are correctly identified, while the high specificity ensure that those unlikely to recover are flagged accurately, enabling early intervention and tailored management. Our findings align with studies such as Cayir S et al who reported a sensitivity of 95% and specificity of 78% for the CRP-albumin ratio in predicting poor outcomes in Bell's palsy.[3] Additionally, Xu L et al found that CRP levels had a specificity of 75.0% for predicting poor facial nerve function, reinforcing the utility of the CRP-albumin ratio in assessing facial nerve recovery.[5]

Conclusion

This study underscores the significant potential of the CRP-albumin ratio (CAR) as a prognostic biomarker in

patients with Bell's palsy. Our findings demonstrate that the CRP-albumin ratio is closely associated with clinical outcomes, offering valuable insight into the inflammatory burden and nutritional status of patients. The high diagnostic accuracy of the CAR, with a sensitivity of 92.6%, specificity of 91.7%, and an overall diagnostic accuracy of 92.1%, confirms its robustness in predicting recovery in Bell's palsy cases. Specifically, a normal CAR was strongly associated with recovery, while an abnormal CAR was linked to unresolved symptoms, supporting its role as an early predictor of poor outcomes. These results align with previous studies and further validate the CRP-albumin ratio as a reliable, non-invasive tool that can aid clinicians in identifying patients at risk for poor recovery and guiding treatment decisions. Given its strong correlation with clinical outcomes, the CRP-albumin ratio has the potential to be integrated into routine clinical practice to monitor and manage Bell's palsy, ultimately improving patient care and prognosis.

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