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ASSOCIATION BETWEEN INDUCED SPUTUM EOSINOPHILS AND ASTHMA SEVERITY ASSESSED BY THE ASTHMA CONTROL TEST: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Eosinophilic airway inflammation is a key mechanism in asthma and is closely linked with inadequate disease control. The percentage of eosinophils in induced sputum is widely regarded as the reference method for assessing airway inflammation; however, its relationship with symptom-based control tools such as the Asthma Control Test (ACT) requires further clarification. Objectives: To evaluate the association between induced sputum eosinophil percentage and asthma severity as determined by ACT. Methods: This hospital-

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Pg. 125-135

DOI:

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based cross-sectional study included 100 adults with spirometry-confirmed asthma. Asthma control status was classified using ACT. Induced sputum samples were obtained using hypertonic saline and analyzed after cytospin preparation. Differences between ACT groups were examined using one-way ANOVA. Pearson's correlation coefficient assessed associations, and receiver operating characteristic (ROC) analysis determined predictive performance. Results: Mean sputum eosinophil percentage rose significantly with worsening asthma control (2.1 ± 1.0% in well-controlled vs 6.8 ± 2.7% in poorly controlled; $p < 0.001$). A strong inverse correlation was observed between sputum eosinophils and ACT score ($r = -0.68$, $p < 0.001$). ROC analysis showed good discrimination for poorly controlled asthma (AUC = 0.88) with an optimal cut-off =4.5% (sensitivity 82%, specificity 81%). Conclusion: Induced sputum eosinophilia demonstrates a strong inverse association with ACT-defined asthma control and remains a dependable marker of disease severity. Incorporating airway inflammatory assessment may improve individualized asthma management.

KEYWORDS: Asthma; sputum eosinophils; Asthma Control Test; airway inflammation; severity.

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Pg. 125-135

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ASOCIACIÓN ENTRE LOS EOSINÓFILOS DEL ESPUTO INDUCIDO Y LA GRAVEDAD DEL ASMA EVALUADA MEDIANTE LA PRUEBA DE CONTROL DEL ASMA: UN ESTUDIO TRANSVERSAL

RESUMEN

Antecedentes: La inflamación eosinofílica de las vías respiratorias es un mecanismo clave en el asma y está estrechamente relacionada con un control inadecuado de la enfermedad. El porcentaje de eosinófilos en el esputo inducido se considera ampliamente el método de referencia para evaluar la inflamación de las vías respiratorias; sin embargo, su relación con herramientas de control basadas en síntomas, como el "Asthma Control Test" (ACT), requiere mayor aclaración. Objetivos: Evaluar la asociación entre el porcentaje de eosinófilos en esputo inducido y la gravedad del asma determinada mediante el ACT. Métodos: Este estudio transversal de ámbito hospitalario incluyó a 100 adultos con asma confirmada por espirometría. El estado de control del asma se clasificó utilizando el ACT. Se obtuvieron muestras de esputo inducido mediante solución salina hipertónica y se analizaron tras su preparación mediante citocentrifugación. Las diferencias entre los grupos del ACT se examinaron mediante ANOVA de una vía. Se evaluaron las asociaciones mediante el coeficiente de correlación de Pearson y se determinó la capacidad predictiva mediante el análisis de la curva característica operativa del receptor (ROC). Resultados: El porcentaje medio de eosinófilos en esputo aumentó significativamente a medida que empeoraba el control del asma (2,1 ± 1,0 % en asma bien controlada frente a 6,8 ± 2,7 % en asma mal controlada; $p < 0,001$). Se observó una fuerte correlación inversa entre los eosinófilos en esputo y la puntuación del

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ACT (r = -0,68; p < 0,001). El análisis ROC mostró una buena capacidad de discriminación para el asma mal controlada (AUC = 0,88), con un punto de corte óptimo del 4,5 % (sensibilidad del 82 %, especificidad del 81 %). Conclusión: La eosinofilia en esputo inducido muestra una fuerte asociación inversa con el control del asma definido por el ACT y sigue siendo un marcador fiable de la gravedad de la enfermedad. La incorporación de la evaluación de la inflamación de las vías respiratorias podría mejorar el manejo individualizado del asma.

PALABRAS CLAVE: Asma; eosinófilos en esputo; Asthma Control Test; inflamación de la vía aérea; gravedad.

INTRODUCTION

Asthma is a chronic inflammatory disorder of the airways characterized by variable respiratory symptoms and fluctuating airflow limitation. Increasing attention has been directed toward inflammatory phenotyping, particularly eosinophilic asthma, which is associated with poor symptom control, increased exacerbation risk, and favorable response to corticosteroid therapy.[1–3]

Although patient-reported tools such as the Asthma Control Test (ACT) are widely used in routine practice, they primarily reflect symptom burden and may not accurately represent the underlying airway inflammatory status. Measurement of eosinophils in induced sputum provides a direct evaluation of airway inflammation and is considered the reference standard for identifying eosinophilic asthma.[3]

Volumen 16, N° 33. Julio-Diciembre 2026
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Pg. 125-135

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In many resource-limited settings, treatment decisions are largely symptom driven. Understanding how sputum eosinophilia relates to ACT-defined control may therefore assist in better risk stratification and more targeted therapeutic decisions.

Aim: To assess the association between induced sputum eosinophil percentage and asthma severity using ACT.

Materials and Methods

Study design and setting

A cross-sectional observational study was conducted at a tertiary care teaching hospital in Chennai.

Study population

A total of 100 adults aged 18–65 years with spirometry-confirmed bronchial asthma were enrolled according to standard reversibility criteria.[1] Eligible patients were recruited consecutively after obtaining written informed consent.

Asthma control assessment

Asthma control was categorized using ACT:

- Well controlled: 20–25
- Not well controlled: 16–19
- Poorly controlled: 5–15

Induced sputum analysis

Sputum induction was performed using 4.5% hypertonic saline nebulization. Samples were processed with dithiothreitol, followed by cytospin preparation and May–

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Grünwald–Giemsa staining. An eosinophil proportion ≥3% was considered indicative of eosinophilic airway inflammation.[3]

Statistical analysis

Data were analyzed using SPSS version 25. Continuous variables are presented as mean ± SD. Group comparisons were performed using one-way ANOVA. Pearson's correlation coefficient was used to examine associations. ROC analysis evaluated predictive accuracy. A p value <0.05 was considered statistically significant.

Results

Baseline characteristics

The mean age of participants was 41.3 ± 11.2 years, with females comprising 56% of the cohort. Most patients demonstrated suboptimal asthma control at presentation.

Asthma control distribution

According to ACT:

- Well controlled: 32%
- Not well controlled: 38%
- Poorly controlled: 30%

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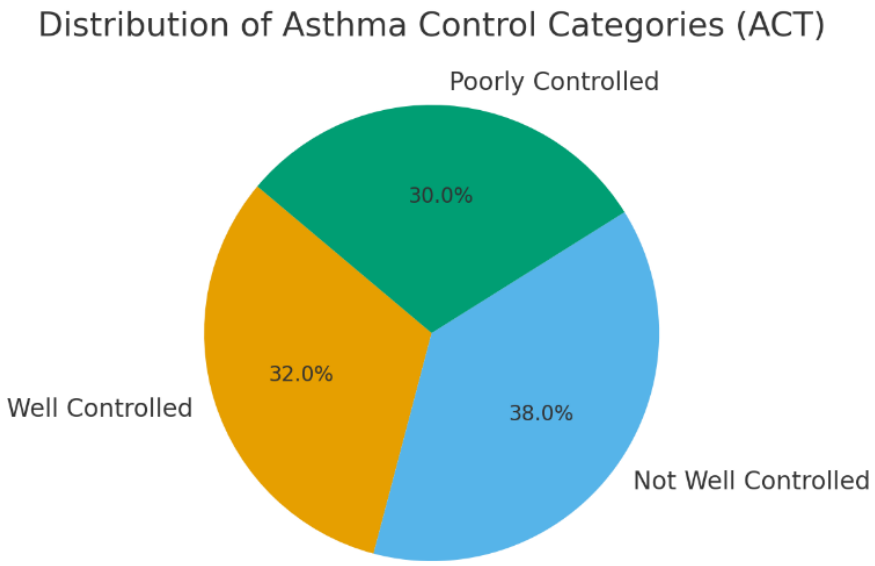

Figure 1: ACT category distribution

Primary outcome

Mean induced sputum eosinophil percentage showed a progressive increase across worsening ACT categories:

Volumen 16, N° 33. Julio-Diciembre 2026
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ACT category	Mean ± SD (%)
Well controlled	2.1 ± 1.0
Not well controlled	4.3 ± 1.9
Poorly controlled	6.8 ± 2.7

The difference was statistically significant ($F = 18.72$, $p < 0.001$).

Correlation analysis

A strong negative correlation was observed between sputum eosinophil percentage and ACT score ($r = -0.68$, $p < 0.001$), indicating poorer asthma control with increasing airway eosinophilia.[3]

ROC analysis

Induced sputum eosinophils demonstrated good predictive performance for poorly controlled asthma:

- AUC: 0.88
- Optimal cut-off: ≥4.5%
- Sensitivity: 82%
- Specificity: 81%

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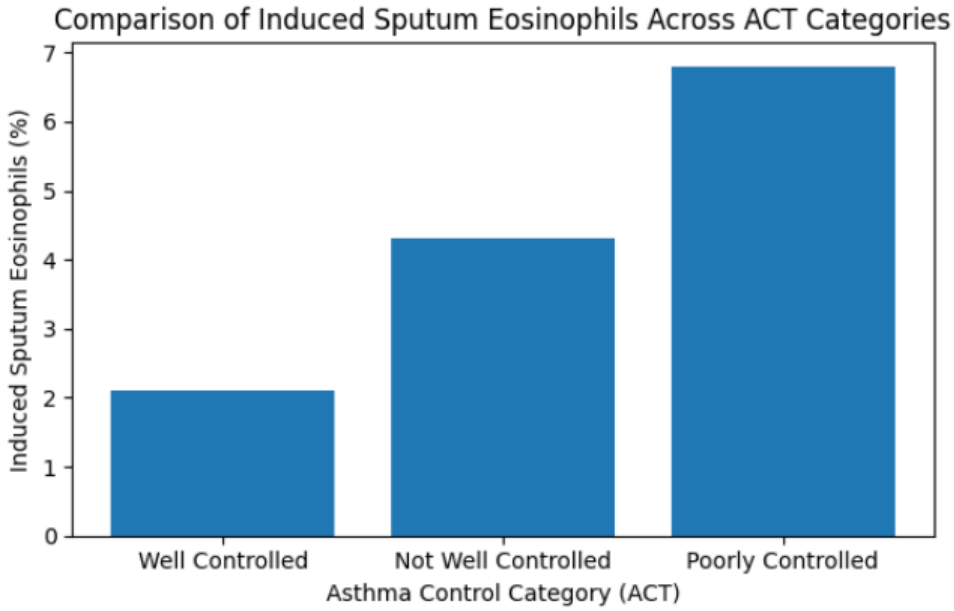

Figure 2: Comparison of sputum eosinophils across ACT groups

Discussion

The present study demonstrates a significant inverse relationship between induced sputum eosinophil percentage and ACT-defined asthma control. The graded increase in sputum eosinophils with worsening ACT categories underscores the central contribution of eosinophilic inflammation in asthma pathophysiology.[2,3]

The strong correlation observed in this study is consistent with earlier reports identifying sputum eosinophils as a reliable indicator of airway inflammation and corticosteroid responsiveness.[3]

Clinically, patients with sputum eosinophils ≥4.5% are more likely to have inadequate asthma control and may benefit from optimization of anti-inflammatory therapy.

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Pg. 125-135

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Biomarker-guided approaches have been shown to improve outcomes and reduce exacerbation risk.[4,5] Higher peripheral blood eosinophil counts have also been linked to greater asthma burden in longitudinal analyses.[6]"

Limitations

- Cross-sectional design
- Single-centre experience
- Background inhaled corticosteroid exposure not fully stratified
- Limited feasibility of sputum induction in routine practice

Conclusion

Induced sputum eosinophil percentage demonstrates a strong inverse correlation with ACT score and remains a robust biomarker of asthma severity. Incorporation of airway inflammatory assessment may facilitate more precise and individualized asthma management.

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