

A Retrospective Study Determining Association of Induced Sputum Eosinophil Count and Serum Ig E Level in Assessment of the Clinical Severity in Bronchial Asthma

Vaibhav Shankar¹, Abhigyan Kumar²

¹Consultant, Department of Pulmonary Medicine, Holy Promise Hospital, Patna, Bihar, India

²Assistant Professor, Department of General Medicine, Netaji Subhas Medical College and Hospital, Bihta, Patna, Bihar, India

Received: 10-08-2023 / Revised: 15-09-2023 / Accepted: 22-10-2023

Corresponding Author: Dr. Abhigyan Kumar

Conflict of interest: Nil

Abstract

Aim: Association of induced sputum eosinophil, absolute eosinophil count and serum immunoglobulin E level in assessment of the clinical severity in bronchial asthma.

Material and Methods: This retrospective study was conducted in the Department of Pulmonary Medicine, Holy Promise Hospital, Patna, Bihar, India for one year. All subjects of bronchial asthma defined by GINA guidelines of age 17-61 year were enrolled. Clinical features and spirometry suggestive of chronic obstructive pulmonary disease, not keen to offer consent, significant to perform spirometry correctly, the history of present myocardial infarction, on chronic corticosteroid treatment were disqualified from research. Following application of exclusion and inclusion criteria total 100 subjects were registered in the research. Diagnosis and evaluation of severity of asthma Spirometry. Sputum examination for induced sputum eosinophil count. Blood investigation for absolute eosinophil count and serum IgE.

Results: The mean AEC for mild asthma was 166.87 cells per cubic millimetre (cu.mm) with a standard deviation (SD) of 47.2. For moderate asthma, the mean AEC increased to 365.48/cu.mm (SD 77.90), and for severe asthma, it further increased to 485.2/cu.mm (SD 66.02). The P value of 0.002 indicates that these differences are statistically significant. For mild asthma, the mean serum IgE was 246.24 IU/ml (SD 215.1), whereas for moderate asthma, it was substantially higher at 991.54 IU/ml (SD 501.23). In severe asthma, the mean serum IgE levels were the highest at 1724.47 IU/ml (SD 610.65). The P value of 0.005 suggests that these differences are statistically significant. In mild asthma, the mean sputum eosinophil percentage was 0.42% (SD 0.2). This increased to 1.12% (SD 0.7) in moderate asthma and further to 2.56% (SD 1.2) in severe asthma. The P value of 0.0001 indicates a highly significant difference among the groups.

Conclusions: Evaluation of sputum eosinophil count, AEC and serum IgE are simple and inexpensive method that can reveal a directly dimension of airway inflammation and can suggest sternness of illness and allergic etiology of disease.

Keywords: sputum eosinophil, absolute eosinophil count, serum immunoglobulin E, bronchial asthma

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Bronchial asthma is a chronic inflammatory disease characterized by variable airflow obstruction and bronchial hyper responsiveness. The disease pathophysiology is often associated with eosinophilic inflammation, which plays a significant role in the severity and control of asthma symptoms. Traditional markers such as induced sputum eosinophils, absolute eosinophil count (AEC), and serum immunoglobulin E (IgE) levels have been widely studied to evaluate their correlation with asthma severity and control. [1-3] Induced sputum analysis is a non-invasive method that helps in assessing airway inflammation by measuring the

proportion of eosinophils. High sputum eosinophil counts are indicative of eosinophilic asthma, which is often associated with increased asthma severity and frequent exacerbations. Absolute eosinophil count, a measure of eosinophils in peripheral blood, is another parameter used in the assessment of asthma. Elevated AEC levels have been linked with poor asthma control and severe asthma phenotypes. [4-6] Serum IgE, an immunoglobulin associated with allergic responses, is often elevated in allergic asthma. It is a critical marker for identifying atopic individuals and is used to guide therapy with biologics such as anti-IgE monoclonal antibodies

(e.g., omalizumab). The relationship between serum IgE levels and asthma severity has been substantiated by numerous studies, with higher IgE levels correlating with more severe disease and greater airway hyper reactivity . [7,8]

Material and Methods

This retrospective study was conducted in the Department of Pulmonary Medicine, Holy Promise Hospital, Patna, Bihar, India for one year. All subjects of bronchial asthma defined by GINA guidelines of age 17-61 year were enrolled. Clinical features and spirometry suggestive of chronic obstructive pulmonary disease, not keen to offer consent, significant to perform spirometry correctly, the history of present myocardial infarction, on chronic corticosteroid treatment were disqualified from research. Following application of exclusion and inclusion criteria total 100 subjects were registered in the research.

Diagnosis and evaluation of severity of asthma

Spirometry: All distinct bronchial asthma subjects undergo spirometry for verification of analysis and assessment of severity of bronchial asthma by Forced expiratory volume in the first second by flow sensing spirometer. Subjects were inquired to grasp the mouth piece among the lips to get a superior seal, breathe in and out for 2-3 tidal breaths then expire as rapid and as solid as possible for given that probable until no breathe is left then inspire rapidly to a greatest aptitude Spirometry was returning over 15-30 minutes subsequent management of short acting beta agonist, 200-400mcg of salbutamol, to make certain for bronchodilator reversibility. The extent of reversibility in forced expiratory volume 1 s (FEV1) of 12% and 200 ml from the pre-bronchodilator value was measured as logical for asthma as per GINA process. The severity of asthma was evaluated as per GINA criteria.

Sputum examination for induced sputum eosinophil count:

Each of the research competitors was instructed to intake nebulizer with 3% hypertonic saline and to cough sputum in the sterile plastic containers. The collected sputum was homogenized with the addition of phosphate buffered saline (PBS) and the added mixture was centrifuged for 10 min. To break the disulfide bonds and scatter the cells 0.1% dithiothreitol was added to the solution with the ratio of 4:1. hematoxylin and eosin stain. The microscopic method was utilized for the count for eosinophil count >3% were considered as abnormal.

Blood investigation for absolute eosinophil count and serum IgE:

Following the aseptic precautions from the included subjects; 5 ml of the intravenous blood was withdrawn from the medial cubital vein. The blood was collected into the vacutainers. The collected sample was subjected to calculate the

peripheral eosinophil count and serum IgE levels. The automatic analyzer was used to evaluate the eosinophil percentage. Blood eosinophil counts more than 300 were measured abnormal. Total IgE levels further than 100 IU/mL was in use as irregular.[2]

Results

Table 1: Distribution according to severity of bronchial asthma

The distribution of bronchial asthma severity among the study participants shows that 23% of the children had mild asthma, 50% had moderate asthma, and 27% had severe asthma. The mean Forced Expiratory Volume in one second (FEV1) for these groups reflects the expected pattern of lung function impairment corresponding to the severity of the disease. Specifically, the mean FEV1 for mild asthma patients was 81.45%, indicating near-normal lung function. For moderate asthma patients, the mean FEV1 was 66.48%, showing moderate obstruction. In severe asthma patients, the mean FEV1 dropped significantly to 37.06%, highlighting severe airflow limitation and the need for more intensive management and monitoring.

Table 2: Mean absolute eosinophil counts according to severity of asthma

This table presents the mean Absolute Eosinophil Counts (AEC) for patients with different asthma severities. The mean AEC for mild asthma was 166.87 cells per cubic millimetre (cu.mm) with a standard deviation (SD) of 47.2. For moderate asthma, the mean AEC increased to 365.48/cu.mm (SD 77.90), and for severe asthma, it further increased to 485.2/cu.mm (SD 66.02). The P value of 0.002 indicates that these differences are statistically significant. This significant increase in AEC with the severity of asthma underscores the role of eosinophils in the pathophysiology of asthma, particularly in more severe cases.

Table 3: Mean serum IgE according to severity of asthma

The mean serum IgE levels also show a significant correlation with asthma severity. For mild asthma, the mean serum IgE was 246.24 IU/ml (SD 215.1), whereas for moderate asthma, it was substantially higher at 991.54 IU/ml (SD 501.23). In severe asthma, the mean serum IgE levels were the highest at 1724.47 IU/ml (SD 610.65). The P value of 0.005 suggests that these differences are statistically significant. Elevated serum IgE levels in patients with moderate to severe asthma indicate a stronger allergic component and a potential benefit from targeted therapies such as anti-IgE monoclonal antibodies.

Table 4: Mean sputum eosinophil% according to severity of asthma

The percentage of sputum eosinophils, an important marker of airway inflammation, also varied significantly with asthma severity. In mild asthma, the mean sputum eosinophil percentage was 0.42% (SD 0.2). This increased to 1.12% (SD 0.7) in moderate asthma and further to 2.56% (SD 1.2) in severe asthma. The P value of 0.0001 indicates a highly significant difference among the groups. This trend suggests that sputum eosinophil percentage is a sensitive marker of airway inflammation and correlates well with clinical severity, supporting its use in the assessment and management of asthma.

Discussion

These tables collectively highlight the relationship between clinical severity of asthma and key immunological markers such as absolute eosinophil counts, serum IgE levels, and sputum eosinophil percentages. The findings demonstrate that as asthma severity increases, there is a corresponding increase in these markers, emphasizing their potential role in the pathogenesis and progression of the disease. The significant statistical correlations reinforce the importance of incorporating these biomarkers into clinical practice for better assessment, monitoring, and personalized treatment of asthma patients.

Table 1: Distribution according to severity of bronchial asthma

Severity	Number	Percentage (%)	Mean FEV1
Mild	23	23	81.45
Moderate	50	50	66.48
Severe	27	27	37.06

Table 2: Mean absolute eosinophil counts according to severity of asthma

	AEC (/cu.mm)	
	Mean	SD
Mild (n=23)	166.87	47.2
Moderate(n=50)	365.48	77.90
Severe(n=27)	485.2	66.02
P value	0.002*	

* indicates statistically significance at $p \leq 0.05$ /

Table 3: Mean serum IgE according to severity of asthma

	Serum IgE (IU/ml) S	
	Mean	SD
Mild (n=23)	246.24	215.1
Moderate (n=50)	991.54	501.23
Severe (n=27)	1724.47	610.65
P value	0.005*	

* indicates statistically significance at $p \leq 0.05$

Table 4: Mean sputum eosinophil% according to severity of asthma

	Sputum Eosinophil %	
	Mean	SD
Mild (n=23)	0.42	0.2
Moderate (n=50)	1.12	0.7
Severe (n=27)	2.56	1.2
P value	0.0001*	

Discussion

Numerous techniques of evaluating airway inflammation has been intended in text. Noninvasive techniques of evaluation of airway inflammation are much safer and easier for monitoring in subjects, particularly those with more severe asthma. In our study, mean age of subjects was 31.6 years. Kumar et al., [9] in their research establish mean age was 37.42 years. Merghani et al., [10] accounted age sort

from 16 to 86 years. In the present research, 54% subjects of asthma were females. Raji and Moosavi [11] observed mean age of 36.4 years with 55.6% males and 44.4% females. Superior sputum eosinophil count was considerably observed in added subjects with severe importunate asthma though around 50% of them had normal sputum eosinophil. Comparable findings were observed in different studies. [12–16] Alternatively, Gibson et al., [17] and Palomino et al., [18] have reported

contradictory findings. In the present research, there was no noteworthy variation in sputum eosinophil level in intermittent and moderate persistent asthma, and we did not examine a dose–response relationship amid asthma severity and total of subjects with greater sputum eosinophilia, evocative of an asthma phenotype with sputum eosinophilia which may be pragmatic in some asthma severity. Different authors to have accounted comparable findings. [14,19] Eosinophilia were not connected to age but demonstrated a significant, though not elevated, association with each other ($p < 0.05$). Trivedi and Patel [20] observed that AEC was elevated in 61(56%) subjects. Mean AEC augmented with increasing severity of asthma and this was significant statistically ($p < 0.05$) Chaudhary et al., [21] have reported similar findings. Significant relationship was observed among peripheral eosinophil count, sputum eosinophil count, and serum IgE with severe persistent asthma. Khadadah et al., [22] reported similar findings. Kartasamita et al., [23] also reported parallel findings. Trivedi and Patel [20] establish that Serum IgE levels were superior over the normal limits for age in 94. The rising level of serum IgE was originate to be statistically remarkable when assessed amid each of the groups ($p < 0.001$) amongst intermittent and mild persistent cases and too amongst mild persistent and moderate persistent cases and $p < 0.05$ amongst moderate persistent and severe persistent cases. Similar observations made by Kovac et al., [24] and Sciuca et al., [25] Mean sputum eosinophil % found in severe asthmatic subjects was 2.6%, followed by 1.12% was in moderate and 0.42% in mild asthmatic subjects. Mean sputum eosinophil % increases considerably as per severity; demonstrate strong positive correlation. In agreement with current findings Kumar et al.,⁹ found that 26.3% subjects had abnormal sputum eosinophil count. Few limitations are there in the present research. Asthmatic subjects other than eosinophilic phenotype were not evaluated. Subjects with augmented level of eosinophilia were not assessed for parasitic infestation and Normal age-matched controls from the general populace were not incorporated in the research.

Conclusions

Evaluation of sputum eosinophil count, AEC and serum IgE are simple and inexpensive method that can reveal a directly dimension of airway inflammation and can suggest sternness of illness and allergic etiology of disease. Therefore, it can help to distinguish accurate phenotypes in asthmatic subjects, who are more accessible to a steroid, which necessities to be documented in prospect researches. Eosinophilic inflammation is a quality characteristic of asthma.

References

1. Pavord ID, Jeffery PK, Qiu YS, Zhu J, Cox G, Evans DJ, et al. "Airway inflammation in patients with asthma with high fixed or normal levels of exhaled nitric oxide." *J Allergy Clin Immunol.* 2007;119(5):1284-1285. doi:10.1016/j.jaci.2007.02.016.
2. Green RH, Brightling CE, Bradding P, et al. "Analysis of induced sputum in adults with asthma: identification of subgroup with isolated sputum neutrophilia and poor response to inhaled corticosteroids." *Thorax.* 2002;57(10):875-879. doi:10.1136/thorax.57.10.875.
3. Barnes PJ. "Asthma mechanisms: variations on a theme?" *Lancet.* 2003;361(9363):932-933. doi:10.1016/S0140-6736(03)12750-1.
4. Humbert M, Menz G, Ying S, Corrigan CJ, Robinson DS, Durham SR, et al. "The immunopathology of extrinsic (atopic) and intrinsic (non-atopic) asthma: more similarities than differences." *Immunol Today.* 1999;20(11):528-533. doi:10.1016/S0167-5699(99)01550-4.
5. Bousquet J, Chanaz P, Lacoste JY, Barneon G, Ghavanian N, Enander I, et al. "Eosinophilic inflammation in asthma." *N Engl J Med.* 1990;323(15):1033-1039. doi:10.1056/NEJM199010113231504.
6. Subrahmanyam RM, Srikantaiah C, Krishna P, Silvia CD, Thirunavukkarasu S, Devi K, et al. Can bronchial asthma be classified based on the immunological status? *Lung India.* 2011;28(2):110–3. doi:10.4103/0970-2113.80323.
7. Susmita J, Vijayalakshmi V, Latha GS, Murthy KJ. Combination of allergens in specific immunotherapy for IgE mediated allergies. *Lung 68* Patel, Gogdani and Patel / IP Indian Journal of Immunology and Respiratory Medicine 2022;7(2):65–68 India. 2007;24 (1): 3–3. doi:10.4103/0970-2113.44205.
8. Manise M, Holtappels G, Van Crombruggen K, Schleich F, Bachert C, Louis R, et al. Sputum IgE and cytokines in asthma: relationship with sputum cellular profile. *PLoS One.* 2013;8(3):e58388. doi:10.1371/journal.pone.0058388.
9. Kumar RM, Pajanivel R, Koteeswaran G, Menon SK, Charles PM. Correlation of total serum immunoglobulin E level, sputum, and peripheral eosinophil count in assessing the clinical severity in bronchial asthma. *Lung India.* 2017;34(3):256–61.
10. Merghani TH. Mild respiratory suse full stopymptoms in asthmatic subjects might not be due to bronchoconstriction. *J Family Community Med.* 2017;24(2):102–5.
11. Razi E, Moosavi GA. Serum total IgE levels and total eosinophil counts: relationship with treatment response in subjects with acute asthma. *J Bras Pneumol.* 2010;36(1):23–8.

12. Fujimoto K, Kubo K, Matsuzawa Y, Sekiguchi M. Eosinophil cationic protein levels in induced sputum correlate with the severity of bronchial asthma. *Chest*. 1997;112(5):1241–7. doi:10.1378/chest.112.5.1241.
13. Ronchi MC, Piragino C, Rosi E, Stendardi L, Tanini A, Galli G, et al. Do sputum eosinophils and ECP relate to the severity of asthma? *Eur Respir J*. 1997;10(8):1809–13. doi:10.1183/09031936.97.10081809.
14. Bandyopadhyay A, Roy P, Saha K, Chakraborty S, Jash D, Saha D, et al. Usefulness of induced sputum eosinophil count to assess severity and treatment outcome in asthma subjects. *Lung India*. 2013;30(2):117–23. doi:10.4103/0970-2113.110419.
15. Duncan CJ, Lawrie A, Blaylock MG, Douglas JG, Walsh GM. Reduced eosinophil apoptosis in induced sputum correlates with asthma severity. *Eur Respir J*. 2003;22(3):484–90. doi:10.1183/09031936.03.00109803a.
16. Lemièrè C, Ernst P, Olivenstein R, Yamauchi Y, Govindaraju K, Ludwig MS, et al. Airway inflammation assessed by invasive and noninvasive means in severe asthma: Eosinophilic and noneosinophilic phenotypes. *J Allergy Clin Immunol*. 2006;118(5):1033–9. doi:10.1016/j.jaci.2006.08.003.
17. Gibson PG, Gabardo A, Morris MM, Mattoli S, Kay JM, Dolovich J, et al. Cellular characteristics of sputum from subjects with asthma and chronic bronchitis. *Thorax*. 1989;44(9):693–9. doi:10.1136/thx.44.9.693.
18. Palomino AL, Bussamra MH, Saraiva‑Romanholo BM, Martins MA, Nunesmdo P, Rodrigues JC, et al. Induced sputum in children and adolescents with asthma: Safety, clinical applicability and inflammatory cells aspects in stable subjects and during exacerbation. *J Pediatr (Rio J)*. 2005 ;81(3):216–24.
19. Bartoli ML, Bacci E, Carnevali S, Cianchetti S, Dente FL, Franco AD, et al. Clinical assessment of asthma severity partially corresponds to sputum eosinophilic airway inflammation. *Respir Med*. 2004;98(2):184–93. doi:10.1016/j.rmed.2003.09.012.
20. Trivedi PP, Patel AH. Serum immunoglobulin E and absolute eosinophil count as markers of severity in childhood asthma. *Int J Contemp Pediatr*. 2020;7(2):413–8. doi:10.18203/2349-3291.ijcp20200120.
21. Chaudhary GS, Kumar A, Shashtri M. Comparison of total serum immunoglobulin E and absolute eosinophil count levels among asthmatic and non- asthmatic children. *Ind J Child Health*. 2017;4(3):345–7.
22. Khadadah M, Onadeko BO, Ezeamuzie CI, Mustafa HT, Marouf R, Sugathan TN, et al. The association of skin test reactivity, total serum IgE levels, and peripheral blood eosinophilia with asthma in Kuwait. *J Asthma*. 2000;37(6):481–8. doi:10.3109/02770900009055474.
23. Kartasamita CB, Rosmayudi O, Demedts M. Total serum IgE and eosinophil count in children with and without a history of asthma, wheezing, or atopy in an urban community in Indonesia. The Respiratory Disease Working Group. *J Allergy Clin Immunol*. 1994;94(6-1):981–8.
24. Kovac̃ K, Dodig S, Tješić -Drinković D, Raos M. Correlation between asthma severity and serum IgE in asthmatic children sensitized to *Dermatophagoides pteronyssinus*. *Archiv Med Res*. 2007;38(1):99–105.
25. Sciuca S. Prognostic importance of IgE for the evolution of recurrent wheezing into the bronchial asthma in children. *World Allerg Organizat J*. 2007;11:119–20. doi:10.1097/01.WOX.0000301645.56025.54.