ORIGINAL ARTICLE

Comparison of the basophil activation test versus the nasal provocation test in establishing eligibility for specific immunotherapy

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KEY WORDS

basophil reactivity, nasal provocation test, stimulation index

ABSTRACT

INTRODUCTION Allergic rhinitis (AR) is the most common atopic disease. Specific immunotherapy (SIT) is the only effective treatment method for AR. In uncertain diagnostic cases, before establishing eligibility for SIT, nasal provocation tests (NPTs) should be performed. However, there are numerous contraindications to performing NPTs, and there is ongoing search for an alternative in vitro method.

OBJECTIVES The aim of the study was to determine whether a specific in vitro provocation, that is, the basophil activation test (BAT), may replace a specific in vivo provocation, that is, the NPT, in establishing patient's eligibility for SIT.

PATIENTS AND METHODS The study included 30 patients with AR caused by allergy to house dust mite or birch pollen, referred for SIT. The assessment of basophil activation by measuring CD63 antigen expression was performed using the Flow2 CAST test. Basophils were stimulated with allergen preparation (concentrations of 5000, 500, and 50 standardized biological units) used in NPTs. BAT results were expressed as stimulation index (SI) and basophil reactivity (BR).

RESULTS Allergen concentrations of 500 and 50 SBU proved to be appropriate for basophil stimulation. Median SI and BR were higher for positive NPT results than for negative NPT results ($P < 0.001$). Sensitivity for SI and BR was in the range from 83% to 100%; specificity, from 78% to 89%; positive predictive value, from 75% to 87%; and negative predictive value, from 89% to 100%. We observed a high correlation of the analyzed parameters for the allergen concentrations of 500 and 50 SBU (range, 0.58–0.74; $P < 0.05$).

CONCLUSIONS If there are contraindications to performing the NPT, BAT may be regarded as an alternative in establishing patients' eligibility for SIT. The optimal concentrations of allergen preparations are 500 and 50 SBU. Both SI and BR are good indicators of basophil activation.

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INTRODUCTION Allergic rhinitis (AR) is the most frequent atopic disease. According to different authors, it affects from 10% to 40% of the global population. The ECAP (Epidemiology of Allergic Diseases in Poland) study[1] conducted in the years 2006–2008 demonstrated that AR affects 25% of the Polish population. AR significantly decreases the quality of patients' life, and, if untreated, may lead to complications such as sinusitis or asthma. Specific immunotherapy (SIT) is the only causative and therefore effective method of AR treatment.[2]

The most important components of diagnostic workup in patients with AR include a properly conducted interview, physical examination, skin prick tests (SPTs), and the measurement of specific immunoglobulin E (sIgE) concentrations. Positive results of the above tests indicate an allergy, but they do not confirm clinically significant hypersensitivity, that is, an allergic disease. In uncertain diagnostic cases, where there is no correlation of clinical symptoms with SPT results or sIgE concentrations (or both), particularly prior

to establishing eligibility for SIT, nasal provocation tests (NPTs) must be performed.[2] German guidelines emphasize the value of NPTs in proving the clinical relevance of house dust mite allergy before referral for SIT.[3]

Specific NPT consists of eliciting a response from the nasal mucosa by controlled exposure to allergens.[4,5] Absolute contraindications to performing an NPT are a history of an anaphylactic shock, allergic disease exacerbation, diseases of the lower airways with advanced restrictive or obstructive disorders, severe forms of systemic diseases, advanced ischemic heart disease, pregnancy, acute bacterial or viral infection of the upper or lower airways, use of β-adrenolytics and angiotensin-converting enzyme inhibitors, lack of access to basic medications and medical equipment for treatment of an anaphylactic shock, and age under 3 years. The patient must discontinue treatment with systemic or intranasal glucocorticosteroids (or both) 4 weeks prior to the NPT, and with oral second-generation antihistamines—1 to 2 weeks prior to the NPT.[4] Therefore, there is a search for diagnostic tests that could be used instead of NPTs, especially in patients with contraindications to perform NPTs, while maintaining reliability and repeatability of results.

The use of in vitro tests is a safe alternative to NPTs. The basophil activation test (BAT) is a test during which basophil activation after stimulation with an allergen with the use of various cell membrane markers, such as CD63 or CD203c,[6] is monitored using flow cytometry. Currently, various parameters are used in BAT assessment, including the stimulation index (SI)[7] and basophil reactivity (BR).[8]

The aim of our research was to assess whether a specific in vitro provocation test (ie, BAT with house dust mite [HDM, *Dermatophagoides pteronyssinus*] or birch pollen allergens) may replace a specific in vivo provocation test (ie, NPT) in establishing patients' eligibility for SIT.

PATIENTS AND METHODS

Patients The study included 30 adult subjects (18 women, 12 men) with AR due to allergy to HDM or birch pollen, diagnosed on the basis of clinical symptoms, SPT results, or the measurement of sIgE levels prior to being referred for SIT. The exclusion criteria were an SIT in the interview and the presence of contraindications to undergo an NPT.[4] All patients had an NPT and BAT done with both allergens, and the results were compared in all 30 patients. Participants were later divided into 2 groups. Group 1 included patients with a positive result of a birch-allergen SPT and a negative result of an HDM-allergen SPT. Group 2 included patients with a positive result of an HDM-allergen and a negative result of a birch-allergen SPT. Group 2 constituted a control group for group 1 and vice versa. The results for SPTs and the measurement of sIgE concentrations of the patients are compared in TABLES 1 and 2.

Methods The study was conducted in the years 2014–2016: in the June–February period (approx. 6 weeks after the birch pollination season) in a group of subjects allergic to birch pollen (group 1) and the March–September period (outside of the heating season) in a group of subjects allergic to HDM (group 2). Preparation of patients involved the discontinuation of medications according to *The Nasal Provocation Tests Performance Standards*.[4] The study included a 30-minute acclimatization during which blood samples were collected for BAT determination and spirometry was performed. An experienced laryngologist-allergist referred patients for provocation based on an interview and physical examination. The provocation with HDM and birch pollen allergens was performed starting with the allergen expected not to cause the reaction. The study project was approved by the Bioethics Committee of the Jagiellonian University (opinion no.: KBET/183/B/2014).

Basophil activation test To perform BAT, 400 µl of blood collected to test tubes containing EDTA was used. The test was performed within 2 hours from blood collection. The assessment of basophil activation by measuring CD63 antigen expression was carried out by means of the Flow2 CAST test (Bühlmann Laboratories AG, Schönenbuch, Switzerland). As a positive control, anti-FceRI monoclonal antibodies (antibodies against the high-affinity IgE receptor) were used, and as a negative control, a stimulation buffer was used. Cells were stimulated with NPT allergen solutions (Allergopharma GmbH, Reinbek, Germany) in the following concentrations: 5000, 500, and 50 standardized biological units (SBU), corresponding to serial dilutions of 1:1, 1:10, and 1:100. The whole process was conducted according to the manufacturer's instructions as described elsewhere.[9] To determine BAT outcome, the SI and BR were calculated. SI was defined as the ratio between the percentage of activated basophils in the presence and absence of antigen.[7] The basophil reactivity was calculated as the percentage of the amount of basophils activated by the allergen used in the study in relation to the percentage of basophils activated by the positive control (allergen CD63/anti-IgE CD63).[10,11] In determining the positive cut-off value for BAT, receiver operating characteristic (ROC) curves were used according to recommendations in the literature.[12,13]

Nasal provocation test The NPT was performed by first administering a control solution, followed after 20 minutes by the HDM or white birch pollen allergen (Allegropharma GmbH, Reinbek, Germany). Bilateral provocation with a single concentration of the studied solution was used (administered in the volume of 0.04–0.05 ml). The early phase of the allergic reaction was assessed. The NPT was interpreted after 5, 15, and 60 minutes, with the use of a clinical symptom scale, taking into consideration the amount of nasal discharge

TABLE 1 Results of skin prick tests and specific immunoglobulin E concentrations in patients with allergy to house dust mite

Patient	SPT histamine,[a] mm	SPT HDM,[a] mm	SPT birch,[a] mm	sIgE HDM, kUI/l	sIgE birch, kUI/l
1	6	10	0	25.6	0.01
2	4.5	6.5	0	5.4	0.3
3	10	20	0	8.17	0.6
4	4	4	0	0.51	0.2
5	4	5	0	34.3	0.03
6	5	5	0	10	0.06
7	5.5	6	0	25.8	0.15
8	4	4.5	0	14.8	0.05
9	17.5	18	0	32.3	0.19
10	5	7	0	22.6	0
11	7.5	17.5	0	7.81	0
12	5	5	0	3.5	0.01
13	4	5	0	40	0
14	5	5	0	9	0.03
15	5	5	0	7.13	0.4
median	5	5	0	10	0.05

a The mean diameters of wheals were calculated from the sum of the largest measurement across the wheal and the largest wheal measurement perpendicular to the former divided by 2.

Abbreviations: HDM, house dust mite; sIgE, specific immunoglobulin E; SPT, skin prick test

TABLE 2 Results of skin prick tests and specific immunoglobulin E concentrations in patients with allergy to birch pollen

Patient	SPT histamine, [a] mm	SPT HDM, mm	SPT birch,[a] mm	sIgE HDM, kUI/l	sIgE birch, kUI/l
1	4	0	5	0.03	100
2	6	0	4.5	0.05	100
3	5	0	5	0	0.25
4	3	0	11	0.1	89
5	4	0	5	0	47
6	7	0	7.5	0	24.3
7	6	0	6	0	13.2
8	4.5	0	5	0.03	27.3
9	6	0	5	0.01	1.48
10	5	0	5	0.16	50
11	6	0	6	0	43
12	6	0	6	0.14	1.53
13	5.5	0	5.5	0	13.8
14	5	0	6	0	27
15	4	0	5	0.19	19
median	5	0	5	0.01	27

a The mean diameters of wheals were calculated from the sum of the largest measurement across the wheal and the largest wheal measurement perpendicular to the former divided by 2.

Abbreviations: see TABLE 1

(0–2 points), number of sneezes (0–2 points), nasal itching (0–1 point), nasal congestion (0–2 points), palate or ear itching (0–1 point), lachrymation or conjunctivitis, urticaria, cough, or dyspnea (0–1 points). Getting 3 or more points in a single test was considered as a positive result, and the highest of the 3 results was later considered the final result.

Statistical analysis Data distribution was calculated using the Shapiro–Wilk test. The results were presented as the median and range. ROC curves were plotted with PQStat (PQStat Software, Poznań, Poland). They were used to assess the BAT optimal positive cut-off value. The area under the ROC curve (AUC) was calculated to quantify the accuracy of BAT (SI, BR) and to compare it with

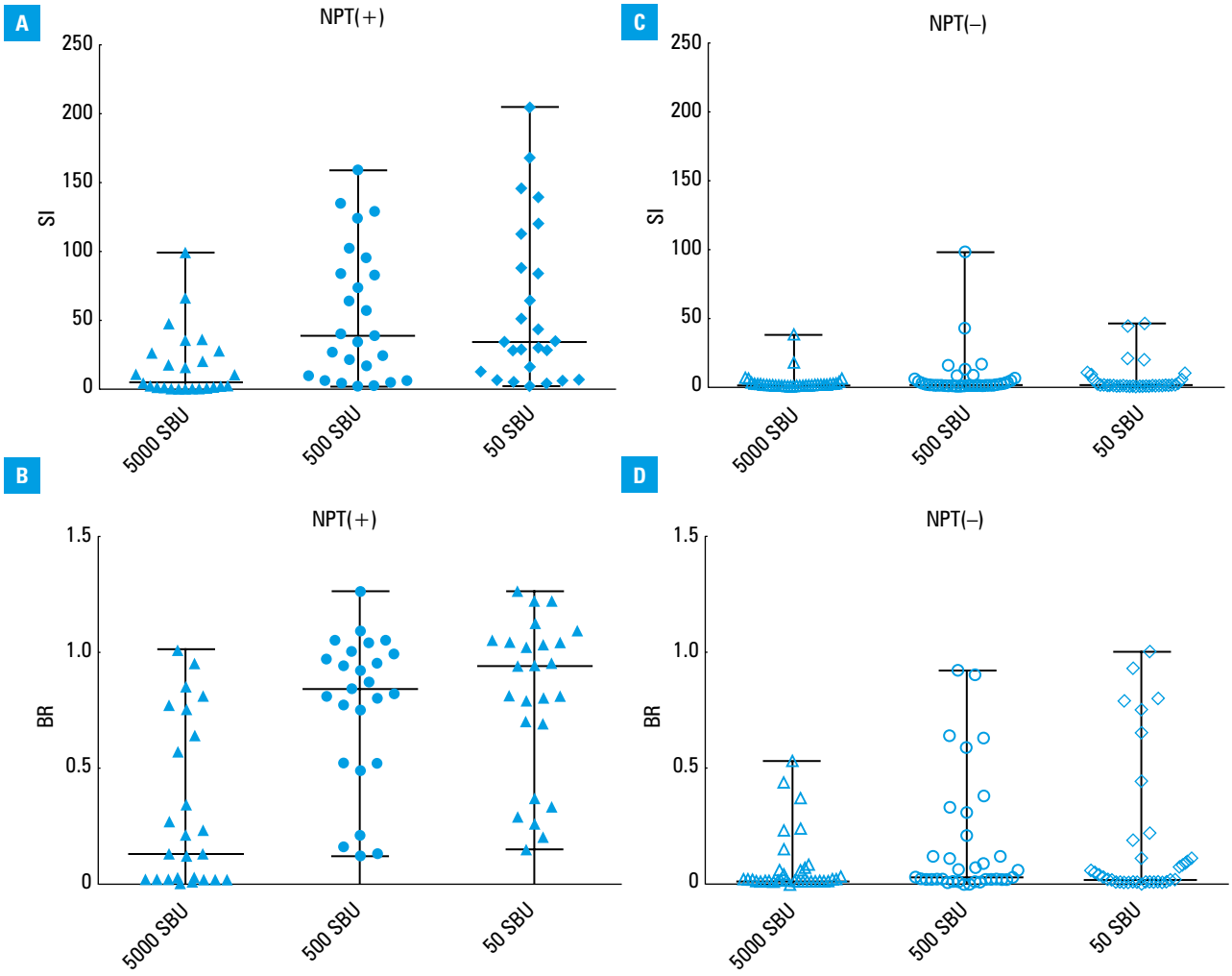

FIGURE 1 Stimulation index (SI) and basophil reactivity (BR) for positive and negative nasal provocation test (NPT) results. SI and BR were higher in the case of a positive NPT result; data are presented as median and quartiles; **A** – SI for positive NPT; **B** – SI for negative NPT; **C** – BR for positive NPT; **D** – BR for negative NPT

the results of NPT, SPT, and sIgE measurement. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated. Correlation coefficients were calculated using the Spearman's rank correlation. To compare the SI and BR between patients with positive and negative NPT results, the Mann–Whitney test was used. Probability values of less than 0.05 were considered as significant. Analyses were performed using GraphPad Prism 6 (GraphPad Software, La Jolla, California, United States).

RESULTS The median basophil activation in the positive control was 78.81% (range, 14.01%–94.3%). Among 30 subjects enrolled in the study, a positive result of NPT with birch allergens in group 1 was obtained in 14 patients and with HDM allergens in group 2—in 12 patients. In all patients with positive NPT results, the median symptom scale was 4 (range, 3–6), and with negative NPT results, it was 0 (range, 0–1). In 1 female patient with AR due to birch pollen allergy, the NPT could not be performed because of aggravated rhinitis symptoms at baseline.

In positive NPTs, the median SI for HDM and birch allergens for a dilution of 1:1 was 4.45 (0.09–99.31); for a dilution of 1:10, 38.78 (2.1 to 158.98); and for that of 1:100, 34.1 (2.22–204.84). In negative NPTs, the median SI was lower: for a dilution of 1:1, it was 0.86 (0.1–38.51); for a dilution of 1:10, 1.03 (0.26–98.55); and for that of 1:100, 1.19 (0.26–46.19). The differences between all dilutions in positive and negative NPTs were significant (P <0.001).

The BR parameter was also higher in the case of a positive NPT result. The median BR for HDM and birch allergens for a dilution of 1:1 was 0.13 (0 to 1.01); for a dilution of 1:10, 0.84 (0.12 to 1.26); and for that of 1:100, 0.94 (0.15 to 1.26). In the case of a negative NPT result, the median BR was 0.01 (0–0.53), 0.02 (0–0.92), and 0.02 (0–1) for the dilutions of 1:1, 1:10, and 1:100, respectively. The differences between all dilutions in positive and negative NPTs were significant (P <0.001). **FIGURE 1** presents SI and BR graphs for positive and negative provocation results.

On the basis of the ROC curve analysis for HDM and birch allergen at dilutions of 1:10 and 1:100, SI results were highly comparable to NPT results. In the case of HDM dilution of 1:10, the optimum SI cut-off point in relation to NPT was set at the level of 16.76; SI sensitivity was 83%; specificity, 89%;

TABLE 3 Results of the receiver-operating characteristic curve analysis considering optimum cut-off values for the stimulation index with house dust mites and birch allergens in comparison with nasal provocation test

Dilution	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	ACC, %	*r*
HDM SI 1:1	0.87[a]	67	94	89	81	83	0.74[a]
HDM SI 1:10	0.87[a]	83	89	83	89	87	0.65[a]
HDM SI 1:100	0.90[a]	91	83	79	94	87	0.63[a]
birch SI 1:1	0.65	62	88	80	75	77	0.30
birch SI 1:10	0.95[a]	92	88	86	94	90	0.68[a]
birch SI 1:100	0.95[a]	100	88	87	100	93	0.60[a]

a $P < 0.001$

Abbreviations: ACC, accuracy; AUC, area under the curve; birch SI, stimulation index for birch allergen; HDM SI, stimulation index for house dust mite allergen; NPV, negative predictive value; PPV, positive predictive value

TABLE 4 Results of the receiver-operating characteristic curve analysis considering optimum cut-off values for the basophil reactivity with house dust mites and birch allergens in comparison with nasal provocation test

Dilution	AUC	Sensitivity, %	Specificity, %	PPV, %	NPV, %	ACC, %	*r*
HDM BR 1:1	0.84[a]	67	89	80	80	80	0.67[b]
HDM BR 1:10	0.92[b]	92	87	85	94	90	0.68[b]
HDM BR 1:100	0.91[b]	100	78	75	100	87	0.58[b]
Birch BR 1:1	0.70	92	53	60	90	70	0.34
Birch BR 1:10	0.95[b]	100	82	81	100	90	0.71[b]
Birch BR 1:100	0.94[b]	100	82	81	100	90	0.64[b]

a $P < 0.05$, b $P < 0.001$

Abbreviations: birch BR, basophil reactivity for birch allergen; HDM BR, basophil reactivity for house dust mite allergen; others, see TABLE 3

PPV, 83%; NPV, 89%; and accuracy, 87%. The AUC for HDM at a dilution of 1:10 was 0.87 ($P < 0.001$), which indicates high conformity of BAT and NPT results. The respective values for birch allergen dilution of 1:10 at the cut-off point of 4.35 were as follows: sensitivity, 92%; specificity, 88%; PPV, 86%; NPV, 94%; and accuracy, 90%. The area under the ROC curve for birch allergen at this dilution was 0.95 ($P < 0.0001$). TABLE 3 presents the results obtained from the ROC curve analysis considering optimum cut-off values for the SI with HDM and birch allergens in comparison with NPT.

Adopting the SI PPV for the cut-off point of 2, as recommended in the available literature for HDM at dilutions of 1:10 and 1:100, we obtained a sensitivity and NPV of 100%, specificity of 44% and 61%, PPV of 54% and 53%, and accuracy of 66% and 77%, respectively. For the birch allergen at dilutions of 1:10 and 1:100, NPV was also 100%, while specificity was 76% and 82%, PPV was 76% and 81%, and accuracy was 86% and 90%, respectively.

BR demonstrated higher sensitivity, specificity, PPV, and NPV in comparison with NPT. The results obtained from the ROC curve analysis for BR and NPT are compared in TABLE 4. The ROC curves with optimal cut-off points for the BR received after stimulating basophils with HDM and birch pollen allergen at a dilution of 1:10 are presented in FIGURE 2.

To calculate the correlation between analyzed basophil activation parameters, namely, the SI and BR, for all allergen concentrations with NPT results, the Spearman's rank correlation test was used. For all measurements, except for the those for the birch allergen at a dilution of 1:1 ($r = 0.30$, $P = 0.103$ for SI and $r = 0.34$, $P = 0.06$ for BR), we obtained a significant correlation ranging from 0.58 to 0.74 (TABLES 2 and 3). The correlation of the SI and BR with NPT results for the optimal HDM and birch allergen at a dilution of 1:10 is presented in FIGURE 3.

DISCUSSION Our results demonstrated that BAT may replace NPT, while maintaining high diagnostic sensitivity and specificity. BAT is currently the subject of intensive research, and it has been gradually introduced into diagnostic workup of allergic diseases. Nevertheless, there is still no standardized methodology of performing the test.[8,13] In our study, we used CD63 as an activation marker due to the direct association of its expression with poststimulation basophil degranulation.[14,16] The BAT was performed using the same 3 dilutions of allergen preparations as in the NPT.[9] Therefore, to adhere to the recommendations, we used the ROC curves to establish an optimum positive cut-off value for BAT.[11,12]

HDM and birch allergen concentrations of 500 and 50 SBU were found to be adequate for

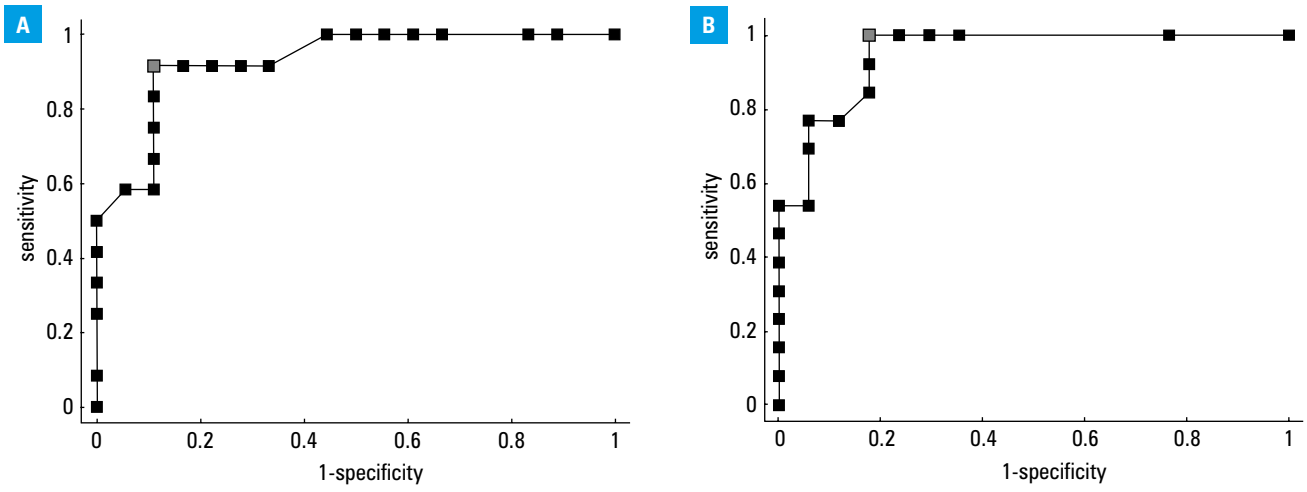

FIGURE 2 Receiver-operating characteristic curves with optimal cut-off points for basophil reactivity received after stimulating basophils with the optimal house dust mite and birch pollen allergens at a dilution of 1:10; **A** – house dust mite allergen; **B** – birch pollen allergen

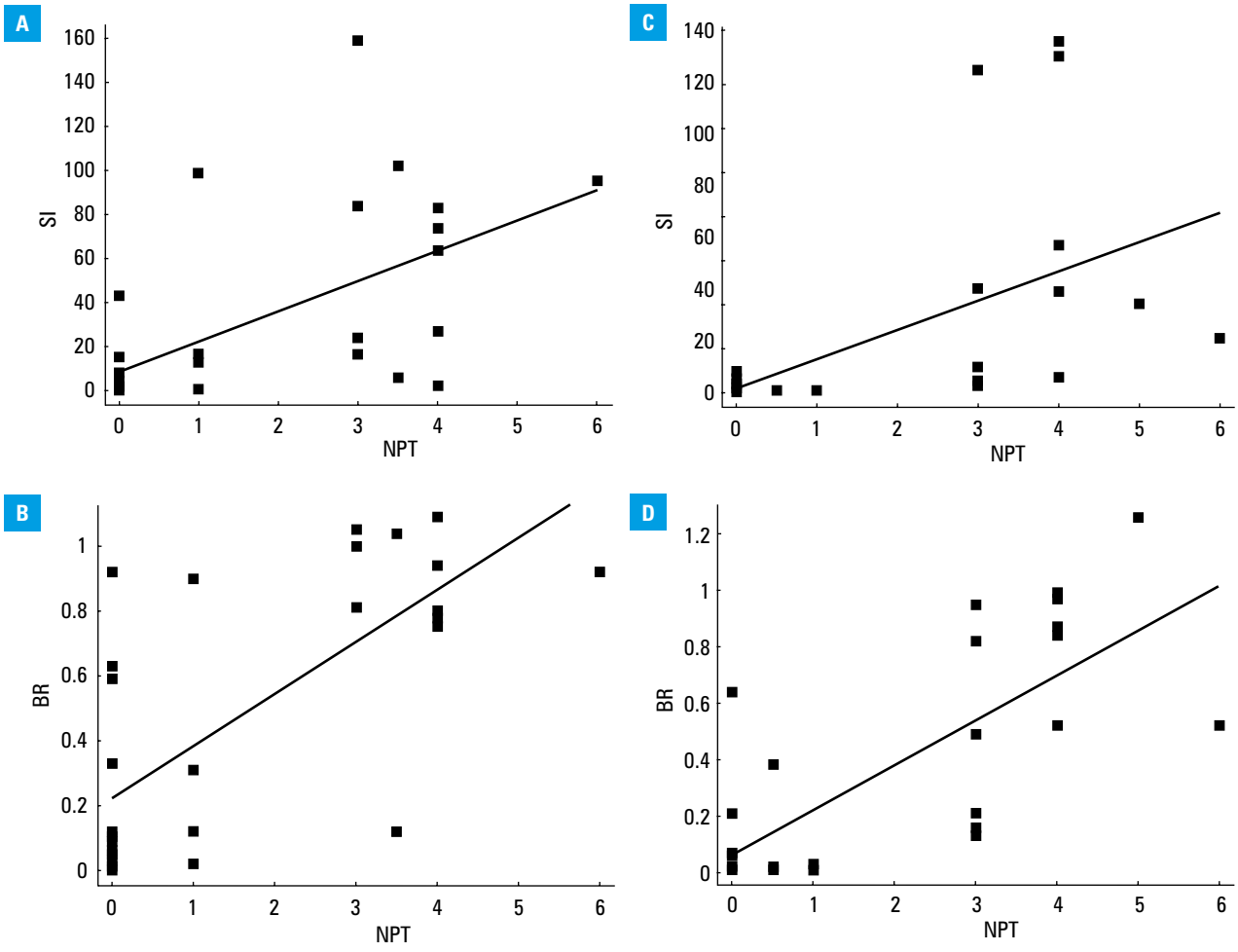

FIGURE 3 Correlation of stimulation index (SI) and basophil reactivity (BR) with nasal provocation test (NPT) results for the optimal house dust mite and birch allergens at a dilution of 1:10; **A** – SI for house dust mite allergen; **B** – SI for birch pollen allergen; **C** – BR for house dust mite allergen; **D** – BR for birch pollen allergen

Abbreviations: see **FIGURE 1**

basophil stimulation. Compared with the NPT, the results obtained for the SI corresponded with those reported by other authors. In the study by Gomez et al,[7] BAT sensitivity with HDM allergens (ALK-Abelló, Madrid, Spain) expressed by the SI was 85%; specificity, 93%; PPV, 92%; and NPV, 87%. The authors suggested that the application of BAT was a good alternative to NPT in local AR, especially that it is time consuming to perform NPT in cases where the allergen potentially

responsible for clinical symptoms is unknown. They also emphasized the low sensitivity of other tests in local AR.[7]

Until now, BR has been compared mostly with oral challenge test results. In our study, we found a significant correlation between the BR for HDM and birch allergen dilutions of 1:10 and 1:100 and intensification of response in specific nasal provocation. Santos et al[10] and Rubio et al[11] reported that also patients with more intensified reactions in specific oral provocation with food had a higher BR. On the other hand, Blumchen et al[17] compared BAT to specific oral provocation and showed no correlation with the severity of clinical reaction but only with threshold levels for peanut allergy.

Zidarn et al[18] performed BAT with grass allergens (AQUAGEN® SQ, freeze-dried allergen extract of grass pollen mix L299; ALK-Abelló) and NPT with grass pollen allergen solution (Mixed Grasses; HAL Allergy, Leiden, The Netherlands). Patients with a positive NPT result had a significantly higher CD63 expression after stimulation with an allergen at a submaximum concentration.[18] In our study, in subjects with a positive NPT result, we obtained significantly higher values both of the SI and of BR. Similarly, Nopp et al[19] obtained similar results of BAT assessed with the use of basophil allergen threshold sensitivity (CD-sens) and NPT assessed with the use of clinical symptoms scale in 22 of 26 patients, whereas when a positive peak nasal inspiratory flow (PNIF) criterion was introduced—in 24 of 26 patients. After repeated provocation, the same symptoms occurred in 14 of 18 patients, and with the same positive peak nasal inspiratory flow—in 17 of 18 patients. All patients had identical CD-sens classification. Dahlen et al[20] performed bronchial provocation and BAT and confirmed that a BAT result is an objective marker of respiratory tract sensitivity to an allergen in patients with stable allergic asthma and may replace specific bronchial provocation.[20]

In comparison to NPT, the advantages of BAT, apart from saving the patient from exposition to an incidence of allergic symptoms during the test, include the possibility of diagnosis regardless of the pollination season[21,22] and no requirement to discontinue the use of many symptom-relief medications.[23] In our study, NPT could not be performed in just 1 patient because of exacerbation of rhinitis symptoms at baseline. In this patient, the BAT confirmed clinical significance of birch pollen allergy.

The false positive results (BAT[+] NPT[–]) we obtained may be explained by basophil hyperreactivity occurring in atopic patients. Khan et al[24] postulated that it may be due to a high level of total IgE in atopic patients, high level of spleen tyrosine kinase, a key regulatory factor in an IgE-mediated signal transduction route in the allergic reaction in mastocytes or basophils, or activation by interleukin 3.[24] In our study, we did not obtain any false negative results (BAT[–] NPT[+]).

We applied clinical instead of objective NPT evaluation. However, the procedure was conducted by a laryngologist-allergist with many years of experience in performing and interpreting NPTs. Similarly, Zidarn et al[18] did not apply nasal provocation objectification in comparing its results against those of BAT.

The good correlation between BAT and specific nasal provocation confirmed in our study seems to result directly from the type I allergic reaction mechanism: after stimulation with an allergen, basophil degranulation and CD63 expression occur. Earlier studies proved that basophils are recruited in the respiratory tract during a specific provocation and are responsible for a local reaction.[25] Hence, BAT with an assessment of appropriate parameters may reflect a target organ's sensitivity to an allergen. Research into the pathogenesis of allergy is the challenge for the future.[26] Currently, several biomarkers are available for airway diseases that help individualize diagnosis and treatment.[27] It seems that the development of assays based on the mechanisms of allergy reactions is a promising strategy.[28]

Conclusions NPT is still a gold standard in the diagnosis of AR. Where there are contraindications to perform NPT, BAT may be regarded as an alternative in establishing patients' eligibility for SIT, but further research is needed to confirm this. In the case of using an allergen preparation for NPT in BAT, its optimum concentrations are 500 and 50 SBU. Both the SI and BR are good indicators of basophil activation.

Contribution statement ML contributed to the concept and design of the study, enrolled subjects into the study, performed nasal provocation tests and statistical analysis, wrote the original draft of the manuscript, and approved the final version of the manuscript. WD conducted all in vitro assays and read and approved the final version of the manuscript. BR participated in the enrollment of subjects into the study, performed the nasal provocation tests, and read and approved the final version of the manuscript. MM participated in the enrollment of subjects into the study, and read, corrected, and approved the final version of the manuscript. EC ccontributed to the concept and design of the study, participated in the interpretation of data, and read and approved the final version of the manuscript.

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Porównanie testu aktywacji bazofilów z testem prowokacji donosowej w kwalifikacji do immunoterapii swoistej

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SŁOWA KLUCZOWE

indeks stymulacji, reaktywność bazofilów, test prowokacji donosowej

STRESZCZENIE

WPROWADZENIE Najczęstszą z chorób atopowych jest alergiczny nieżyt nosa (ANN). Immunoterapia swoista (*specific immunotherapy* – SIT) jest jedyną efektywną metodą leczenia ANN. W wątpliwych przypadkach diagnostycznych przed kwalifikacją do SIT należy wykonać donosowe próby prowokacyjne (*nasal provocation tests* – NPT). Wykonanie NPT wiąże się z szeregiem przeciwwskazań, dlatego trwają poszukiwania alternatywnej metody *in vitro*.

CELE Celem badania była ocena, czy w kwalifikacji do SIT swoista prowokacja *in vitro*, czyli test aktywacji bazofilów (*basophil activation test* – BAT), może zastąpić swoistą prowokację *in vivo*, czyli NPT.

PACJENCI I METODY Do badania włączono 30 pacjentów z ANN z uczuleniem na roztocze kurzu domowego lub pyłek brzozy kwalifikowanych do SIT. Ocenę aktywacji bazofilów przez pomiar ekspresji antygenu CD63 przeprowadzono za pomocą testu Flow2 CAST. Bazofile stymulowano preparatem alergenowym brzozy i roztoczy (stężenia 5000, 500 i 50 standaryzowanych jednostek biologicznych) stosowanym w NPT. Wyniki BAT wyrażano jako indeks stymulacji (*stimulation index* – SI) oraz reaktywność bazofilów (*basophil reactivity* – BR).

WYNIKI Stężeniami alergenu odpowiednimi do stymulacji bazofilów okazały się 500 i 50 SBU. Mediana SI oraz BR dla alergenów w przypadku pozytywnego wyniku NPT była wyższa niż dla alergenów przy negatywnym wyniku NPT ($p < 0{,}001$). Dla SI i BR czułość wahała się w zakresie 83–100%, swoistość 78–89%, wartość predykcyjna dodatnia 75–87%, a wartość predykcyjna ujemna 89–100%. Korelacja analizowanych parametrów dla alergenów w stężeniach 500 i 50 SBU była wysoka (zakres 0,58–0,74; $p < 0{,}05$).

WNIOSKI Jeśli istnieją przeciwwskazania do NPT, BAT może być alternatywą w kwalifikacji do SIT. Optymalnymi stężeniami roztworów alergenowych są 500 i 50 SBU. Zarówno SI, jak i BR są dobrymi wskaźnikami aktywacji bazofilów.

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