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Effect of adding pranayama yoga exercises to laser acupuncture on inflammatory markers in elderly with allergic rhinitis: A randomized controlled study

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ABSTRACT

Objectives: Laser acupuncture (LA) is used to improve inflammatory markers in chronic diseases including allergic rhinitis (AR) but the effect of pranayama yoga exercises (PYE)–as an add-on therapy–was not investigated. This AR study aimed to investigate the effect of adding PYE to LA on inflammatory markers in sufferers aged > 65 years old.

Materials and methods: In this complementary interventional randomized trial, elderly with AR who were randomly recruited from a university hospital were randomly assigned to one of two eight-week interventional groups. The first group (n = 20 elderly with AR) received a 1-hour PYE daily plus LA (3 sessions/week). The second group (n = 20 elderly with AR) received LA only. Measurement of serum immunoglobulin E, erythrocyte sedimentation rate, total eosinophil count, interleukin-1β, and C-reactive protein was performed.

Results: The protocol of LA alone or combined with PYE produced a significant improvement in the parameters studied within the two AR groups studied. In favor of the first group (PYE plus LA), there were post-treatment significant between-group improvements in AR patient's parameters.

Conclusions: Positive effect of LA on inflammatory markers in elderly with AR can be magnified by adding PYE.

Keywords: pranayama, yoga, laser acupuncture, inflammatory markers, allergic rhinitis, elderly

INTRODUCTION

Affecting 40% of adults worldwide, allergic rhinitis (AR) is considered a major chronic disorder in the population aged < 65 years old [1]. Inflammatory disease of patients' nose and the paranasal sinuses, main presence of nasal symptoms (sneezing, obstruction, itching, post-nasal drip, and smell disorders), possible presence of ocular symptoms (eye itching, congestion, and lividity), and possible presence of respiratory symptoms (cough, dyspnea, and wheezing), and possible presence of dermatological symptoms (eruption, itching, rash, and urticarial) are criteria/definition of AR [2].

Immunological/inflammatory reaction to immunoglobulin E (IgE) to allergen exposure complicated with eosinophilic cell infiltration of the membranes lining the nose is the main suggested pathophysiology/cause of AR [1].

The current recommended AR management is allergen avoidance and pharmacotherapies (topical steroids, oral antihistamines, and/or immunotherapy). Despite the fast relief of AR-induced nasal symptoms, unpleasant side effects (e.g., epistaxis, ocular dryness, and sedation) limit the adherence to AR medications [3] besides the problem of quantitative pharmacotherapeutic problems in geriatric population that induce drug-drug interactions [1]. Unfortunately, neglected/untreated AR not only negatively affect the physical/psychosocial well-being and quality of life, but it is also related to the potential development of serious complications, involving sinusitis, bronchial asthma, otitis media, allergic conjunctivitis, and nasal polyps [4].

Specifically for AR and asthma, acupuncture–a cost-effective and evidence-based recommended complementary therapy for allergy relief and AR-associated increase of inflammatory mediators–has been evaluated [5].

The common stimulation methods of acupuncture points stimulation in chronic diseases are electrical or manual stimulation [6]. Moreover, both invasive stimulation methods involve some invasive injury risk [7], the use in majority of patients is restricted to their fear of needles, anxiety, and stress from long timed sessions that enforce the therapists to shorten sessions and retention time of inserted needles, and replacement of longer needles with shorter ones for ease of insertion and control [8]. Noninvasive acupoint-stimulation modalities, such as laser acupuncture (LA) [9], besides it has a greater acceptance by patients than the invasive acupoint electrical/manual stimulation, it was proven that long-term LA application could improve AR-associated immune dysfunctions and AR-associated increase in pro-inflammatory

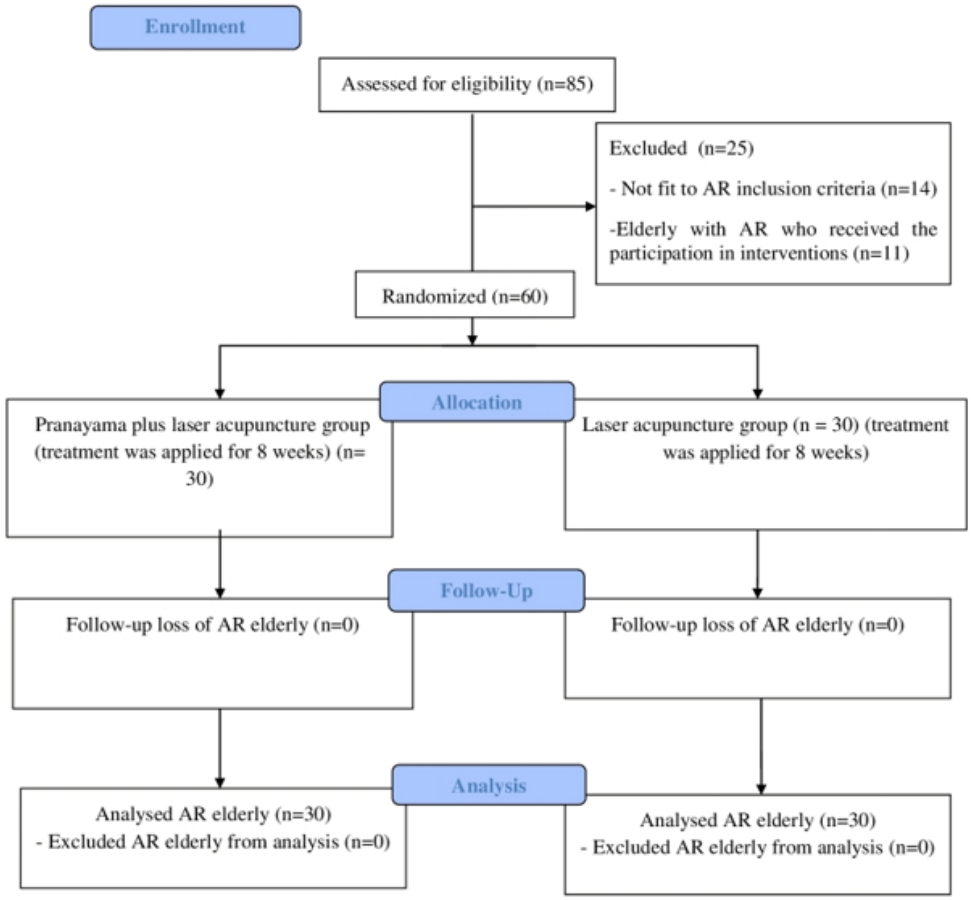

Figure 1. Flow chart of elderly with allergic rhinitis (Source: Authors' own elaboration)

markers [10, 11], but LA application in AR elderly was not investigated before.

On the other hand, the regular practice of the common yoga breathing exercise, pranayama ('prana' means the vital power and 'yama' means the regulation/control to be translated in Sanskrit as breathing control) [12, 13], improves the efficacy of pharmacological agents, decreases airway sensitivity, lowers IgE and eosinophil counts, and decreases inflammatory markers in chronic diseases such as bronchial asthma, rhinitis, and chronic bronchitis [14].

Since immuno-pathological mechanisms (IgE-mediated immunological reaction to allergen exposure complicated with eosinophilic cell infiltration of the airway mucosa) between asthma and AR are nearly the same [15], it is supposed that the above-mentioned evidence-based in-asthma effects of pranayama yoga exercises (PYE) may occur in AR patients but no study examined these effects. The hypothesis of this complementary interventional study was based on the following claim: there was no an effect of adding PYE to LA on inflammatory markers in elderly with AR. The complementary interventional study aimed to investigate this hypothesis.

MATERIAL AND METHODS

Design and Settings of This Allergic Rhinitis Study

The complementary interventions of this AR study were randomized controlled interventions. AR elderly were randomly recruited with ages > 65 years old.

Participants

Sixty chronic AR elderly (from both sexes) were randomly included in this study. Elderly with nasal congenital deformities, surgeries, sinusitis, or midline nasal masses were excluded. Besides the exclusion of AR elderly who received complementary therapies in the last 6 months, elderly with cardiac disorders, acute or chronic upper/lower respiratory tract infections, chest diseases (e.g., asthma), chronic inflammatory diseases, local skin irritation/wounds, or photosensitivity reactions were excluded. Elderly with intellectual/cognitive impairments or disabilities were excluded.

Randomization of Allergic Rhinitis Elderly

Elderly with the regular use of their prescribed AR medications were randomly assigned to eight-week interventional groups (PYE plus LA group or LA group, n = 30 for each group) via the closed envelope technique (**Figure 1**).

While the three authors did not participate in the randomization procedure, a physiotherapy assistant who did not know the aim of this AR study performed the randomization procedure on the elderly. This is an AR complementary study from 5th July 2023 to 30 December 2023.

This complementary interventional study in AR elderly was prospectively registered on clinicaltrial.gov (ID: NCT05915507). Cairo University approved this trial ethically (P.T./REC/012/004534, 5th April 2023).

Table 1. Mean ± standard deviation of AR elderly's anthropometric data

Variables	Group of PYE and LA	LA group	p-value
Age of AR elderly (year)	72.83 ± 3.73	71.06 ± 3.85	0.075
Body mass index of AR elderly (kg/m^2)	23.95 ± 2.68	24.91 ± 2.74	0.175
AR females: AR male*	15:15	13:17	0.267

Note. *This variable was tested via Chi-square test & p-values are non-significant (because it is > 0.05)

Laser Acupuncture Therapy

Every AR older patient received LA sessions (3 sessions weekly) with the following parameters: 904-nm wavelength, 100-mw power, and 1-cm beam spot size. According to the traditional Chinese medicine theory, the selected bilateral 1-minute LA stimulation was completed to the large intestine meridian points (LI_{19} and LI_{20}), stomach meridian points (ST_2, ST_4, ST_6, ST_7, ST_{17}, and ST_{36}), gall bladder meridian point (GB_{14}), governosal vessel meridian (GV_{24}), urinary bladder meridian point (BL_2), small intestine meridian point (SI_{18}), and Ex-HN_5.

Pranayama Yoga Exercises

The daily supervised PYE session lasted one hour approximately. It is composed of diaphragmatic breathing exercises, rapid abdominal breathing exercises, alternate nostril breathing exercises (ANBE), and Bhramari pranayama exercises (BPE) in a sitting position. According to [16], the details of these breathing exercises were as follows:

The DBE (known as *dirga svasam* in yogic practice) is composed of inhalation (a through-nose gentle inhalation, then gentle expansion of the abdomen area, then gentle expansion of the thoracic cage), exhalation (a through-nose gentle exhalation started with the gentle relaxation of the thoracic cage and ended with gentle abdominal muscle contraction), and rest for 5 seconds. The exercise was repeated for 3 minutes (on average) followed by a 3-minute rest (on average). The 3-minute exercise and the 3-minute rest are considered one cycle. This cycle was repeated 3 times (18 minutes).

The RBE (known as *kappala bhati* in yogic practices) is done after DBE. RBE is the through-nose exhalation by the sudden gentle forced abdominal contraction to push the air out of both nostrils followed by through-nose inhalation through relaxation of the abdomen to allow the air to return to both lungs without effort/force. Three sets of RBE were performed for a total of 4 minutes every set. A ½-minute rest was given between RBE sets. The average total duration of RBE exercise was 13.5 minutes.

The ANBE (known as *nadhi suddhi* in yogic practices) [17], is done after RBE. The AR participant was ordered to make a relaxed touching to both nostrils with the thumb and index fingers of the right hand (the thumb touched the right nostril while the index touched the left nostril). During the closure of the right nostril with the right thumb, the AR participant was ordered to exhale slowly through the left nostril for a count of 8 (the count was done by the therapist), then to inhale through the left nostril for a count of 4 (the count was done by the therapist). This was followed by the ring finger closure to the left nostril to exhale gently through the right nostril for a count of 8 and then inhaling through the right nostril for a count of 4 (the count was done by the therapist). Now, the AR participant was ordered to close his/her right nostril with the thumb to exhale through his/her left nostril for a count of 8. The pattern of ANBE continued for up to 2 minutes, followed by one-minute rest. This pattern (2-minute ANBE followed by one-minute rest) was repeated 5 times (the total average time of ANBE was 15 minutes).

The BPE is done after ANBE. The AR participants were ordered to make from-both-nostril slow and deep inhalations (nearly for 5 seconds), followed by deep and slow expiration in the same pattern (nearly for 15 seconds) with AR elderly's thumbs on/closing their external auditory canals. During the expiration, AR elderly's were ordered to chant the *"Mmm"* (a humming nasal sound similar to that of a wasp). This *"Mmm"* sound caused mild vibrational waves to the laryngeal walls and both-nostril inner walls. The average time of one BPE cycle was 3 minutes (120 seconds followed by a 60-second-rest). Every AR older patient repeated the cycle 5 times [12] (i.e., the total average BPE time was 15 minutes).

Outcomes

Measurement of serum IgE, erythrocyte sedimentation rate (ESR), total eosinophil count (TEC), interleukin-1β (IL-1β), and C-reactive protein (CRP) was performed before and after 8-week complementary interventions.

Blinding

The laboratory staff who analyzed IgE, ESR, TEC, IL-1β, and CRP outcomes did not know the introduced complementary interventions to the elderly with AR.

Sample Size Calculation (Using ESR as the Main Outcome)

G*power program (d = 0.77, power 80%) showed that 27 AR elderly in the LA group or the group of PYE plus LA were needed (these results were obtained from a pilot test on 16 elderly with AR). The number of elderly with AR in the LA group or the group of PYE plus LA was increased by 3 elderly with AR to eliminate dropouts (10%).

Statistical Analysis

Due to its normal distribution confirmed by the Smirnov test (SPSS, version 18), AR elderly's significance of data within or between treated AR groups were tested using an ANOVA (repeated measure).

RESULTS

Demographic data (**Table 1**), IgE, ESR, TEC, IL-1β, and CRP (**Table 2**) showed a non-significant pre-treatment difference between the two studied AR groups. Within the two AR groups studied, there were highly significant improvements ($p < 0.001$) in IgE, ESR, TEC, IL-1β, and CRP. In favor of the group of PYE plus LA, there were post-treatment significant between-group improvements in IgE, ESR, TEC, IL-1β, and CRP (**Table 2**).

DISCUSSION

This study used the LA alone or with the add-on PYE therapy to improve the AR-associated inflammatory markers in

Table 2. Within- and among-group comparisons of AR elderly's inflammatory markers (data are expressed as mean ± standard deviation)

Variables	Group of PYE plus LA	LA group	Among-group p-value
Pre-ESR (mm/hour)	21.86 ± 2.47	23.01 ± 2.09	0.056
Post-ESR (mm/hour)	15.43 ± 1.94	17.96 ± 1.99	< 0.001*
p-value within AR groups	< 0.001*	< 0.001*	
Pre-IgE (IU/ml)	384.26 ± 67.93	401.10 ± 41.51	0.252
Post-IgE (IU/ml)	326.36 ± 62.05	365.10 ± 45.42	0.008*
p-value within AR groups	< 0.001*	< 0.001*	
Pre-TEC (%)	4.10 ± 0.96	4.62 ± 1.13	0.061
Post-TEC (%)	2.18 ± 0.70	3.57 ± 0.91	< 0.001*
p-value within AR groups	< 0.001*	< 0.001*	
Pre-CRP (mg/L)	16.88 ± 2.09	17.72 ± 1.77	0.099
Post-CRP (mg/L)	13.73 ± 2.13	15.42 ± 1.69	< 0.001*
p-value within AR groups	< 0.001*	< 0.001*	
Pre-IL-1β (pg/ml)	12.63 ± 1.80	13.55 ± 2.06	0.072
Post-IL-1β (pg/ml)	10.98 ± 1.68	12.27 ± 1.93	0.008*
p-value within AR groups	< 0.001*	< 0.001*	

Note. *Significant p-value (because it is < 0.05)

elderly. PYE with LA produced a greater significant improvement in AR-associated inflammatory markers than LA alone.

Although countless investigations have proven that acupuncture is effective for addressing a variety of allergy disorders, its exact mode/mechanism of action is still unknown [10]. Laser-emitted photic energy application on acupuncture points improves the immune system in AR by inhibiting the synthesis of cytokines (including interleukins), regulating CD-3 and CD-4 T cells, normalization/rearrangement of cellular metabolism, increasing nitric oxide release that improves the local nasal circulation, stimulating the release of the neuropeptides involved in analgesia and healing process [11] and down-regulating of the transient receptor potential vanilloid subfamily member 1 receptors signaling (receptors that mediate histamine-induced cardinal symptoms of AR) [18].

Acupuncture-induced reduction of AR-associated nasal mucosal inflammation and hypersensitivity occurs due to the reduced production of IgE. The decreased differentiation of Th cells to Th2 cells (cells involved in antibodies synthesis) along with the increased down-regulation of neurotrophins and proinflammatory neuropeptides is the suggested cause of acupuncture-induced low production of IgE in AR [19].

Involvement of some physiological neurogenic pathways/axes such as stress or hypothalamus-pituitary-adrenal (HPA), sympathoadrenal medullary, and parasympathetic cholinergic axes appears to be responsible for the acupuncture-mediated reflexive central inhibition of inflammatory markers, and hence the inhibition of the innate immune system in AR [18].

In previous old AR study, acupuncture-induced significant reduction of serum IgE and absolute blood eosinophils count was proven [20]. The significant reduction in IgE, ESR, TEC, and CRP after 6 weeks of LA was also previously reported in AR children aged 4-18 years [11]. Also, the significant reduction in IgE after 6 weeks of LA in AR rhinitis children (aged 7-18 years) supported our results again [10]. Also, in AR rats, 10-day acupuncture significantly improved the inflammatory markers, including IL-1β and IgE [21]. Also, in familial Mediterranean fever patients with osteoarthritis, a significant reduction in ESR, eosinophils, and CRP was reported after 4weeks of LA [22].

Oppositely, previous acupuncture reports in AR were not compatible with us due to the non-significant improvements of IgE [19, 23] and blood eosinophils [23]. In another study that opposed us, the 6-week acupuncture of liver-3 acupoint in rheumatoid arthritis patients was not sufficient to induce significant improvements in ESR and CRP [24]. The high variation of lupus activity along with the small number of acupuncture sessions (n = 10) may be the cause of the opposed non-significant improvement in IL-β levels in a non-recent acupuncture study [25].

On the other hand, the mechanism that explains the yoga-induced improvement of inflammatory markers in chronic diseases is not fully explained. *Kappala bhati* (rapid breathing exercise) boosts the mechanistic decarboxylation and oxidation of lung tissue, which is thought to "*calm*" the higher respiratory centers by lowering sympathetic nervous system activity. It has been documented that the immune system and its related actions/functions are boosted by PYE-induced suppression of the sympathetic nervous system [26, 27].

PYE-induced regulation in the action of different neurological axes including the HPA axis and vagal efferent stimulation axis is thought to have played a role in the down-regulation of inflammatory markers [27]. Besides the reported decrease in cortisol and stress levels, PYE-induced modulation of oxidative stress is thought to enhance immune activities. PYE may help respiratory tract disease patients to maintain the homeostasis of allergen-induced pathogenetic mechanisms in the long run by reducing the usual exaggerated body's immune response to external triggers/antigens [28].

BPE is thought to have a role in boosting immunity in upper tract infections such as rhinosinusitis and AR. Frequent air vibrations during humming or BPE prevent microbes and/or allergens from settling down in the nasal cavity [29]. Humming-induced nasal increase of NO regulates the filling capacity of the nasal vessels. This, in turn, improves the air temperature, humidification, and conditioning of nasal mucosa. This, in turn, improves the nasal ciliary movement, increases the drainage of the nasal and paranasal sinuses, increases the local rapid viral/allergen clearance, and suppresses rhinovirus-induced local epithelial expression of AR-associated pro-inflammatory cytokines/markers [30]. Also, BPE-induced NO increase in the nasal area acts as a non-specific host defense mechanism against the development of bacterial/viral paranasal infections which prevents or controls the signs and symptoms of upper and lower respiratory tract diseases [31].

Relaxation training in DBE–as a part of PYE–could initiate a cascade of transcriptomic changes in different cellular molecules involved in different biological responses including inflammatory/immune response and energy metabolism [32]. This cascade of transcriptomic changes contributes to the reduction of inflammatory markers. The PYE-associated slow breathing pattern produces a state of hypercapnia. Through modulating NFkB-mediated inflammatory signaling, this state reduces pro-inflammatory markers and cytokines [33].

Yoga-induced reduction of ESR and CRP is related to the functional regulation of metabolic processes of the internal organ system. Yogic intervention stimulates proper iron absorption from the small intestine along with the increased absorption of its combination, the beta-globulin complex, in the blood resulting in lowered ESR levels. Also, the yoga-induced optimization of the increased hepcidin levels declines the high levels of CRP [34].

Pranayama-induced improvement in immune activities reduces the TEC as previously documented in the allergen-stimulated bronchial asthma which was compatible was our results in AR patients [35]. The 4-week treatment of bronchial asthma via breathing exercises and LA significantly improved the patients' serum IgE [36].

Also, the significant reductions of ESR and CRP after 8-week *kappala bhati*, *nadhi suddhi*, and *BPE* were compatible with our results but in rheumatoid arthritis patients [37]. Our results were compatible with the results of two preceding systematic reviews that affirmed yoga's immune-boosting benefits in chronic diseases by the downregulation of pro-inflammatory markers [38, 39].

The significant reduction of IL-1β–after a 20-minute yoga session–was compatible with our results but in the healthy adults' saliva [33]. Also, the significant reduction of IL-1β [40] and CRP [41] after a 12-week yoga program (including *kappala bhati*, *nadhi suddhi*, and *BPE*) was compatible with our results but in industrial workers working in direct contact with various environmental pollutants released by industrial effluents. An 8-week *hatha* yoga combined with PYE significantly lowered CRP [42] and IL-1β [43] in heart failure patients [42] or healthy young Chinese women [43]. Also, the 3-month follow-up to IL-1β after 12-week pranayama–as a part of a physical (*hatha*) yoga program–showed a significant reduction in breast cancer survivors [44].

On the other hand, despite the significant decrease in TEC, ESR did not significantly improve after regular training in a yoga program that included *nadhi suddhi* and *bhramari* PYE in school students [45]. Also, TEC did not show a significant reduction after regular training in a yoga program that included PYE in patients with irritable bowel disease [46]. The salivary non-significant improvement of IL-1β in the study in [47] opposed our results due to the small number of participating thyroid-disease women (n = 15) in the DBE training program.

Limitations

Failure to follow up on anti-inflammatory PYE results is the definite shortcoming of this AR study, which should be covered in future AR studies in elderly.

CONCLUSIONS

The authors refuse the hypothesis of this complementary trial in AR elderly because the results gained from LA in improving the inflammatory markers–IgE, ESR, TEC, IL-1β, and CRP–in elderly with AR can be strengthened by adding PYE.

Author contributions: AMAI: conceptualization, data curation, investigation, methodology, supervision of laser acupuncture and yogic breathing exercises, software validation, visualization, writing – original draft, writing – review and editing; **MA:** data interpretation, project administration, funding, writing – original draft, writing – review and editing; **HFE:** data curation, interpretation, visualization, design of the concept, methodology, writing – review and editing, formal analysis; **HAMG:** conceptualization of this AR study, curation of AR data, investigation, methodology, supervision of laser acupuncture and yogic breathing exercises, software validation, visualization, writing – original draft, writing – review and editing. All authors have agreed with the results and conclusions.

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Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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