

Treatment of asthma with lipid extract of New Zealand green-lipped mussel: a randomised clinical trial

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ABSTRACT: Asthma is a chronic inflammatory disease of the airways mediated at least in part by leukotrienes and other lipid mediators. Experimental studies have shown that lipid extract of New Zealand green-lipped mussel, *Perna canaliculus*, is effective in inhibiting 5'-lipoxygenase and cyclo-oxygenase pathways responsible for production of eicosanoids, including leukotrienes and prostaglandins. The aim of this study was to assess its effect on symptoms, peak expiratory flow (PEF) and hydrogen peroxide (H₂O₂) in expired breath condensate as a marker of airway inflammation in patients with steroid-naïve atopic asthma in a double-blind randomised, placebo-controlled clinical trial.

Forty six patients with atopic asthma received two capsules of lipid extract (Lyprinol®) or placebo *b.i.d.* for 8 weeks. Each capsule of lipid extract contained 50 mg ω-3 polyunsaturated fatty acids and 100 mg olive oil, whereas placebo capsules contained only 150 mg olive oil.

There was a significant decrease in daytime wheeze, the concentration of exhaled H₂O₂ and an increase in morning PEF in the lipid extract group compared to the placebo group. There were no significant side-effects.

The authors conclude that lipid extract of New Zealand green-lipped mussel may have some beneficial effect in patients with atopic asthma.

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Asthma is a chronic inflammatory disease of the airways mediated, at least in part, by leukotrienes and other lipid mediators. Experimental studies have shown that lipid extract of the New Zealand green-lipped mussel (*Perna canaliculus*) is effective at inhibiting 5'-lipoxygenase and cyclo-oxygenase pathways, which are responsible for the production of eicosanoids, including leukotrienes and prostaglandins [1–3]. The lipid extract Lyprinol is rich in eicosapentaenoic acid and docosahexanoic acid, ω-3 fatty acids that inhibit the metabolism of arachidonic acid [4]. This extract is effective in reducing pain, swelling and stiffness and in improving the functional index in patients with rheumatoid arthritis and osteoarthritis [5, 6]. Its efficacy in the treatment of airway inflammation is unknown.

The aim of this study is to assess the effect of lipid extract of New Zealand green-lipped mussel on symptoms, peak expiratory flow (PEF) and hydrogen peroxide (H₂O₂) in expired breath condensate as a marker of airway inflammation in patients with atopic asthma in a double-blind randomised, placebo-controlled clinical trial.

Methods

Patients

Volunteers aged 18–56 yrs with mild-to-moderate atopic asthma were recruited in the outpatients

department of the Hospital Therapeutic Clinic, Pavlov Medical University, St.Petersburg, Russia (table 1). Patients were diagnosed according to the American Thoracic Society definition of asthma [7]. Diagnosis was based upon clinical history, reversibility of forced expiratory volume in one second (FEV₁) of >15% and diurnal variability of PEF of >20%. Atopic status was assessed by positive skin-prick test (>3 mm) to common inhalant allergens (house-dust mite, animal allergens, pollen). All patients were sensitised to house-dust mite. Severity of asthma was classified according to the National Institutes of Health/World Health Organization (NIH/WHO) guidelines [8]. Briefly, subjects with mild asthma had symptoms twice a week or less often with FEV₁ ≥80% of predicted and used inhaled short-acting β₂-agonists for symptom relief. Patients with moderate asthma had daily symptoms and an FEV₁ between 60 and 80% pred, and used inhaled short-acting β₂-agonists daily. Exclusion criteria were use of inhaled steroids within the previous 4 weeks, oral steroid treatment within the previous 3 months, current or exsmokers, clinically significant heart, renal, liver and intestinal disorders, women of childbearing potential not using adequate contraception. Only patients fully cooperative in all procedures were considered for inclusion in the run-in period of the trial.

The study was approved by the Local Ethics Committee and all participants gave written consent.

Table 1. – Characteristics of patients with atopic asthma treated with Lyprinol and placebo

Characteristics of patients	Placebo	Lyprinol
Patients n	23	23
Sex M:F	5:18	7:16
Age yrs	37.4±2.2	40.8±2.4
Duration of asthma yrs	4.5±0.9	7.32±1.2
FEV ₁ % pred	90.4±3.0	82.9±4.2
Concomitant medications	Short-acting inhaled β ₂ -agonists as required	Short-acting inhaled β ₂ -agonists as required

Data are expressed as mean±SEM. M: male; F: female. FEV₁: forced expiratory volume in one second. Differences between two groups of asthmatic patients are not significant.

Study design

The study was a single-centre, double-blind, parallel-group, randomised, placebo-controlled trial. Patients who fulfilled the inclusion criteria at the initial visit entered a 2 week observation run-in period, in which regular treatment was stopped and short-acting β₂-agonists (salbutamol or terbutaline) as required were the only medications allowed. Asthma symptoms and use of rescue medications were recorded in a diary. Patients were excluded if they received inhaled steroids or were hospitalised for asthma during the run-in period.

After the run-in period patients were randomly assigned to receive either lipid extract of New Zealand green-lipped mussel, two capsules twice daily or matching placebo for a period of 8 weeks. Each lipid extract capsule contained 50 mg ω-3 polyunsaturated fatty acids (eicosapentaenoic acid and docosahexaenoic acid) and 100 mg olive oil (Lyprinol®, Mac Lab, Melbourne, Australia). Each identical placebo capsule contained 150 mg olive oil only. Randomisation was computer-generated in balanced blocks of two treatment regimens. Inhaled salbutamol delivered *via* pressurised metered-dose inhaler or terbutaline delivered by dry powder inhaler (Turbuhaler) were used as rescue medications throughout the study. No other medications were allowed. All short-acting inhaled β₂-agonists were stopped at least 6 h before baseline FEV₁ and exhaled H₂O₂ measurements.

Measurements

Subjects kept a twice-daily diary card throughout the study. They were provided with individual peak-flow meters (Vitalograph Ltd, Buckingham, UK). The best of three peak flow values was recorded before taking the morning and evening study medications. Patients recorded daytime wheeze, nocturnal awakenings from asthma, daily use of short-acting inhaled β₂-agonists and compliance with the study medications. Asthma symptoms were ranked on a scale from 0 (none) to 3 (very uncomfortable and interferes with normal activities). At the beginning and the end of the study, subjects attended the research clinic for measurement of FEV₁, which was measured by dry spirometry (Vitalograph Ltd). The concentration of exhaled H₂O₂ was measured at the beginning of the study, and at 4 and 8 weeks of treatment. Study medications and inhaled short-acting β₂-agonists were

withheld for at least 6 h before spirometry and exhaled H₂O₂ measurements.

Expired breath condensate was collected using a glass condensing device, which was placed in a large chamber with ice as previously described [9]. After mouth rinsing, subjects breathed tidally through a mouthpiece for 20 min while wearing a nose-clip. The mouthpiece was also used as a saliva trap. The volume of condensate was 2–4 mL and H₂O₂ was assayed immediately. H₂O₂ was measured by using a colorimetric assay as described previously [10]. Briefly, 100 μL of condensate was mixed with 100 μL of 3,3',5,5' tetramethylbenzidine in 0.42 M citrate buffer, pH 3.8, and 10 μL of horseradish peroxidase (52.5 U·m⁻¹). The samples were incubated at room temperature for 20 min and the reaction stopped by the addition of 10 μL 18 N sulphuric acid. The reaction product was measured spectrophotometrically (Model 46; Lomo Inc., St-Petersburg, Russia) at 450 nm. A standard curve of H₂O₂ was performed for each assay.

Safety of the treatment

At each visit subjects were specially asked for any adverse events and health problems that may have occurred. All unusual signs and symptoms were recorded for further consideration. The safety of the treatment was evaluated by monitoring blood pressure, concentrations of creatinine, bilirubin, activity of liver transaminases and alkaline phosphatase in serum at clinical visits.

Analysis of data

Paired and unpaired two-tailed t-tests were used for statistical analysis. A p-value <0.05 was considered significant, and the data are expressed as mean±SEM.

Results

Subjects

Of 60 volunteers recruited to the study, 46 fulfilled the entry criteria and were randomised to treatment. The most common reason for withdrawal before randomisation was deterioration in asthma control (14 subjects). These patients had a lower FEV₁

(70.3±2.1% pred) than those who were randomised (87.60±2.5, $p<0.001$). All randomised patients completed the treatment and were included in the statistical analysis. Thirty six of them had mild asthma and 10 patients had moderate asthma.

Compliance

The mean self-recorded compliance with the two-times daily study medications (Lyprinol or placebo) was 95% and 93%, respectively.

Asthma symptoms and bronchodilator use

Mean daytime wheeze was significantly reduced in patients treated with Lyprinol compared to those treated with placebo (table 2). There were no

significant differences between the two treatment groups in respect to nocturnal awakening and use of short-acting β_2 -agonists (table 2).

Lung function tests

Mean FEV₁ and evening PEF during the treatment with Lyprinol did not significantly differ from those during the treatment with placebo. However, mean morning PEF was significantly higher during the treatment with Lyprinol than with placebo (table 2).

Exhaled hydrogen peroxide

Mean concentrations of exhaled H₂O₂ were significantly reduced during the treatment with Lyprinol compared to placebo (table 2).

Table 2. – Efficacy results

Parameters	Placebo	Lyprinol	p-value
Patients n	23	23	
Daytime wheeze			
Baseline	1.41±0.42	2.27±0.36	0.131
4 week	1.23±0.26	1.07±0.23	0.637
Δ	-0.17±0.33	-1.20±0.24	0.023
8 week	1.29±0.17	0.73±0.21	0.041
Δ	-0.11±0.43	-1.53±0.42	0.026
Night awakenings			
Baseline	0.69±0.24	1.09±0.16	0.195
4 week	0.54±0.18	0.45±0.16	0.737
Δ	-0.15±0.27	-0.64±0.20	0.184
8 week	0.61±0.14	0.36±0.20	0.308
Δ	-0.08±0.29	-0.73±0.19	0.085
Usage of β_2 -agonists puffs·day ⁻¹			
Baseline	2.17±0.64	3.17±0.56	0.252
4 week	1.92±0.43	1.92±0.78	1.0
Δ	-0.25±0.52	-1.25±0.55	0.202
8 week	2.00±0.48	1.58±0.42	0.253
Δ	-0.17±0.38	-1.59±0.60	0.022
FEV ₁ % pred			
Baseline	92.32±2.9	82.89±4.2	0.073
8 week	90.53±3.2	82.87±3.6	0.124
Δ	-1.79±4.4	-0.02±2.85	0.708
Morning PEF L·min ⁻¹			
Baseline	384.3±21.5	361.3±17.4	0.409
28 day	376.0±26.0	392.2±18.9	0.619
Δ	-8.3±9.4	30.9±13.6	0.022
56 day	350.9±21.3	408.3±18.7	0.049
Δ	-33.4±6.2	47.0±11.7	0.00001
Evening PEF L·min ⁻¹			
Baseline	399.6±16.7	375.4±18.2	0.333
4 week	395.9±23.0	404.8±17.1	0.758
Δ	-3.7±11.4	29.4±11.5	0.047
8 week	403.9±18.3	406.5±19.7	0.923
Δ	4.3±10.3	31.1±14.6	0.136
Exhaled H ₂ O ₂ μ M			
Baseline	0.12±0.04	0.11±0.02	0.706
4 week	0.11±0.02	0.07±0.01	0.072
Δ	-0.01±0.03	-0.04±0.02	0.509
8 week	0.16±0.04	0.05±0.01	0.022
Δ	0.04±0.05	-0.06±0.01	0.0001

Data are expressed as mean±SEM. Δ : change from baseline value; FEV₁: forced expiratory volume in one second; PEF: peak expiratory flow; H₂O₂: hydrogen peroxide. Asthma symptoms were ranked on a scale from 0 (none) to 3 (very uncomfortable and interferes with normal activities).

Safety of the treatment

One patient treated with Lyprinol and one patient treated with placebo had skin itch. One patient in the Lyprinol group and two patients in the placebo group complained of a metallic taste. There were no significant changes in blood pressure, or in concentrations of serum creatinine, bilirubin, liver transaminases or alkaline phosphatase in either group of patients (data not shown).

Discussion

The data from this study show that a stabilised lipid extract of New Zealand green-lipped mussel, *Perna canaliculus* (Lyprinol), reduces daytime wheeze and improves morning PEF in steroid-naïve patients with atopic asthma compared to placebo. There were no differences between patients treated with Lyprinol and placebo with respect to FEV₁. It should be noted that most of the patients had mild asthma and FEV₁>80% pred and thus there was little room for improvement in this measurement.

Lyprinol was well tolerated and had very few side-effects. The findings of the present study are in agreement with a previously published study [1].

The mechanism by which lipid extract of New Zealand green-lipped mussels exerts its beneficial effect remains to be elucidated. Lyprinol inhibits leukotriene production by stimulated human polymorphonuclear leukocytes *in vitro* [2]. Much of this activity was associated with its content of ω-3 polyunsaturated fatty acids (eicosapentaenoic acid and docosahexaenoic acid) and antioxidants such as carotenoids. ω-3 polyunsaturated acids inhibit arachidonate metabolism by 5'-lipoxygenase and cyclo-oxygenase [6], thus reducing the formation of leukotrienes and prostaglandins. Dietary supplementation with ω-3 polyunsaturated fatty acids can suppress synthesis of interleukin-1 and tumour necrosis factor-α by mononuclear cells [11]. Epidemiological studies in Inuit, Dutch [12], American [13], Australian [14] and Japanese populations [15] have shown that a high dietary intake of ω-3 polyunsaturated fatty acids is associated with lower incidence of cardiovascular disease and inflammatory diseases, such as asthma and rheumatoid arthritis. Dietary supplementation with fish oil rich in the ω-3 polyunsaturated fatty acids over a 10-month period is beneficial in children with asthma following a strictly controlled diet and controlled allergen exposure [16].

Leukotrienes are mediators of airway inflammation in asthma. They induce bronchoconstriction and airway smooth muscle proliferation [17, 18], stimulate mucus secretion [19], increase microvascular permeability and cause infiltration of inflammatory cells such as eosinophils and neutrophils into the airways [20, 21]. These cells release superoxide anions which then undergo spontaneous or enzyme-catalysed dismutation to form H₂O₂. H₂O₂ is a highly reactive oxygen species involved in cellular injury *via* further reactions leading to hydroxyl radical and lipid peroxidation products [22]. Increased production of free

radicals occurs in airway inflammation, and H₂O₂ is detectable in exhaled air [23].

Several studies have shown that H₂O₂ in expired breath condensate may be a nondirect marker of oxidative stress and airway inflammation in asthmatic patients [24, 25]. Exhaled H₂O₂ levels have previously been related to the eosinophil differential counts in induced sputum and activity of peripheral neutrophils in asthmatic patients [25, 26]. Therefore, elevated concentrations of H₂O₂ may result from an enhanced number and activity of inflammatory cells in the airways.

In the present study, the authors found that elevated concentrations of exhaled H₂O₂ were significantly decreased during treatment with Lyprinol compared to placebo. This may result from a reduction in the number of inflammatory cells in asthmatic airways because of decreased synthesis of leukotrienes and may also be due to the antioxidants such as β-carotene contained in Lyprinol.

In conclusion, this study shows that a lipid extract of New Zealand green-lipped mussel may have some beneficial effects in patients with steroid-naïve atopic asthma. Further clinical studies are needed to determine whether it may be useful as a supplement to other medications in the treatment of asthmatic patients.

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