Respiratory Medicine xxx (2015) 1–5

Contents lists available at ScienceDirect

Respiratory Medicine

journal homepage: www.elsevier.com/locate/rmed

The effect of body posture during medication inhalation on exercise induced bronchoconstriction in asthmatic children☆

Reina Visser [a, *], Mariet Wind [b], Beike J. de Graaf [c], Frans H.C. de Jongh [d], Job van der Palen [e, f], Bernard J. Thio [a]

[a] Department of Pediatrics, Medisch Spectrum Twente, P.O. Box 50 000, 7500 KA, Enschede, The Netherlands
[b] Department of Emergency, Röpcke-Zweers Hospital, Hardenberg, The Netherlands
[c] Department of Psychiatry, Ziekenhuisgroep Twente, Almelo, The Netherlands
[d] Department of Pulmonary Function, Medisch Spectrum Twente, Enschede, The Netherlands
[e] Medical School Twente, Medisch Spectrum Twente, Enschede, The Netherlands
[f] Department of Research Methodology, Measurement and Data Analysis, University of Twente, Enschede, The Netherlands

ARTICLE INFO

Article history:
Received 27 April 2015
Received in revised form
1 August 2015
Accepted 15 August 2015
Available online xxx

Keywords:
Asthma
Pediatrics
Body position
Inhalation therapy
Pulmonary deposition

ABSTRACT

Rationale: Inhaling medication in a standard body posture leads to impaction of particles in the sharp angle of the upper airway. Stretching the upper airway by extending the neck in a forward leaning body posture may improve pulmonary deposition. A single dose of inhaled corticosteroids (ICS) offers acute, but moderate protection against exercise induced bronchoconstriction (EIB). This study investigated whether inhaling a single dose of ICS in a forward leaning posture improves this protection against EIB.
Methods: 32 Asthmatic children, 5–16 years, with EIB (Median fall in FEV_1 or $FEV_{0.5}$ 30.9%) performed two exercise challenge tests (ECT's) with spirometry in a single blinded cross-over trial design. Children inhaled a single dose of 200 μg beclomethasone dipropionate (BDP) 4 h before the ECT, once in the standard posture and once with the neck extended in a forward leaning posture. Spirometry was also performed before the inhalation of the single dose of BDP.
Results: Inhalation of BDP in both body postures provided similar protection against EIB (fall in $FEV_{1\ or}$ $FEV_{0.1}$ in standard posture 16.7%; in forward leaning posture 15.1%, $p = 0.83$). Inhaling ICS in a forward leaning posture significantly delayed EIB compared to inhaling in the standard posture (respectively 2.5 min ± 1.0 min vs. 1.6 min ± 0.8 min; difference 0.9 min (95CI 0.25; 1.44 min); $p = 0.01$).
Conclusion: Inhalation of a single dose BDP in both the forward leaning posture and the standard posture provided effective and similar protection against EIB in asthmatic children, but the forward leaning posture resulted in a delay of EIB.
Register: NTR3432 (www.trialregister.nl).

1. Introduction

In recent years there is a trend towards the use of breath-actuated inhalers (BAI's) to overcome coordination problems. A drawback however is the massive impaction in the oropharynx. A radio-labelled study showed that under optimal conditions in children of 5–14 years 40–60% of the dose of beclomethasone dipropionate (BDP) inhaled via a breath actuated inhaler (BAI) impacted in the oropharynx. Oropharyngeal deposition was inversely related to age [1]. Dubus et al. showed that approximately 60% of asthmatic children using inhaled BDP or budesonide reported local side effects such as coughing, hoarseness, dysphonia and oral candidiasis [2].

A recent study of Brandao et al. showed that inhaling nebulised bronchodilators in a forward leaning posture during an asthma exacerbation improved recovery of lung function in asthmatic adults compared to the conventional posture [3]. It was suggested

Abbreviations: ICS, Inhalation corticosteroids; EIB, exercise induced bronchoconstriction; FEV_1, forced expiratory volume in 1sec; $FEV_{0.5}$, forced expiratory volume in 0.5sc; ECT, exercise challenge test; BPD, beclomethasone-dipropionate; BAI, breath actuated inhaler; (C)-ACT, (childhood) asthma control test.

☆ This study was performed in Medisch Spectrum Twente, Enschede, the Netherlands.

* Corresponding author.
E-mail address: reinavisser85@gmail.com (R. Visser).

http://dx.doi.org/10.1016/j.rmed.2015.08.012
0954-6111/

that this was due to an increased pulmonary deposition [4,4a,4b].

Exercise induced bronchoconstriction (EIB) is a highly prevalent and specific symptom of childhood asthma and reflects airway inflammation [5]. Long term regular use of inhaled corticosteroids (ICS) reduces EIB in asthmatic children [6]. Several studies showed that a single high dose of ICS (1000–1600 μg), also offers acute protection against EIB [7–10]. We hypothesize that a single low dose of 200 μg ICS inhaled in a forward leaning body posture with the neck extended would also improve protection against EIB.

The aim of this study was to investigate the protective effect against EIB of a single low dose of 200 μg BDP inhaled 4 h prior to an ECT.

2. Methods

2.1. Subjects

This study had a prospective cross-over design. Children 5–16 years, with a paediatrician's diagnosis of asthma were recruited from the outpatient clinic of the paediatric department of Medisch Spectrum Twente, Enschede, The Netherlands, from October 2013 through February 2014. None were taking ICS or nasal corticosteroids for at least 2 months prior to the study. Children with other pulmonary or cardiac disorders were excluded. Children being admitted to the hospital or being prescribed systemic corticosteroids because of an exacerbation in the last eight weeks prior to the ECT were excluded.

2.2. Inhalation technique

Children performed two ECT's within a time period of two weeks preceded by the inhalation of 200 μg BDP with an Autohaler® (Qvar®) without a spacer. Four hours prior to one ECT they inhaled BDP in the standard body posture and head position according to the standardized instructions from the Dutch Lung Foundation [11]. Four hours prior to the other ECT they inhaled BDP in the forward leaning body posture with the neck extended (Fig. 1). The different body postures during inhalation were randomized. The investigator performing the ECT was blinded to the body posture in which the children had inhaled their medication.

A well-trained medical student administered the medication at the child's home or school, after a baseline pulmonary function measurement was performed.

2.3. Exercise challenge test

In the hours between the medication administration and the ECT, children were allowed to go to school or play but without exercising. Therefore, parents had to take their child to the ECT by car, while older children arrived by bus or scooter. The two ECT's were performed within a time period of 2 weeks at an indoor ice skating rink, because of the standardized cold and dry air conditions (9.5–10° and humidity 57–59%), reflecting real life outdoor conditions in the Netherlands. The minimal time period between the two ECT's was 48 h.

The ECT's were performed as previously described by Van Leeuwen et al. and Driessen et al. [12,13]. In summary, children 6–10 years old jumped for a maximum of 6 min on a jumping castle and children 12–16 years old performed both ECT's on a treadmill with a 10° slope (Trimline® 7150). Children 10–12 years old could choose between the two ECT formats. Heart rate was continuously monitored by a radiographic device (Garmin Forerunner 610) and the target was to achieve 80%–90% of the maximum estimated heart rate (220-age). Pulmonary function was measured before, during and after exercise using standard European Respiratory Society (ERS) protocol [14] in case of an ECT on the jumping castle and only before and after the ECT in case of running on the treadmill. An exercise induced fall in FEV_1 of ≥13% (or $FEV_{0.5}$ if FEV_1 was not reproducible in the youngest children) compared to baseline was considered as positive for EIB [15]. An exercise induced fall in FEV_1 or $FEV_{0.5}$ ≥13% during exercise compared to baseline was considered positive for break through asthma. Percentage of predicted baseline FEV_1 was measured with the aid of the Koopman formulae [16].

2.4. Questionnaires

Children <12 years old answered, with their parents, the Childhood Asthma Control Test (C-ACT) at the end of the study to measure asthma control. Children ≥12 years old answered the Asthma Control Test (ACT) [17,18].

Children (and parents) were asked for the body posture and head position they commonly used during inhaling medication at home.

Children were also asked for any possible discomfort during the forward leaning posture.

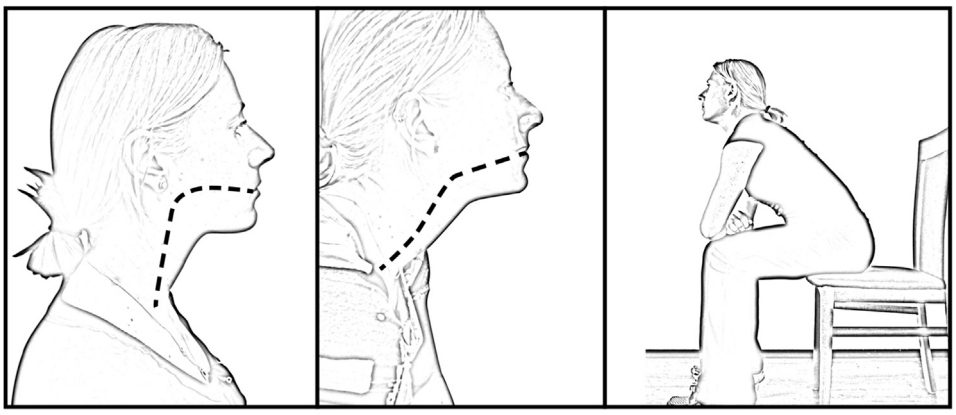

Fig. 1. Different body postures during BDP inhalation.

Please cite this article in press as: R. Visser, et al., The effect of body posture during medication inhalation on exercise induced bronchoconstriction in asthmatic children, Respiratory Medicine (2015), http://dx.doi.org/10.1016/j.rmed.2015.08.012