



Use of Assist Devices to Actuate Pressurized Metered-Dose Inhalers in Elderly Patients with Asthma

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ABSTRACT

Introduction: Some elderly patients experience difficulty when attempting to use pressurized metered-dose inhalers (pMDIs) due to reduced finger muscle strength. However, no studies have investigated the finger muscle strength required for pMDI actuation. Therefore, we created a modified pMDI pinch gauge and examined the finger muscle strength in elderly asthmatic patients with and without the use of a pMDI assist device to push the canister.

Methods: We measured the finger muscle strength (N) required to spray pMDI formulations (Adoair[®], Alvesco[®], Flutiform[®], and Breztri[®]) using one hand in healthy individuals. We then similarly measured the finger muscle strength when using the modified pinch gauge in older adults aged 65 years or older with

bronchial asthma who used pMDI formulations.

Results: The finger muscle strength required to actuate these devices was 29.4 N or more in healthy individuals. In the older patients with asthma, the finger muscle strength was 38.45 ± 5.80 N in men and 31.34 ± 9.94 N in women. The finger muscle strength was ≤ 29.4 N in 6.6% of men and 40.0% of women.

Conclusions: Finger muscle strength should be considered when selecting a device for older patients with asthma, and the use of a pMDI assist device to push the canister is recommended in patients with weaker finger muscles.

Keywords: Elderly patients with bronchial asthma; Finger muscle strength; Pinch gauge; pMDI assist device; Pressurized metered-dose inhaler (pMDI)

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Key Summary Points

Why carry out this study?

Drugs delivered via pressurized metered-dose inhalers (pMDIs) are indispensable for the management of asthma, but there is difficulty in actuating the pMDI, especially in those with reduced finger muscle strength such as older patients; thus, the expected effects for disease control are not obtained in many cases.

To the best of our knowledge, there have been no studies on finger muscle strength in the context of asthma and the delivery of medication by pMDIs.

We aimed to determine the finger muscle strength of older adults with asthma (aged ≥ 65 years) as compared to healthy individuals using a novel pMDI pinch gauge that we have created with the hypothesis that the force needed to adequately deliver inhaled medications is inadequately generated by older individuals with asthma.

What was learned from the study?

The finger muscle strength required to spray medication from these devices was 29.4 N or more in healthy individuals; among the older patients with asthma, it was 38.45 ± 5.80 N in men and 31.34 ± 9.94 N in women; and it was 29.4 N or less in 6.6% of men and 40.0% of women.

Finger muscle strength should be considered when selecting a device for older patients with asthma, and the use of a pMDI spacer is recommended in patients with weaker finger muscle strength.

DIGITAL FEATURES

This article is published with digital features, including a summary slide, to facilitate understanding of the article. To view digital features for this article go to <https://doi.org/10.6084/m9.figshare.13615433>.

INTRODUCTION

Inhaled drugs are indispensable for the treatment of asthma [1]. Inhaler devices can be categorized as pressurized metered-dose inhalers (pMDIs), dry powder inhalers (DPIs), and soft mist inhalers. The problem with pMDIs is the difficulty surrounding coordination of actuation and inhalation, but despite an extensive literature review, we found no studies on finger muscle strength required for spraying. Elderly patients often have decreased muscle strength, respiratory function, hearing ability, comprehension, motivation, and sensitivity to symptoms due to aging, and they often have concurrent dementia, neurological diseases, and motor disease; in many cases, the expected effects of treatment are not attained [2]. One report noted that the level of acquisition of inhalation technique in elderly patients aged 75 years or older was similar to that in 5-year-old children [3]. One of the possible causes of this is weak finger muscle strength in the elderly. We have managed patients who could not push a pMDI canister with one hand, which patients in adolescence and middle age can easily do. To the best of our knowledge, there have been no reports of studies that have objectively measured and compared the finger muscle strength required to use a pMDI. Therefore, we created a pMDI pinch gauge (finger muscle strength meter) and compared the finger muscle strength between elderly patients with asthma treated with a pMDI assist device and those treated without a pMDI assist device to push the canister.

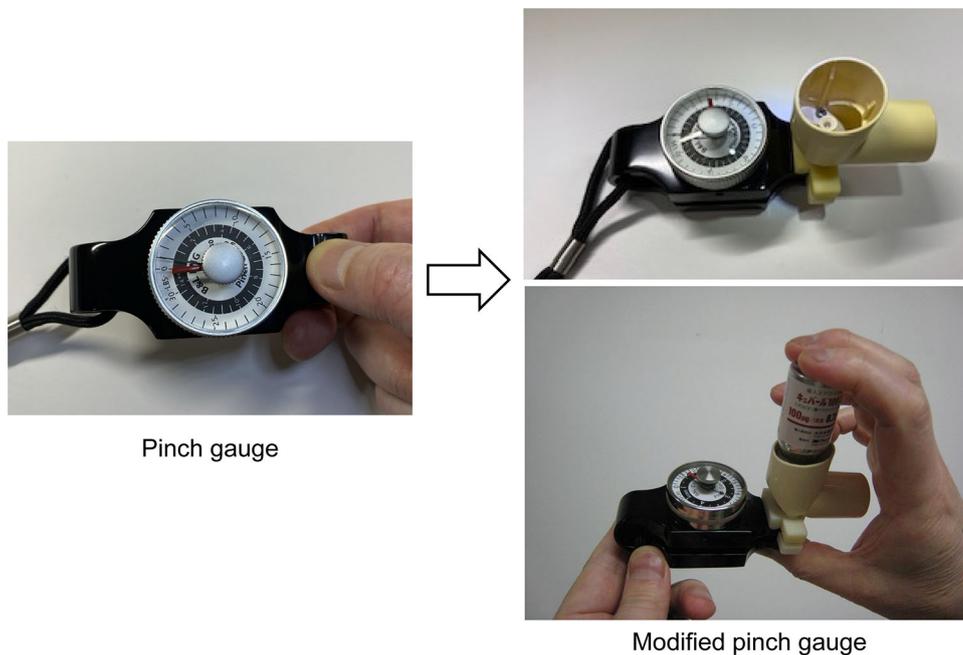


Fig. 1 Creation of a modified pinch gauge

METHODS

This study was approved by Fujita Health University Medical Research Ethics Committee (14-037) and was performed in accordance with the Helsinki Declaration of 1964 and its later amendments. All study participants provided written informed consent to participate in the study and to publish their data.

A pinch gauge is used to measure the finger muscle strength in patients with conditions such as neuromuscular disease [4]. We created a modified pinch gauge to measure the finger muscle strength required to spray pMDI formulations (Fig. 1). We ordered a custom-made plastic appliance to attach a pMDI formulation canister to the pinch gauge (Model, PG-30; Serial Number, B3S233; manufactured by B&L Engineering, Santa Ana, CA, USA). Since the unit of measurement for the pinch gauge is lbs, calculation was based on $1 \text{ lb} = 4.4482 \text{ N}$.

A pMDI was fitted to the plastic part, and the formulation was sprayed with the first finger of the dominant hand placed under the pinch gauge and the second and third fingers placed on the pMDI cylinder; the pressure at that time was measured.

The finger muscle strength required to spray pMDI formulations (Adair[®], Alvesco[®], Flutiform[®], Breztri[®]) using only one hand was measured in healthy individuals (10 men and 10 women; age, 28–58 years; mean age, 40.2 ± 9.63 years). The assist devices used with pMDI formulations are shown in Fig. 2. Measurements were performed with and without the use of an assist device. All results are presented as mean \pm standard deviation. Stat View J 5.0 was used for statistical analysis, and $p < 0.05$ was considered statistically significant by *t* test.

Next, finger muscle strength was measured using a modified pinch gauge in 60 elderly outpatients with bronchial asthma, aged 65 years or older, at our institution who had no neuromuscular disease and used pMDI formulations [age 65–94 years; 30 men (mean age 77.40 ± 7.46 years) and 30 women (mean age 78.00 ± 9.05 years)].

RESULTS

The finger muscle strength required to spray devices using one hand measured in healthy



Fig. 2 Pressurized metered-dose inhalers (pMDIs) with assist devices to push the canisters

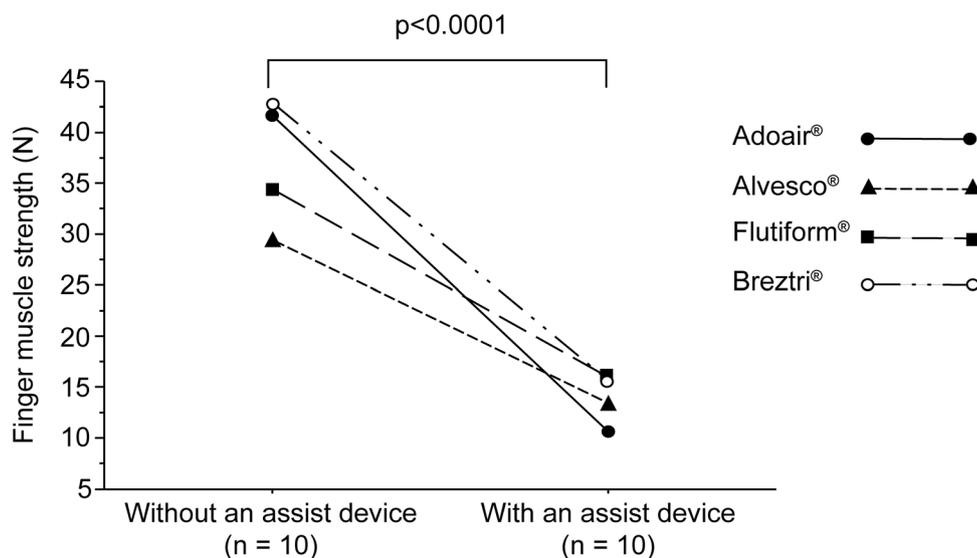


Fig. 3 Measurement of finger muscle strength required to spray pressurized metered-dose inhaler (pMDI) formulations using a modified pinch gauge

individuals using a modified pinch gauge is presented in Fig. 3. Without an assist device, the smallest finger muscle strength was required to spray an Alvesco® pMDI, followed by Flutiform®, Adoair®, and Breztri®. With an assist

device, the smallest finger muscle strength was required to spray an Adoair® pMDI, followed by Alvesco®, Breztri®, and Flutiform® (Table 1). All pMDI formulations could be sprayed using less

Table 1 Measurement of the finger muscle strength required to spray pMDI formulations using a modified pinch gauge in healthy individuals

	Without an assist device (n = 10)	With an assist device (n = 10)
Adoair®	41.7 ± 0.46 N	10.7 ± 0.64 N
Alvesco®	29.4 ± 0.76 N	13.7 ± 0.65 N
Flutiform®	34.5 ± 0.62 N	16.0 ± 0.77 N
Breztri®	42.3 ± 1.02 N	15.6 ± 0.75 N

pMDI pressurized metered-dose inhaler

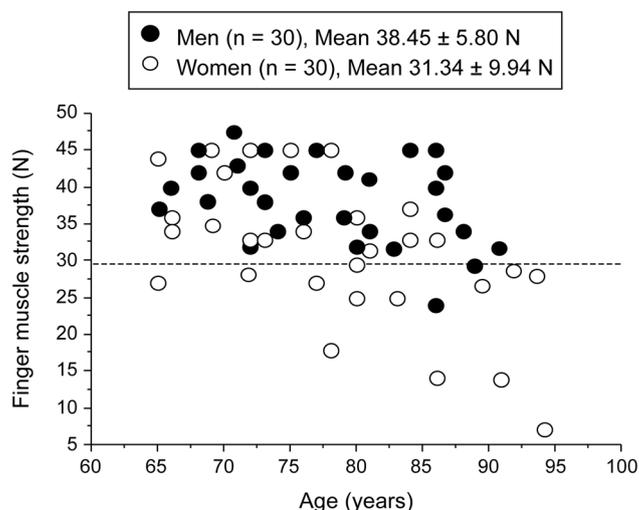


Fig. 4 Measurement of the finger muscle strength in elderly patients using inhalers

finger muscle strength with the use of an assist device.

Figure 4 shows the measurement results of finger muscle strength using a modified pinch gauge in elderly patients with asthma. The mean finger strength was 38.45 ± 5.80 N in men ($n = 30$) and 31.34 ± 9.94 N in women ($n = 30$; Fig. 4). The dotted line indicates the finger muscle strength of 29 N required for the Alvesco[®] pMDI, which could be sprayed with the least finger muscle strength. In total, 2/30 (6.6%) men and 12/30 (40.0%) women were unable to reach the required finger muscle strength of 29.4 N to spray the device; 40% of women had inadequate finger muscle strength to use a pMDI.

DISCUSSION

In this study, we created a modified pinch gauge and measured the finger muscle strength required to spray various pMDI formulations (Adoair[®], Alvesco[®], Flutiform[®], and Breztri[®]). We found that Alvesco[®] required the least finger muscle strength of 29.4 N to spray the formulation, while the other pMDI formulations required a finger muscle strength of 30 N or more. However, with an assist device to push the canister, all pMDI formulations could be sprayed with finger muscle strengths of 20 N or

lower. The finger muscle strength in elderly patients was 30 N or lower in 6.6% of men and 40% of women, suggesting that spraying pMDI formulations with one hand is impossible without an assist device to push the canister. Therefore, when recommending pMDI formulations to elderly patients with asthma or patients with disorders, such as neuromuscular diseases, it is necessary to confirm whether they are able to spray the sample formulation, using a pinch gauge near the mouth, prior to prescription. The use of the assist device is ideal for patients with weak finger muscle strength.

The number of elderly patients who cannot use devices well is greater than that anticipated by physicians. When selecting a device for elderly patients with asthma, it is necessary to select a device suitable to the patient's medical history [4]. This study demonstrated that a possible solution is to consider the patient's finger muscle strength. Particularly in elderly patients, it is necessary to manually check whether they can use devices without any problems after being prescribed pMDI formulations. In the future, we would like to investigate whether the use of a pMDI assist device in patients with weak finger muscle strength would lead to an improvement in asthma control.

CONCLUSIONS

We found that finger muscle strength should be considered when selecting a device for older patients with asthma, and that the use of a pMDI assist device to push the canister is recommended for patients with weaker finger muscle strength. As the present investigation is a basic study, in the future, we plan to investigate the clinical efficacy of the pMDI assist device by comparing the outcomes of patients treated with and without the use of such a device. We also plan to analyze the exacerbation control to contribute to the improvement of quality of life of patients treated for asthma.

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Compliance with Ethics Guidelines. This study was approved by Fujita Health University Medical Research Ethics Committee (14-037) and was performed in accordance with the Helsinki Declaration of 1964 and its later amendments. All study participants provided written informed consent to participate in the study and to publish their data.

Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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