Concurrent Use Of Metered Dose Inhalers Without Spacer And Dry Powder Inhalers By Asthmatic Children Adversely Affect Proper Inhalation Technique

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Abstract

Asthma is a common chronic disease of children. A good control of symptoms will improve quality of patient life. Inhalation technique is an important aspect in the management of asthma. The better the inhalation technique the better the lung deposition of asthma therapy especially inhaled corticosteroids. This will lead to better control of symptoms and improve adherence to treatment. In the following study the inhalation technique of asthma devices were compared using inhalation technique score system. The asthma devices studied were metered dose inhalers (pressurized MDI) without spacers and dry powder inhalers (DPI). The hypothesis studied was that the inhalation technique score of dry powder inhalers will be adversely affected with concurrent use of metered dose inhalers without spacers.

INTRODUCTION

The purpose of the current study was to examine whether asthmatic children using multiple types of inhalers demonstrate poor inhalation technique scores in comparison to those patients using only one type of inhaler. The working hypothesis is that the inhalation technique score for the dry powder inhalers (DPI) when used in combination with the metered dose inhaler (pressurized MDI without spacer) will exhibit lower inhalation technique scores than when DPI are used alone.

Pediatric outpatients (n=97) at Farwania Hospital who regularly used pMDI and /or DPI (Turbuhaler or Diskus) asthma inhalers were evaluated.

METHODS

Informed consent was obtained from caregivers of 97 outpatient asthmatic children at the Asthma Clinic in Farwania Hospital. All subjects met the inclusion criteria, i.e. asthmatics on inhaled asthma therapy and able to perform inhalation technique for the medication they were using.The DPI inhalers investigated were Turbuhaler (TH; AstraZeneca) or Diskus (DK; GlaxoWellcome). Subjects used one of these DPI inhalers alone or in combination with pMDI. All pMDI were HFA type. The old CFC inhalers contain chlorofluorocarbons, which harm the ozone layer. Replacements of CFCs have been available since 1996, and are known as HFAs (hydrofluoroalkanes). HFA inhalers provide the same level of safety and efficacy as CFC inhalers, but without harming the ozone layer (the Montreal Protocol on Substances that Deplete the Ozone Layer (15).

The technique of pMDI without spacer is different than pMDI with spacer. The actuation inhalation coordination is crucial for pMDI while this is not important if using a spacer. In is a common practice for children older than 6 years to use pMDI without spacer because of portability and cost issues. Assessments were performed in the outpatient clinic. The inhalation technique was evaluated during the clinic visit and scored using a modified inhaler-specific checklist adapted from the Dutch Asthma Foundation technique score. These patients received inhalation technique instruction from the asthma clinic if they were follow-up patients, or alternatively received instruction from outside the asthma clinic if they were new patients to the clinic. All consenting patients who were taking inhaled treatments for asthma were recruited for this study. A well trained investigator, using inhaler-specific checklists adapted from the Dutch Asthma Foundation (12) assessed the patients' inhalation technique with their prescribed asthma inhalers (tables 1-3). The total score was obtained by multiplication of all the scores then multiplying the total by

100 to get a percent score. Steps of inhalation technique were given certain score according to the importance and degree of accuracy (2-5). The investigator counted the number of correct steps in a child's technique, with each step assigned certain point. The total points were then divided by the maximum points and further multiplied by 100 to determine a percentage score. This system incorporates the relative importance of each step in the inhalation technique. For each inhaler, items essential to the delivery of active drug into the lungs were identified. These key items involve preparing or loading the device prior to inhalation, which is performed differently for pMDI and DPI, and the inspiration maneuver. DPI requires a deep and forceful inhalation which can be graded according to the inspiration strength; whereas for the pMDI, a slow continuous inhalation, which should not be halted when the medicine is fired into the mouth, is required. With the pMDI, hand/lung coordination is a well known problem which does not exist with the DPI; however, inspiration flow of 30 to 60 l/min is crucial to the Diskus and the Turbuhaler DPI. An inhaler score of 50% or less will be judged as 'inadequate', 50-75% as 'adequate', and >75% as 'good' (6).

Figure 1

Table 1 Inhalation technique scoring for pMDI

Step	*Yes*	*No*
1. Remove cap* (3)	1	0
2. Shake canister (4)	1	0.8
3. Slow exhalation of tidal volume	1	0.9
4. Hold canister upright in front of or in mouth (tilt head back slightly)	1	0.9
5. Actuate the MDI once*	1	0
6. One deep inhalation (4)	1, 0.75, 0.5, 0.25	0
7. Hold breath for at least 5 s(4)	1	0.9
8. Wait at least 30 s before next actuation	1	0.8
Total score multiplied by 100 to get %		

*Failure to perform any of these maneuvers results in a score of zero.

Figure 2

Table 2 DPI – Turbuhaler inhalation technique score

Step	*Yes*	*No*
1. Remove the cap*	1	0
2. Load the turbuhaler*	1	0
3. Hold inhaler upright, don't tip, and tilt head back slightly (2)	1	0.9
4. Breath out slowly (2)	1	0.9
5. Close lips tightly around mouthpiece of the inhaler	1	0.5
6. Inhale rapidly* (1),(2)	1, 0.75, 0.50, 0.25	0
7. Breath in to total lung capacity (2)	1, 0.75, 0.50, 0.25	0
8. Hold breath for at least 5 s(2)	1	0.9
Total score		

Figure 3

Table 3 Diskus inhalation technique score:

Step	*Yes*	*No*
1. Hold inhaler horizontal	1	0.9
2. Open diskus*	1	0
3. Rotate grip and back until click*	1	0
4. Exhale away from mouthpiece to residual volume	1	0.9
5. Mouthpiece between teeth and lips	1	0.9
6. Keep head upright or slightly tilted	1	0.9
7. Inhale rapidly to total lung capacity	1, 0.75, 0.50, 0.25	0
8. Hold breath for 5-10 s	1	0.9
Total score		

STATISTICAL ANALYSIS

For the purpose of statistical analysis, patients were grouped into 3 treatment groups: DPI, DPI + pMDI or pMDI alone. Thirty patients (30.9%) used DPI only, while there were 38 patients (39.2%) in the combination group and 29 patients (29.9%) in the pMDI alone group. Descriptive statistics on all variables were performed. One way analysis of variance was performed on the duration of asthma variables for the 3 treatment group situation. Independent sample t-tests were performed on duration of asthma, inhalation technique score for pMDI, Turbuhaler and Diskus devices, the sum of pMDI device scores, and the sum of all DPI technique scores.

RESULTS

In 97 asthmatic children (mean age 11.59 ± SD 3.9 years) inhalation technique was assessed. Of these, 59 (60.8%) were males and 76 (78.4%) received instruction in the asthma clinic (Table 4). Those who received instruction in the asthma clinic had asthma for a mean of 8.6 years. Those who received teaching from outside the clinic (21 children) had asthma for a mean of 4.5 years. Twenty-eight patients (25 from within the asthma clinic and 3 from outside) used the Turbuhaler, with 12 of these 28 patients using it in combination with pMDI. Meanwhile, 40 children used the Diskus inhaler (35 from within the asthma clinic and 5 from outside), with 26 of these users combining the Diskus device with pMDI. Overall, there were 30 patients (30.9%) in the DPI treatment group and 38 patients (39.2%) using both DPI and pMDI inhalers. The DPI alone group exhibited a significantly higher inhalation technique score (85.7% vs. 61.9%; $p<0.05$). The mean of the Turbuhaler technique score was 87% when used alone, which decreased to 61.3% when used in combination with pMDI ($p<0.05$). Similarly, the mean of the Diskus technique score was also significantly reduced (83.4% to 62%) under these same conditions ($p<0.05$) (tables 5 and 6).

Figure 4

Table 4 Demographic and key baseline characteristics of all patients

characteristics			
Sex			Total n = 97
Male	59 (60.8%)		
Female	38 (39.2%)		
Age: Mean (range)	11.59 (7.69- 15.49)		
Technique teaching		Duration of Asthma	
In Asthma clinic	76 (78.4%)	8.6 years	
Primary care	21(21-6%)	4.5 years	
Turbuhaler Group	Total 28	pMDI combination	
Asthma clinic	25	yes 12	
From Primary Care	3	No 16	
Diskus Group	Total 40	pMDI combination	
Asthma clinic	35	yes 26	
Primary Care	5	No 14	
Groups		Technique score	p<0.05
DPI group	30 (30.9%)	85.7%	
DPI +pMDI	38 (39.2%)	61.9%	

Figure 5

Table 5

Inhalers	Patients n (% of total)	Technique score
DPI	30 (30.9%)	85.7%
DPI + MDI	38 (39.2%)	61.9%* p≤0.05

Figure 6

Table 6

	Alone	With pMDI	Significance
Turbuhaler score	87%	61.3%	p≤0.05
Diskus score	83.4%	62%	p≤0.05

DISCUSSION

One of the largest changes in asthma management has been the development of inhaled therapy as the preferred route of administration (7,8). In a previously published report, Paterson and Crompton showed that 15% of their subjects who were using metered dose inhalers had poor inhaler technique despite repeated instructions on correct usage (1).Other authors have suggested that greater than 60% of aerosol inhaler users do not have adequate technique (8). Most reports on inhaler technique relate to metered dose inhalers but a wide range of alternative devices have now been produced. The addition of spacer devices to pMDI have enabled young children and severely affected patients to benefit from inhaled therapy, as well as the recent widespread use of dry powder devices (2). If patients are not using their inhalers correctly, the need for increased dosages, systemic steroids, and regular visits to the doctor may ensue (5). Therefore, the correct inhalation technique is extremely important. If the correct device is chosen and the patient can use it effectively, more of the inhaled drug will reach the lungs, thus providing greater lung deposition and, ultimately, better asthma control (10). The National Heart, Lung, and Blood Institute's “Practical Guide for the Diagnosis and Management of Asthma” recommends that practitioners follow these steps for effective inhaler technique training when first prescribing an inhaler: 1. teach patients the steps and give written instruction handouts. 2. Demonstrate how to use the inhaler step-by-step. 3. Ask patients to demonstrate how to use the inhaler. Let the patient refer to the handout on the first training. Then use the handout as a checklist to assess the patient's future technique. 4. Provide feedback to patients about what they did right and what they need to improve. Have patients demonstrate their technique again, if necessary. The last two steps should be performed (i.e., demonstration and providing feedback on what patients did right and what they need to improve) at every subsequent visit. If the patient makes multiple errors, it is advisable to focus on improving one or two key steps at a time (13).

To our knowledge, no previously reported studies have investigated the influence of the use of multiple types of inhalers on the adequacy of inhalation technique of DPI when used in combination with pMDI in children. In the adult litrature only one study looked at this issue . Van der Palen et al found that in 208 adult asthmatics with only one inhaler, 71% made no inhalation errors versus 61% of 113 patients with two or more different inhalers. Of patients with a combination of DPI 68% performed all essential checklist items correctly, versus 54% of patients with the combination of pMDI and DPI (12). In our study the most common inhalers used were MDI, Turbuhaler and Diskus, whereas other inhalers were used more commonly by their patients such as diskhaler, rotahaler since this study was done at the era of old inhalers before the popular use of turbuhaler and diskus. We think the low inhalation technique of 71% in the only one of inhaler group was due to the multiple inhalers studied creating an inhomogenous group which affected the total score to be low. In our study we tried to avoid this error and compare the most common inhalers used in the market and also because the other inhalers such as diskhaler and rotahaler are not available in our pharmacy any more.

We found that the inhalation technique scores associated with both the Diskus and Turbuhaler were significantly reduced when used in combination with pMDI. The explanation of this finding might be that, when inhaling with

a DPI the patient has to inspire forcefully, where as with an MDI the inhalation has to be slow and in coordination with actuation. This basic difference might be confusing for patients. In our study the inhalation technique score was higher than the van der Palen study, we think the age group of the patient is a major factor since they have an older group of patients. Increasing age might partly explain the decreased ability to inhale medication correctly.

In a more recent study done by Chan DS et al (14) there finding were totally different from our study. they found that the mean score for the pMDI with spacer (pMDI/S) only group was 86 +/- 17% and, for the MDI/S + DPI group, 90.1 +/- 12% (p = 0.15). More patients in the MDI/S group had inadequate scores (18%) compared with those in the MDI/S + DPI group they concluded that concurrent use of the DPI inhalers did not adversely affect MDI/S technique scores of pediatric patients with persistent asthma, compared with those using MDI/S alone. Although they studied children at the same age range of our patients, the main difference was they looked at MDI with chambers only, in our patients all were using MDI without spacer and this will require a different technique and may influence the inhalation technique negatively in our patients. It seems that using MDI with spacer or chamber is protective for the inhalation technique as they found and this stress more on the recommendation of using MDI with spacers better than MDI alone. In their study they did not comment on the DPI technique score if it was affected or improved when used in conjunction with MDI/S. This observation has been noticed in other studies where the inhalation technique of the pMDI was lower than that of the DPI especially the Turbuhaler (6).

We conclude that the use of DPI inhalers in conjunction with pMDI inhalers confuses patients and reduces the likelihood of proper inhalation technique. When prescribing asthma therapy for patients, we advise physicians to consider similar devices to reduce inhalation technique errors, which may improve the drug deposition and lead to better asthma control. When MDI inhalers are to be prescribed it is important to stress on using MDI with spacer or valve holding chamber to improve inhalation technique and to reduce errors thereby improving lung deposition of the drug required. For patients using dry powder inhalers, who experience side effects caused by inhaled steroids despite good inhalation technique and rinsing of the mouth, a metered dose inhaler with holding chamber is recommended. This option is perfect for children because it is cost effective and reduces technique errors.

CONCLUSION

The data presented here suggest that the use of DPI inhalers in combination with pMDI inhalers may confuse patients and reduce the likelihood of proper inhalation technique. When prescribing asthma therapy for patients, we advise physicians to consider similar devices to reduce inhalation technique errors, which may improve the drug deposition and lead to better asthma control.

In conclusion, the use of DPI inhalers alone may be preferable to the combination of both DPI and pMDI inhalers, particularly in children.

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