

A comparative analysis of errors in inhaler technique among COPD versus asthma patients

Birsen Ocakli¹
Ipek Ozmen¹
Eylem Acartürk Tunçay¹
Sinem Gungor¹
Hilal Altinoz¹
Nalan Adiguzel¹
Zafer Ali Sak²
Gokay Gungor¹
Zuhal Karakurt¹
Peri Arbak³

¹University of Health Sciences, Sureyyapasa Chest Diseases and Thoracic Surgery Training and Research Hospital, Istanbul, Turkey; ²Department of Chest Diseases, Harran University, Faculty of Medicine, Sanliurfa, Turkey; ³Department of Chest Diseases, Duzce University, Faculty of Medicine, Duzce, Turkey

Purpose: This study was designed to evaluate errors in inhaler technique in COPD vs asthma patients and to investigate the association of poor inhaler technique with patient demographics and clinical variables.

Patients and methods: A total of 509 adult patients with COPD (n=328) or asthma (n=181) who were currently using an inhaler device were included in this study. Data on patient demographics, duration of disease, type and duration of inhaler therapy, and assessment of inhaler technique were recorded.

Results: Metered dose inhaler (MDI) was the most common type of inhaler used by a similarly high percentage of patients in both COPD (83.2%) and asthma (77.3%) groups. Failure to exhale before inhaling through device (75.8% and 68.5% for MDIs; 73.2% and 71.8% for Aerolizer[®]/Handihaler[®]; 53.1% and 66.7% for Turbuhaler[®]) was the most common error in inhaler technique, in both COPD and asthma groups. Device-specific errors in inhaler techniques were more common in asthma patients as compared with COPD patients, particularly for MDIs (*P*-values ranged from 0.046 to 0.0005), as associated with female gender (failure to press the buttons on both sides of Aerolizer[®]/Handihaler[®], *P*=0.006), shorter duration of disease (failure to hold MDI or head in a vertical position, *P*<0.001, and to keep Turbuhaler[®] upright, *P*=0.005), and shorter duration of inhaler usage (failure to hold head in a vertical position during MDI usage, *P*=0.006, and to keep Turbuhaler[®] upright, *P*=0.012).

Conclusion: In conclusion, our findings revealed that errors in inhaler technique in terms of inhalation maneuvers and device handling were similarly common in COPD and asthma patients. Errors in certain device handling maneuvers, particularly with MDIs, were more common among asthma patients than among COPD patients and associated with female gender and shorter durations of disease and inhaler therapy.

Keywords: chronic obstructive pulmonary disease, asthma, inhaler therapy, inhaler technique, metered dose inhalers, dry powder inhalers

Introduction

Inhaled therapy is a mainstay in the management of asthma and COPD.¹⁻³ Metered dose inhalers (MDIs), dry powder inhalers (DPIs), and nebulizers are the most common inhaler devices used to administer aerosolized medication in routine respiratory practice.¹⁻⁵

Optimal inhaler technique depends on correct preparation and handling of the device before inhalation and an optimal inhalation technique.³ Although MDIs are considered to be more difficult to use than DPIs,^{3,6-9} errors in inhaler technique are very common among COPD and asthma patients in daily real-life practice.^{3,5,10-16} Poor inhaler technique has been associated with inadequate drug delivery to the lungs and thus with poor disease control and worse disease outcomes.^{1-3,9,14,17-19}

Correspondence: Birsen Ocakli
University of Health Sciences,
Sureyyapasa Chest Diseases and Thoracic
Surgery Training and Research Hospital,
34854 Maltepe, Istanbul, Turkey
Tel +90 216 421 4200
Fax +90 216 421 4110
Email birsenocakli@hotmail.com

Recent global position documents from the Global Initiative for Asthma (GINA) and GOLD both highlight the critical importance of assessing inhaler technique to guide appropriate inhaler prescribing and correcting poor inhalation technique before escalating drug therapy.^{20,21}

However, published data on the interaction between patient, device, and inhaler technique are considered to be insufficient and inconsistent.¹⁹ Moreover, comparison of inhaler techniques in COPD vs asthma patients also revealed inconsistent findings with similar rate of errors^{14,17,19} or higher odds of incorrect inhaler technique in COPD patients than in asthma patients,⁸ after adjusting for age, gender, and level of education. Indeed, older age and higher prevalence of comorbidities in COPD patients have been associated with a higher likelihood of poor inhaler technique as compared with asthma patients.^{3,8} In addition, discordance between self-assessment and medical supervision in terms of rates of correct inhaler technique has been noted in COPD and asthma patients, while COPD patients were reported to be more uncertain with MDI technique on self-assessment and to make more errors during direct observation when compared to asthmatics.²²

Being addressed in a limited number of studies to date, the differences between asthma and COPD in terms of etiology, symptoms, pathophysiology, consequences of inflammation, response to therapy, and clinical course may affect the inhaler performance of patients. Thus, comparison of inhaler technique among COPD and asthma patients may help to better understand how to improve the use of inhalers. This study was therefore designed to comparatively evaluate errors in inhaler technique in COPD vs asthma patients and to investigate the association of poor inhaler technique with patient demographics and clinical variables.

Material and methods

Study population

A total of 509 adult patients with COPD (n=328) or asthma (n=181) who were currently using at least one inhaler device for at least 1 month were included in this cross-sectional, observational study conducted at a tertiary pneumology outpatient clinic from February to May 2018. MDI, Aerolizer[®]/Handihaler[®], Diskus[®], and Turbuhaler[®] were assessed in this study as the most commonly used devices of those available in Turkey. Patients aged >18 years and diagnosed with asthma according to the GINA²⁰ or with COPD according to the GOLD²¹ were included in the study. Use of inhaler therapy for less than a month, lack of attendance of regular

control visits, confirmed or suspected pregnancy, breastfeeding, allergy, sensitivity or intolerance to asthma or COPD therapy, and being on nebulizer therapy per se were the exclusion criteria of the study.

Written informed consent was obtained from each subject following a detailed explanation of the objectives and protocol of the study, which was conducted in accordance with the ethical principles stated in the Declaration of Helsinki and approved by the University of Health Sciences, Sureyyapasa Chest Diseases and Thoracic Surgery Training and Research Hospital Ethics Committee (date of approval: February 5, 2018, protocol number: 018).

Data collection

Data on patient demographics (age, gender), duration of disease, type and duration of inhaler therapy, and assessment of inhaler technique (correct, incorrect) were recorded in COPD and asthma groups. The inhaler technique for each device was evaluated through direct observation of patient's performance using checklists developed in-house specifically for each inhaler device based on the manufacturers' instructions and recommendations for correct implementation of inhalers provided by Turkish Thoracic Society Patient Information Handbook on Asthma²³ and Turkish Thoracic Society National Asthma Diagnosis and Management Guidelines.²⁴ The same interviewer, who was an experienced respiratory technician blinded to diagnosis group, registered whether each step was performed properly and in an adequate order, and errors in inhaler technique were compared between COPD and asthma groups. Errors in maneuvers that significantly differed between patients with COPD and asthma were further analyzed in relation to demographic and disease-related characteristics.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 21.0 (IBM Corporation, Armonk, NY, USA). Chi-squared test was used to analyze the comparison of categorical data between COPD and asthma groups and to analyze the influence of gender on errors in inhaler techniques that differed between COPD and asthma groups. Student's *t*-test and Mann-Whitney *U* test were used for sub-analysis of errors in inhaler techniques that differed between COPD and asthma groups in terms of age and duration of disease and inhaler therapy. Data were expressed as mean SD, percent (%), and minimum-maximum where appropriate. $P < 0.05$ was considered statistically significant.

Results

Demographic and clinical characteristics in COPD and asthma groups

The COPD group was associated with older patient age (mean SD 64.6 [10.3, 29–89] vs 56.0 [14.5, 17–90] years, $P<0.001$) and higher percentage of males (65.2% vs 22.7%, $P<0.001$) than the asthma group (Table 1).

MDI was the most common type of inhaler used by a similarly high percentage of patients in both COPD (83.2%) and asthma (77.3%) groups, followed by Aerolizer[®]/Handihaler[®] (75.9%) type of inhalers in COPD group and by Diskus[®] (41.4%) in the asthma group (Table 1).

Errors in inhaler technique in COPD and asthma groups

In both COPD and asthma patients, errors in inhalation maneuvers were the most prevalent errors, including failure to exhale before inhaling through device (75.8% and 68.5% for MDIs; 73.2% and 71.8% for Aerolizer[®]/Handihaler[®]; 53.1% and 66.7% for Turbuhaler[®]) and failure to deeply inhale (75.0% and 80.0%) for Diskus[®] type inhalers (Table 2).

The most common errors were device-specific errors and were related to shaking the MDI device before use (51.1% and 57.3%), removing the Diskus[®] (50.0% and 49.2%), and pressing the buttons on both sides of Aerolizer[®]/Handihaler[®] (26.8% and 52.6%) (Table 2).

Poorer inhaler technique was noted in asthma patients as compared with COPD patients with higher rate of errors in steps including taking off the inhaler cap (8.1% vs 14.5%,

$P=0.046$), holding the MDI in a vertical position (19.4% vs 9.9%, $P=0.011$), and holding the head in a vertical position (20.2% vs 9.9%, $P=0.007$) during MDI usage, in pressing the buttons on both sides of the device (52.6% vs 26.8%, $P=0.0005$) and holding breath for 10 seconds (33.3% vs 19.5%, $P=0.012$) during Aerolizer[®]/Handihaler[®] usage, and keeping the Turbuhaler[®] upright (25.6% vs 6.3%, $P=0.029$) (Table 2).

Sub-analysis of errors in inhaler techniques that differed between COPD and asthma groups

Shorter duration of disease (failure to hold MDI or head in a vertical position, $P<0.001$, and to keep Turbuhaler[®] upright, $P=0.005$) and shorter duration of inhaler therapy (failure to hold head in a vertical position during MDI usage, $P=0.006$, and to keep Turbuhaler[®] upright, $P=0.012$) were associated with increased likelihood of device-specific errors in inhaler techniques in patients with COPD or asthma (Table 3).

Failure to press the buttons on both sides of the Aerolizer[®]/Handihaler[®] was more common among females than among males (42.0% vs 27%, $P=0.006$) with COPD or asthma (Table 3).

Discussion

Our findings revealed that errors in inhalator technique were very frequent in both COPD and asthma patients. The inhaler techniques of COPD vs asthma patients differed mostly in certain device-specific errors rather than the inhalation maneuvers. Poor inhaler technique in device handling

Table 1 Baseline characteristics of patients in COPD and asthma groups

Patient demographics	COPD (n=328)	Asthma (n=181)	P-value
Age (years), mean (SD, min-max)	64.6 (10.3, 29–89)	56.0 (14.5, 17–90)	<0.001 ^a
Gender, n (%)			
Female	114 (34.8)	140 (77.3)	<0.001 ^b
Male	214 (65.2)	41 (22.7)	
Duration (years), mean (SD, min-max)			
Disease	9.5 (7.7, 0–40)	9.2 (9.5, 0–46)	0.727 ^c
Inhaler therapy	8.0 (6.6, 0–35)	7.0 (7.6, 0–40)	0.146 ^c
Inhaler type, n (%)			
MDI	273 (83.2)	140 (77.3)	0.067 ^b
Aerolizer [®] /Handihaler [®]	249 (75.9)	69 (38.1)	<0.001 ^b
Diskus [®]	78 (23.8)	75 (41.4)	<0.001 ^b
Turbuhaler [®]	34 (10.4)	43 (23.8)	<0.001 ^b
Nebulizer	111 (33.8)	32 (17.7)	<0.001 ^b

Notes: ^aStudent's *t*-test; ^bChi-square test; ^cMann–Whitney *U* test.

Abbreviation: MDI, metered dose inhaler.

Table 2 Errors in inhaler technique in COPD and asthma groups

	Patients with errors, n (%)		P-value
	COPD (n=223)	Asthma (n=124)	
Instructions for MDI			
Take off the inhaler cap	18 (14.5)	18 (8.1)	0.046
Shake the MDI before use	114 (51.1)	71 (57.3)	0.162
Hold the MDI in a vertical position	22 (9.9)	24 (19.4)	0.011
Hold your head in a vertical position	22 (9.9)	25 (20.2)	0.007
Exhale before use	169 (75.8)	85 (68.5)	0.092
Put the mouthpiece in your mouth, and close your lips	39 (17.5)	23 (18.5)	0.456
Press the canister when inhaling slowly	36 (16.1)	24 (19.4)	0.269
Inhale deeply	96 (43.0)	48 (38.7)	0.251
Hold your breath for 10 seconds	58 (26.0)	36 (29.0)	0.314
Exhale and wait for 30–60 seconds before the other puff	32 (14.3)	14 (11.3)	0.263
Instructions for Aerolizer®/Handihaler®			
Pull off the Aerolizer cover	20 (9.8)	12 (15.4)	0.131
Open the mouthpiece of Aerolizer	20 (9.8)	11 (14.1)	0.200
Remove the capsule from the package and put it into the space	27 (13.2)	14 (17.9)	0.201
Press the buttons on both sides of Aerolizer	55 (26.8)	41 (52.6)	0.0005
Hold your head in a vertical position	30 (14.6)	13 (16.7)	0.398
Turn your head away from Aerolizer and exhale	150 (73.2)	56 (71.8)	0.463
Put the mouthpiece in your mouth, and close your lips	26 (12.7)	12 (15.4)	0.338
Inhale deeply	93 (45.4)	42 (53.8)	0.382
Hold your breath for 10 seconds	40 (19.5)	26 (33.3)	0.012
Dispose of the capsule and put the cover back on the Aerolizer	20 (9.8)	9 (11.5)	0.407
Instructions for Turbuhaler®			
Remove the cover	2 (6.3)	8 (20.5)	0.082
Keep Turbuhaler upright	2 (6.3)	10 (25.6)	0.029
Twist grip at the base; twist around and then back until click is heard	5 (15.6)	8 (20.5)	0.415
Hold your head in a vertical position	2 (6.3)	8 (20.5)	0.082
Exhale	17 (53.1)	26 (66.7)	0.179
Put the mouthpiece in your mouth, and close your lips	4 (12.5)	12 (30.8)	0.059
Breathe in strongly and deeply	16 (50.0)	20 (51.3)	0.552
Hold your breath for 10 seconds	10 (31.3)	11 (28.2)	0.491
Breathe out gently	3 (9.4)	7 (17.9)	0.247
Put the cover back and wait for 30–60 seconds for the second dose	4 (12.5)	7 (17.9)	0.385
Instructions for Diskus®			
Open Diskus by pushing the thumb grip right around until it clicks	15 (25.0)	18 (27.7)	0.446
Hold the mouthpiece toward you and push the lever away from you until it stops	6 (10.0)	8 (12.3)	0.452
Exhale	5 (8.3)	13 (20.0)	0.053
Hold your head in a vertical position	8 (13.3)	14 (21.5)	0.167
Put the mouthpiece to your lips	6 (10.0)	12 (18.5)	0.137
Breathe in strongly and deeply	45 (75.0)	52 (80.0)	0.324
Remove your Diskus	30 (50.0)	32 (49.2)	0.537
Hold your breath for 10 seconds	22 (36.7)	21 (32.3)	0.373
Breathe out gently	11 (18.3)	12 (18.5)	0.585
Close Diskus by sliding the thumb grip back to the original position and wait for 30–60 seconds for the second dose	10 (16.7)	4 (6.2)	0.057

Notes: Chi-square test. Values in bold indicate statistical significance ($P < 0.05$).

Abbreviation: MDI, metered dose inhaler.

was associated with shorter duration of disease and inhaler therapy.

MDI-type inhalers were the most commonly used inhalers in both COPD and asthma patients in our cohort. However, past studies in patients with COPD and asthma revealed more prevalent usage of DPIs (77.0%–78.9%) than MDI- (12.0%–16.8%) type inhalers.^{13,17,19} This seems notable given

that MDIs require a good ability of hand–lung coordination and is therefore considered to be inherently more difficult to use than DPIs.^{13,25,26} In fact, while considered to be more likely with MDI-type inhalers,^{9,15,27–29} suboptimal inhaler technique is very common in real life with both MDIs and DPIs, and in the majority of asthma and COPD patients, despite advances in inhaler device technology.^{3,5,10–16}

Table 3 Sub-analysis of errors in inhaler techniques that differed between COPD and asthma groups

	Age, mean (SD)	Gender, n (%)		Duration (years), mean (SD)	
		Male	Female	Disease	Inhaler therapy
Instructions for MDI					
Take off the inhaler cap					
Incorrect use	57.9 (10.5)	17 (10.0)	19 (10.7)	8.8 (8.8)	7.5 (6.6)
Correct use	62.4 (13.0)	153 (90.0)	158 (89.3)	9.8 (8.2)	8.1 (7.1)
P-value	0.058		0.481	0.494	0.643
Hold the MDI in a vertical position					
Incorrect use	60.0 (12.9)	18 (10.6)	28 (15.8)	6.6 (4.7)	6.6 (4.8)
Correct use	62.3 (12.8)	152 (89.4)	149 (84.2)	10.0 (8.5)	8.1 (7.2)
P-value	0.275		0.100	<0.001	0.180
Hold your head in a vertical position					
Incorrect use	58.3 (12.7)	21 (12.4)	26 (14.7)	6.6 (4.5)	5.8 (4.5)
Correct use	62.5 (12.8)	149 (87.6)	151 (85.3)	10.1 (8.6)	8.2 (7.2)
P-value	0.044		0.316	<0.001	0.006
Instructions for Aerolizer®/Handihaler®					
Press the buttons on both sides of device					
Incorrect use	63.2 (12.0)	41 (27.0)	55 (42.0)	10.0 (8.9)	8.3 (8.1)
Correct use	64.0 (10.5)	111 (73.0)	76 (58.0)	10.1 (8.5)	8.2 (7.0)
P-value	0.596		0.006	0.910	0.924
Hold your breath for 10 seconds					
Incorrect use	62.6 (11.0)	40 (26.3)	26 (19.8)	10.7 (9.3)	8.9 (8.7)
Correct use	64.1 (11.0)	112 (73.7)	105 (80.2)	9.7 (8.3)	8.0 (7.0)
P-value	0.344		0.127	0.425	0.421
Instructions for Turbuhaler®					
Keep inhaler upright					
Incorrect use	61.9 (10.5)	4 (26.3)	8 (19.8)	5.0 (3.2)	4.3 (3.4)
Correct use	55.8 (14.3)	32 (88.9)	27 (77.1)	9.5 (8.9)	8.2 (7.4)
P-value	0.168		0.158	0.005	0.012

Notes: Chi-square test, Student's t-test, Mann-Whitney U test. Values in bold indicate statistical significance ($P < 0.05$).

Abbreviation: MDI, metered dose inhaler.

Overall, with no significant difference between COPD and asthma groups, the most common errors in inhaler technique for MDIs and DPIs in our cohort were failure to exhale before use of inhaler, followed by device-specific errors and failure to deeply inhale and to hold breath. In addition, errors related to device handling were common among MDI users than among DPI users. Likewise, failure to exhale before inhaling through device, inability to coordinate activation with inhalation, and failure to hold breath have also been reported to be errors in inhalation maneuvers that are common in all types of inhalers among COPD and asthma patients.^{13,17,30,31} In accordance with our findings, a high frequency of poor and/or suboptimal inhaler use has consistently been reported in past studies alongside a higher likelihood of errors related to device handling with use of MDIs compared with DPIs among COPD and asthma patients.^{9,15,29}

Past studies indicated either no difference between COPD and asthma patients in terms of inhaler technique^{17,19,32} or higher odds of incorrect inhaler technique in COPD

patients attributed to older age and higher prevalence of comorbidities.^{8,28,33} Although the COPD patients were older than the asthma patients in our cohort, our findings revealed no significant difference between asthma and COPD patients in terms of basic inhalation maneuvers, whereas there was poorer inhaler technique in asthma than COPD patients, particularly in certain device-specific steps. Regarding the steps that significantly differed between asthma and COPD patients, a higher likelihood of incorrect technique was associated with shorter duration of disease and therapy for MDI and Turbuhaler® users, and with female gender for Aerolizer®/Handihaler® users. This seems to support the reported association of longer duration of therapy (repeated instructions over a period of time and regular follow-ups)^{14,34–36} with a proper inhaler technique³⁷ as well as higher odds ratio of poor inhaler technique reported in females as compared to males.¹⁹

Indeed, with overconfidence of patients toward use of the device, a steep rise in number of errors with a longer duration of therapy has also been noted, emphasizing a need for

regular instructions and intermittent checkups of inhalation techniques, given the increased number of errors.¹⁴ In addition, the preponderance of female patients in the asthma group compared to the COPD group in our cohort seemed to also be associated with the poorer inhaler technique noted among asthma patients with regard to certain device-specific maneuvers.

Hence, our findings support that structured and detailed education of patients on inhaler techniques should be an essential part of the pulmonary clinic practice.⁸ Past studies revealed a likelihood of incorrect use of inhaler devices even by medical personnel.^{38–41} In this regard, the sufficient ability of health care professionals themselves to use the inhaler devices and their awareness of all the correct steps and possible mistakes is considered to be of critical importance regarding the close follow-up of patients with repeated checking of inhaler techniques and correction of suboptimal techniques with tailored, in-depth support.^{3,14,34}

The major strength of this study seems to be the comparative assessment of inhaler technique in a large-scale cohort of COPD vs asthma patients through direct observation of patients' performance in real-life clinical practice and by using checklists based on the manufacturers' instructions and national guidelines. However, certain limitations to this study should be considered. First, the cross-sectional design limits the interpretation of the findings and establishment of any cause and effect relationships. Second, inhaler technique was assessed based on frequently used type of inhalers, and several types of infrequently used inhalers could not be included in the analysis. Third, lack of data on past history of patient training in inhaler technique is another limitation which otherwise would have extended the knowledge gained in the current study.

Conclusion

In conclusion, our findings revealed that errors in inhaler technique in terms of inhalation maneuvers and device handling were similarly common in COPD and asthma patients. Errors in certain device handling maneuvers, particularly with MDIs, were more common among asthma patients than among COPD patients, and associated with female gender and shorter durations of disease and inhaler therapy. Our findings emphasize that suboptimal inhaler technique is common in real life for both MDIs and DPIs, emphasizing the potential role of regular assessment and reinforcement of correct inhalation technique in achieving treatment efficacy and improved disease outcomes.

Disclosure

The authors report no conflicts of interest in this work.

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