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*Comparison of chosen spirometric parameters measured
by pocket spirometers and diagnostic spirometry in the same patients*

Laboratory-based spirometry is the „gold standard” for the assessment of lung function in asthma and COPD, both in clinical and research conditions. Full diagnostic pulmonary function test (PFT) should contain results of SVC (slow vital capacity), FVC (forced vital capacity) and MVV (maximal voluntary ventilation) (1, 3, 7). For monitoring asthma and an assessment of the treatment efficacy the following indicators are sufficient: FEV₁ (forced expiratory volume in one second) and PEF (peak expiratory flow) (8, 6,14).

Every year new spirometers appear on the market. Recently cheap pocket-sized spirometers have appeared enabling to evaluate of FEV₁ and PEF. Some of them can measure FEV₆ (forced expiratory volume in six second) and also the ratio of FEV₁/FEV₆. The value of FEV₆ in most healthy young subjects is comparable to VC_{max} and FVC, but in patients demonstrating severe obstruction the two last parameters are significantly higher (2).

The aim of the study was comparison of two pocket-sized spirometers, Koko Pro Peak and Piko-1, with classic diagnostic spirometer (Koko Digidoser) in clinical conditions. Forced expiratory volume in one second and PEF were the main compared parameters.

MATERIAL AND METHODS

Studies were performed on a group of 65 patients diagnosed because of asthma or pollinosis suspicion. These patients had bronchial provocation tests performed. All the compared spirometers are produced and distributed by Ferraris (USA). Koko Digidoser is a daily calibrated spirometer with brass Fleisch-type pneumotach enabling SVC, FVC and MVV performance. It can be also used as a Rosenthal-French dosimeter during bronchial provocation tests. This spirometer fulfills ERS and ATS criteria (1, 11). Pocket-sized spirometer Koko Pro Peak enables evaluation of the following parameters: FEV₁, PEF, FEV₆, FEV₁/FEV₆. Using Piko-1, FEV₁ and PEF can be measured. Each patient from the studied group had baseline spirometry performed, then bronchial provocation test with methacholine according to five breath methods and finally a bronchial provocation test with an allergen according to modified Ryan's method (9, 10). At each stage of the study three comparable attempts of spirometry were repeated and the results with the highest FEV₁ were chosen for analysis. For each patient about 24–25 assessments were saved, and in whole group – about 1605.

Software STATISTICA was used as a tool to analyze the study results. The following statistic parameters were evaluated: distribution, descriptive statistics and statistical significance of the differences between results measured with 3 compared spirometers (12).

RESULTS

All the 3 spirometers enable to measure FEV_1 and PEF, and results touching these parameters were in detail analysed (Table 1). Pocket spirometer Koko Pro Peak enables to measure FEV_6 , which in healthy subjects usually has a nearing value to FVC, but in patients demonstrating airway obstruction differs from it. In our group there were also patients demonstrating bronchoconstriction. It was the cause to give up a detailed comparison these parameters.

Table 1. Comparison of the average value, mediane and standard deviation for chosen parameters measured by diagnostic spirometr and pocket spirometers in the same patients

	Koko Digidoser			Koko-Pro Peak			Piko-1		
	average	mediane	SD	average	mediane	SD	average	mediane	SD
$FEV_1(L)$	3.373	3.34	1.01	3.370	3.34	1.02	3.306	3.22	1.00
PEF (L/min)	394	379	132	382	360	124	376	351	125
FEV_6 or FVC (L)	4.29	4.08	1.25	4.02	3.89	1.19	-	-	-
FEV_7/FVC	0.78	0.81	0.82	-	-	-	-	-	-
FEV_1/FEV_6	-	-	-	0.82	0.86	0.85	-	-	-

Values of FEV_1 measured by pocket-sized spirometers were very similar to those evaluated by diagnostic spirometer (Fig. 3). The differences between average values were very low, 2.0 ml between Koko Digidoser and Koko Pro Peak and 67 ml between Koko Digidoser and Piko-1 (Table 1 and Fig. 2). No statistical differences between the two first spirometers were found. Using pocket-sized Piko-1 we obtained results of FEV_1 lower than those measured by Koko Digidoser or Koko Pro Peak and the differences were statistically significant.

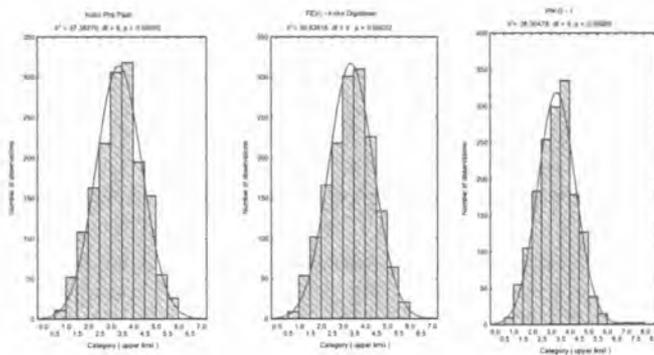


Fig. 1. Comparison of FEV_1 distributions measured by different spirometers (n – 1605)

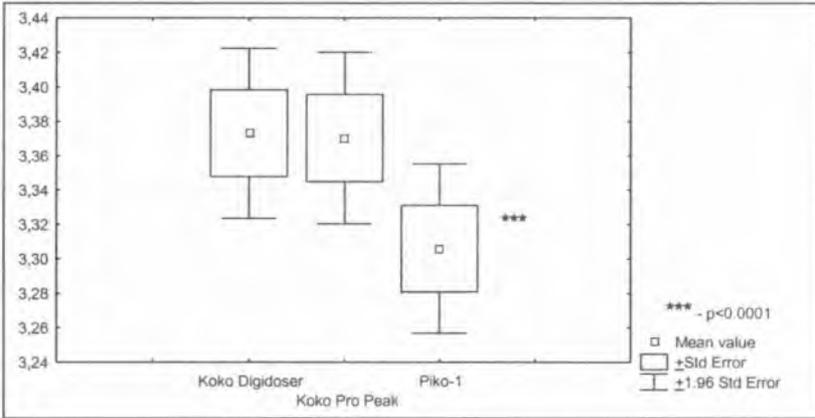


Fig. 2. Comparison of the FEV₁ evaluation by 3 different spirometers. No found statistical difference between Koko Digidoser and Koko Pro Peak

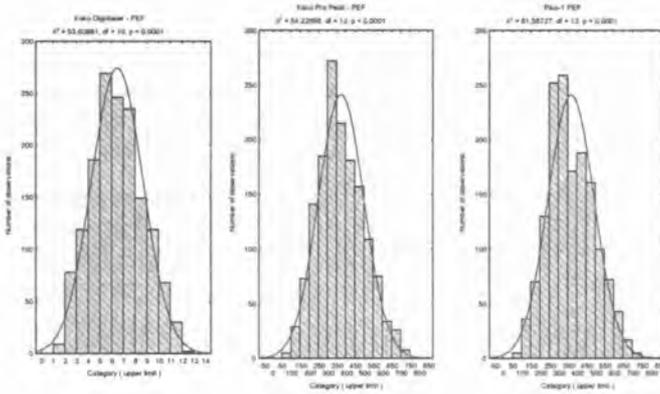


Fig. 3. Comparison of PEF distributions measured by different spirometers (n – 1605)

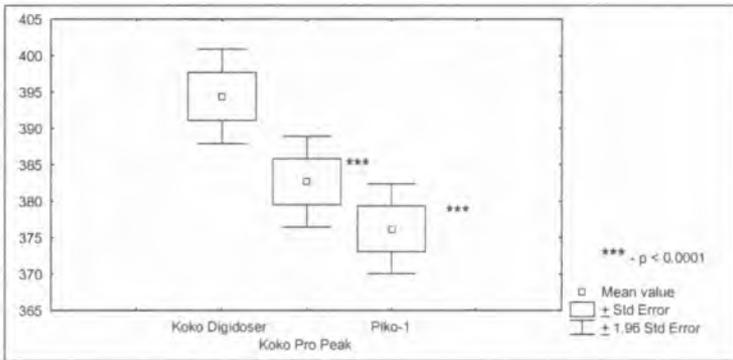


Fig. 4. Comparison of the PEF evaluation by 3 different spirometers

Peak expiratory flow (PEF), another spirometric parameter evaluated by the three studied spirometers, was also analyzed in detail. The highest values were from Koko Digidoser and the lowest from Piko-1. Differences between the average values of PEF measured by Koko Digidoser and Koko Pro Peak and Piko-1 were 12 L/min and 18L/min, respectively.

DISCUSSION

It is known that proper performance of PFT needs good cooperation between staff and the subject. Large screens in laboratory diagnostic spirometers help to make it properly. New pocket-sized spirometers enabling assessment of FEV_1 and PEF are usually devices without graphical display. The Piko-1 and Koko Pro Peak are sold as advanced devices available at a price comparable with mechanical peak flow meters. Companies developing new spirometers usually assess them in laboratory conditions using computer-generated waveforms and healthy subjects for *in vivo* testing. The best method to test new spirometers seems to be measurement of PFT in patients with various degree of air flow limitation (14). Our results based on patients with asthma suspicion showed that the two above mentioned pocket-sized spirometers enabled to obtain results of FEV_1 and PEF comparable to them measured by the diagnostic spirometer when the procedures were assisted by staff. FEV_1 is thought as the most stable parameter to evaluate asthma severity and treatment efficacy. According to ERS, ATS and PTF guidelines successive attempts can be considered as reproducible if difference between them are less than 0.2L (1, 3, 11). Most studied patients can easily fulfill these criteria. Although the analyzed differences were statistically significant, most of them were lower than 0.2L. Recently Tovar et al. recommend Piko-1 as a tool for monitoring pulmonary function in asthma and COPD (15). Another turbine pocket spirometer (Micro Plus Spirometer) was tried as a tool for bronchial challenge and was positively evaluated (5).

Twenty years ago Granthil et al. evaluated the usefulness of so-called pocket-sized spirometers in preoperative respiratory assessment. In their opinion this type of spirometers enables a reliable assessment of obstruction or restriction suspicion (4).

CONCLUSIONS

1. Koko Pro Peak permits to measure FEV_1 as precisely as diagnostic spirometer
2. Differences in FEV_1 and PEF between Piko-1 and the diagnostic spirometer are statistically significant but from the clinical point of view they are very low.

REFERENCES

1. American Thoracic Society – Standardization of Spirometry, 1994 Update. Am. J. Respir. Crit. Care Med., 152, 1107, 1995.
2. B o r o s P. et al.: Zasady interpretacji wyników badania spirometrycznego. W: Zalecenia Polskiego Towarzystwa Ftyzjopneumonologicznego dotyczące wykonywania badań spirometrycznych. Pneumonol. Alergol. Pol., 72, Suppl. 2, 19, 2004.
3. G o n d o r o w i c z K., S i e r g i e j k o Z.: Procedury wykonywania badań, akceptowalności i powtarzalności pomiarów. W: Zalecenia Polskiego Towarzystwa Ftyzjopneumonologicznego dotyczące wykonywania badań spirometrycznych. Pneumonol. Alergol. Pol., 72, Suppl. 2, 16, 2004.

4. Granthil C. et al.: So-called pocket-sized spirometry versus respiratory function tests: a comparative study of vital capacity, forced expiratory volume in 1 second and Tiffenau coefficient. *Ann. Fr. Anesth. Reanim.*, 3, 342, 1984.
5. Keskinen H. et al.: Pocket-sized spirometer for monitoring bronchial challenge procedures. *Clin. Physiol.*, 16, 633, 1996.
6. Llewellyn P. et al.: The relationship between FEV₁ and PEF in the assessment of the severity of airway obstruction. *Respirology*, 7, 333, 2002.
7. Mortimer K. M. et al.: Evaluating the use of a portable spirometer in a study of pediatric asthma - clinical investigations. *Chest*, 123, 1899, 2003.
8. Palma-Carlos A. G., Palma-Carlos M. L.: Correlation between clinical classification, PEF and FEV₁; guidelines and reality. *Allergie et Immunologie*, 34, 274, 2002.
9. Ryan G. et al.: Standardization of inhalation provocation tests: two techniques of aerosol generation and inhalation compared. *Am. Rev. Resp. Dis.*, 123, 195, 1981.
10. Siergiejko Z., Chyrek-Borowska S.: The evaluation of the specific bronchial provocation test with allergen and allergen solution in allergic asthma patients. *J. Aerosol Med.*, 4, 287, 1993.
11. Standardized lung function testing. Official statement of the European Respiratory Society. *Eur. Respir. J.*, Suppl. 16, 1, 1993.
12. Stanis A.: Przystępny kurs statystyki w oparciu o program STATISTICA PL na przykładach z medycyny. StatSoft Polska, Kraków 2001.
12. Swart F. et al.: Comparison of a new desktop spirometer (Spirospec) with a laboratory spirometer in respiratory out-patients clinic. *Respiratory Care*, 48, 591, 2003.
13. Światowa Strategia rozpoznawania, leczenia i prewencji astmy. Raport NHLBI/WHO. *Medycyna Praktyczna – wydanie specjalne* 6/2002.
14. Tovar J. M., Gums J. G.: Monitoring pulmonary function in asthma and COPD: point-of-care testing. *Ann. Pharmacother.*, 38, 126, 2004.

SUMMARY

Recently very cheap pocket-sized spirometers have appeared on the market. The aim of the study was a comparison of two of them, Koko Pro Peak and Piko-1, with classic diagnostic spirometer (Koko Digidoser) in clinical conditions. Forced expiratory volume in one second and PEF were the main compared parameters. Studies were performed on a group of 65 patients diagnosed because of asthma or pollinosis suspicion. These patients had bronchial provocation tests performed. For each patients about 24–25 assessments were saved, and in the whole group about 1605. Our results based on patients with asthma suspicion showed that two above mentioned pocket-sized spirometers enabled to obtain results of FEV₁ and PEF comparable to them measured by the diagnostic spirometer when the procedures were assisted by staff. Conclusions: 1. Koko Pro Peak permits to measure FEV₁ as precisely as diagnostic spirometer, 2. Differences in FEV₁ and PEF between Piko-1 and the diagnostic spirometer are statistically significant but from clinical point of view they are very low.

Porównanie pomiarów wybranych parametrów wentylacyjnych uzyskiwanych za pomocą minispirometrów i spirometru diagnostycznego

Ostatnio na rynku pojawiły się bardzo tanie minispirometry. Celem pracy było porównanie dwóch z nich: Koko Pro Peak i Piko-1 z diagnostycznym spirometrem Koko Digidoser. Porównano FEV_1 i PEF, badania przeprowadzono w grupie 65 pacjentów diagnozowanych z powodu podejrzenia astmy lub pyłkowicy. Wszyscy byli poddani oskrzelowej prowokacji z metacholiną i alergenem. Każdy z nich miał zarejestrowanych 24–25 wyników badań spirometrycznych na każdym ze spirometrów. Ogółem do analizy użyto 1605 wyników każdego spirometru. Uzyskane dane pokazują, że pod nadzorem badane minispirometry pozwalają uzyskać wyniki FEV_1 i PEF porównywalne z uzyskanymi za pomocą spirometru diagnostycznego. 1. Spirometr Koko Pro Peak pozwala uzyskać pomiary FEV_1 tak dokładne jak za pomocą spirometru diagnostycznego, 2. Różnice między wynikami FEV_1 i PEF z pomiarów Piko-1 i spirometru diagnostycznego są wprawdzie znamienne statystycznie, ale z klinicznego punktu widzenia bardzo małe.