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Spirometry using facemask versus conventional tube in patients with neuromuscular disorders

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ABSTRACT

Background: Respiratory derangement is a major health hazard in patients with neuromuscular disorders (NMD). This study aimed to compare spirometry results using facemask with that of conventional tube in patients with NMD and accordingly possible use of facemask instead of conventional tube in this group of patients.

Methods: Thirty-six patients with NMD and fifty normal volunteers were recruited within 9 months. Assessment of patients included history and physical examination specially presence of respiratory symptoms, duration and stage of neuromuscular illness, bulbar symptoms, sensory, motor and cranial nerve assessment. Then all participants were subjected to spirometry and respiratory pressures assessment using both conventional tube and facemask.

Results: Spirometry and respiratory pressure assessment using facemask versus tube measured in all participants. For patients with NMD; spirometric measures P_{Imax} and P_{Emax} were higher in tube than facemask. FEV_1, FEV_1%, FEV_1/FVC %, and P_{Imax} showed statistically significant difference. For patients with bulbar palsy; SVC was higher in facemask without statistically significant difference. For other spirometric measures, P_{Imax} and P_{Emax}; using tube was higher than facemask with only FEV_1, FEV_1% showed statistically significant difference ($p = 0.023$ and 0.015 respectively). For patients without bulbar palsy; all spirometric measures, P_{Imax} and P_{Emax} were higher when using tube with only FEV_1/FVC % showed statistically significant difference ($p = 0.004$). Also for control group; data were higher in tube with only FEV_1 showed statistically significant difference ($p = 0.031$). For patients with NMD; fractional functional defect (FFD) was very high for P_{Imax} and P_{Emax}.

Conclusion: The use of facemask during assessment of spirometric and respiratory pressures measures in patients with NMD and more specifically in patients with bulbar palsy is promising and can be considered a good alternative to conventional tube assessment for functional screening rationale.

Introduction

Neuromuscular disorders (NMD) can be either inherited and acquired diseases. Respiratory impairment is a major health hazard in these disorders as with progressive muscle weakness; there will be impaired cough and secretion clearance, aspiration, recurrent respiratory tract infections, lung restriction, and progressive airway obstruction. This can lead to alveolar hypoventilation and respiratory failure [1].

In NMD, the extent to which peripheral muscle weakness is affected can not accurately predict the degree of respiratory muscle affection. Significant respiratory muscle dysfunction can exist

Abbreviations: FEV_1, forced expiratory volume in one second; FFD, fractional functional defect; FVC, forced vital capacity; MVV, maximum voluntary ventilation; P_{Imax}, maximal inspiratory pressure; P_{Emax}, maximal expiratory pressure; MRP, maximum respiratory pressure; NMD, neuromuscular disorders; RV, residual volume; SVC, slow vital capacity; TLC, total lung capacity.

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in the presence of mild or no peripheral muscle weakness [2]. Forced vital capacity (FVC) declines with time in those patients and is an indicator of disease progression such that both the FVC at diagnosis and the rate of decline in FVC are predictors of survival [3].

Therefore, tests of respiratory muscle function are essential to identify the patient who is at risk for respiratory failure. However, these measures may be difficult to obtain from patients with significant bulbar dysfunction because they may have difficulty creating a seal with the mouth piece mainly while performing forced maneuvers as FVC and maximal respiratory pressure (MRP) measurements [4]. So, the use of classic flanged or tube of mouthpiece may be not adequate for evaluation of respiratory muscle function [5]. This study aimed to compare spirometry results using facemask with that of conventional tube in patients with NMD and accordingly possible use of facemask instead of conventional tube in this group of patients.

Patients and methods

This study was conducted in Pulmonary Function Testing Unit, Chest department, Mansoura university hospital from July 2015 to June 2016. Ethics approval has been obtained from Institutional Research Board, Mansoura University. Patients with NMD and normal volunteers who can understand and cooperate with the spirometry and respiratory pressures assessment maneuvers were recruited from outpatient clinic of neurology department. Patients were assessed first for their disease and then referred for performance of maneuvers in one visit with no need for admission. On the other side, patients with history of chronic respiratory illness and those who cannot cooperate with the maneuvers were excluded from the study.

The included population was classified into 2 groups:

1. Group A (36 patients): patients with NMD.
2. Group B (50 control): normal volunteers.

Assessment of patients included history and physical examination with respect to respiratory symptoms, bulbar symptoms, duration and stage of neuromuscular illness, sensory, motor and cranial nerve assessment.

Then all participants were subjected to the following measurements:

- Slow vital capacity (SVC)
- Forced expiratory volume in one second (FEV_1)
- FVC
- Erect and Supine FVC
- FEV_1/FVC ratio
- Maximum voluntary ventilation (MVV)
- Maximal inspiratory pressure (P_{Imax})
- Maximal expiratory pressure (P_{Emax})
- Fractional functional defect (FFD)

$$FFD = (\text{Normal value of control group} - \text{Measured value of NMD group}) \times 100/\text{Normal value of control group}$$

Apart from erect and supine FVC; all other measurements were done twice for every participant; one with conventional tube and the other one with facemask (Full silicone resuscitation reusable mask; size 4 or 5).

Spirometry was performed using (smart pft lab, Medical Equipment Europe GmbH, Germany) according to the standardized protocol [6]. Patients were advised to be in the sitting position with head slightly elevated. When using a tube mouthpiece; nose clip attached, tube mouthpiece in mouth and lips closed around the mouthpiece. **For SVC;** the maneuver was not forced and was done in a relaxed manner. Participants inhaled maximally, and then exhaled completely slowly and evenly to residual volume (RV). **For FVC maneuver;** every participant inhaled completely and rapidly with a pause of less than one second at total lung capacity (TLC), then exhaled maximally until no more air can be expelled**. For MVV maneuver;** the participants were advised to breathe as rapidly and deeply as possible for 12 s [6].

For respiratory pressures assessment, it was performed using a handheld mouth pressure meter (Micro MPM; Micro Medical, UK). This device consists of a pressure transducer and electronic calculator. The system has a small leak about 1–2 mm hole to avoid closure of glottis and decrease buccal muscles use. It was performed while the subjects were in setting position with wearing a nose clip when using the tube mouthpiece, with performance of maximal inspiratory and expiratory efforts, starting from near RV and near TLC respectively [7].

Statistical analysis

The statistical analysis of data was done using Excel and SPSS program version 21.0. The normality of data was first tested with one-sample Kolmogorov-Smirnov test. Categorical data were presented as numbers (percentage). For data with normal distribution; descriptive statistics were used to calculate mean ± standard deviation (SD); independent-samples *t*-test was used to compare the results between 2 groups and paired samples *T* test was used to compare the results within same group. Chi square test was used to compare paired proportions (or Fisher Exact Test when needed). Fractional functional defect (FFD) was done for study group. Statistical significance was defined as p value less than 0.05.

Results

Thirty-six patients (36) with NMD and fifty (50) healthy volunteers (as control) were recruited in this study. Tables 1 and 2 illustrate demographic data of all studied population (Table 1) and subcategories of NMD group (Table 2). Participants were matched regarding age and sex without statistically significant differences.

Table 3 shows types of NMD in group A. For both categories; myasthenia gravis was the most common (77.8% and 44.4% for category 1 and 2 respectively).

Tables 4–6 demonstrate spirometry and respiratory pressures assessment results using facemask versus tube in all participants. For patients with NMD; spirometric measures P_{Imax} and P_{Emax} were higher in tube than facemask. FEV_1, FEV_1%, FEV_1/FVC %, and P_{Imax}

Table 1
Demographic data of all studied population.

	NMD group (A) N = 36	Control healthy group (B) N = 50	P value
Age	38.56 ± 12.8	41.12 ± 14.07	t = 0.865 p = 0.389
BMI	28.65 ± 5.41	26.79 ± 3.44	t = 1.918 p = 0.059
Gender			
Male	18 (50%)	27 (54.0%)	χ^2 = 0.134
Female	18 (50%)	23 (46.0%)	p = 0.714
Smoking			
Non smoker	25 (69.4%)	22 (44.0%)	χ^2 = 5.571
Smoker	6 (16.7%)	17 (34.0%)	p = 0.062
Former smoker	5 (13.9%)	11 (22.0%)	

NMD; neuromuscular disorders, **BMI**; body mass index.

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