The mask: Style and volume do not influence rhinomanometry*

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SUMMARY *We have tested the influence of face-mask style and volume on rhinomanometric measurements. Using an artificial head-and-piston pump to standardize the test conditions, four types of face masks (volumes varying from 120 to 200 ml) have been tested in a series of 20 measurements per mask. No statistical difference could be found between the series using a Chi-square test. We conclude that there is no influence of form and volume of the face mask on the accuracy of the rhinomanometric measurement.*

Key words: rhinomanometry, accuracy measurements, technique standardization

INTRODUCTION

Since the introduction of rhinomanometry into clinical work the questionable accuracy of this measurement has lead to extensive discussions. It is our aim to find the sources of inaccuracy in modern computerized rhinomanometry and their influences on the measurement. In a previous paper we have reported on a testing device for rhinomanometers (Gammert and Scherrer, 1993). The comparison was made under standardized conditions (airflow, mask, artificial nose, connections, and temperature) to eliminate all influences besides the purely technical ones.

Different factors are known to influence rhinomanometric measurements. Technical inaccuracies in the measuring system are due to the pneumotachograph with the pressure transducers and the connecting tubes. Under standardized conditions the error due to technical causes lies between 3% and 10% (Gammert and Scherrer, 1993). Another important factor is the interface between the patient and the measuring system. One aspect is the influence of the mask on the patient's face due to form and shape. On the other hand, the operation of the measuring device itself (tightness, deformation of the nose) and the connection between the device and the nose (surgical tape, olive) are important. Finally, physiological factors such as the intensity of breathing and the function of the nasal valve may influence results (Bachmann, 1982).

In this paper we discuss the influence of form and volume of the face mask on the rhinomanometric measurement. Standard rhinomanometers measure the volume-flow by means of a pneumotachograph. It uses the principle that a fixed resistance in the gas-flow causes a pressure drop which is linearily related to the value of volume-flow. The linear relationship between pressure drop and volume-flow is restricted by the requirement of laminar gas-flow in the resistance. At a Reynold's number of >2,000 the flow turns to become turbulent, with the result of a non-linear relationship between pressure drop over the resistance and flow velocity. Moreover, the transition from laminar flow to turbulent flow is not smooth, but abrupt. Turbulences might be induced by the shape of the mask. Further inaccuracies occur due to gas jetting into the central portion of the tube caused by the geometry of tube and mask. The damping on nasal airflow due to the dead space of the mask could also be a factor influencing the accuracy of the measurements (Thomann, 1988).

MATERIAL AND METHODS

The masks were tested on an artificial head – a phantom for bronchoscopy issued by CLA (Coburg, Germany). Breathing was simulated by a piston pump designed by Boutellier et al. (1981; cf. Figure 1). With each mask series of 20 measurements were performed on a "Rhino-Comp" rhinomanometer (Cintec, Sweden). Technical inaccuracies inherent in this specific system are known to be 5–7% (Gammert and Scherrer, 1993). For statistical testing of the data we used a Chi-square test.

The following four masks were tested (Figure 2): Dräger No. 3 (volume: 120 ml); Laerdal adult mask No. 4 (volume: 130 ml); Weinmann WM 5074 No. 5 (volume: 180 ml); and Weinmann WM 5074 No. 5 (volume: 200 ml).

All measurements were performed by the same person and based on the recommendations of the International Committee on Standardization of Rhinomanometry (Clement, 1984).

RESULTS

The data of the tests performed with the Laerdal No. 5 were used as the basis for the calculation of the comparisons with the other masks.

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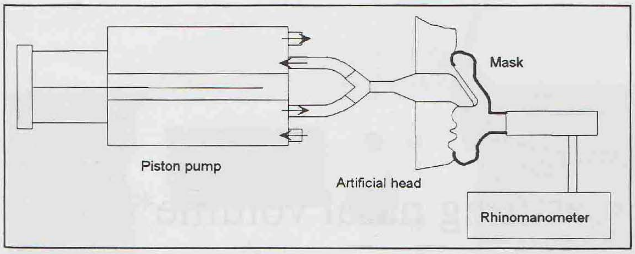

Figure 1. Experimental set-up of the test.

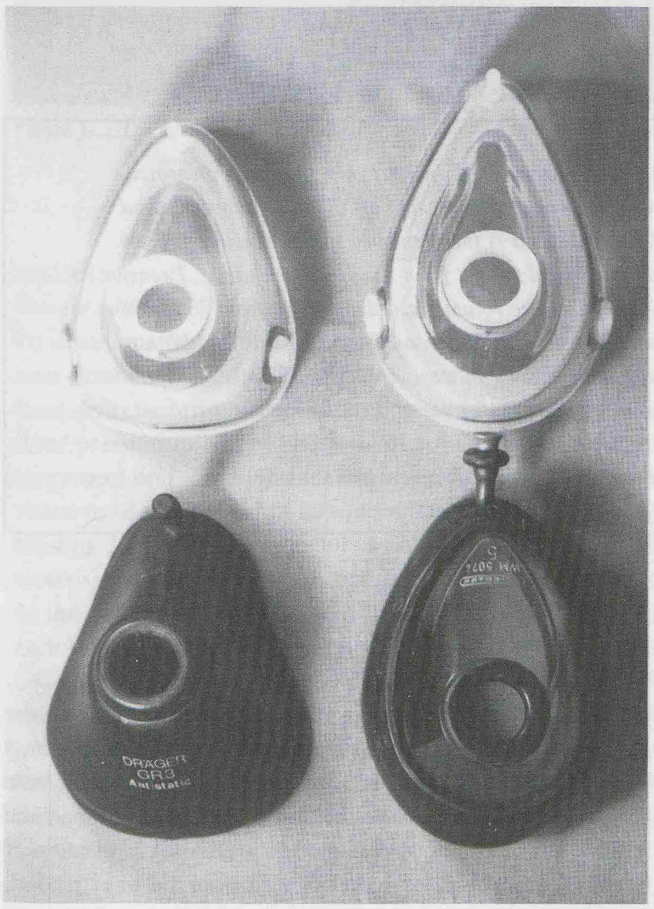

Figure 2. Four commonly used types of mask, differing from each other in shape and volume, tested in this study.

The series of measurements showed the following deviations: at Δp=75 Pa: 13.5±0.03%; at Δp=150 Pa: 6±0.02%; and at Δp=300 Pa: 7±0.02%. The technical inaccuracies of the "Rhino-Comp" are known (Gammert and Scherrer, 1993): at Δp=75 Pa: 6%; at Δp=150 Pa: 6-7%; and at Δp=300 Pa: 5-7%.

The means of each series of 20 measurements were at 75 Pa: 193–207 ml/s; at 150 Pa: 416–442 ml/s; and at 300 Pa: 586–624 ml/s (Figure 3). When compared, the difference between the means, attained with each mask style tested, is in the range of 6.2–6.7%, the same as the known technical inaccuracy of the rhinomanometer used. Also, the comparison of the test series based on a Chi-square test showed no significant difference.

DISCUSSION

From the obtained data it can be seen that common face-fitting masks have no influence on the accuracy of the rhinomanometric measurement. Besides the technical factors inherent in the system (pneumotachograph, connecting tubes), a major factor which may influence accuracy is the handling of the system. The average accuracy of the measurements was found to be in the expected range, but with great variance. Users of rhinomanometry have to deal with inaccuracies in a range as small as 0.3% (best case) up to 20% (worst case). The average is between 6% and 10% per series. The mask as a source of inaccuracy can be neglected. However, as contact pressure is increased to ensure an air-tight seal, the reliability of resistance values is decreased because of deformation of middle face and nose (Cole, 1989). Therefore, the main effort has to be made on the contact interface between the subject's face and the mask and the behaviour of the patient during measurement.

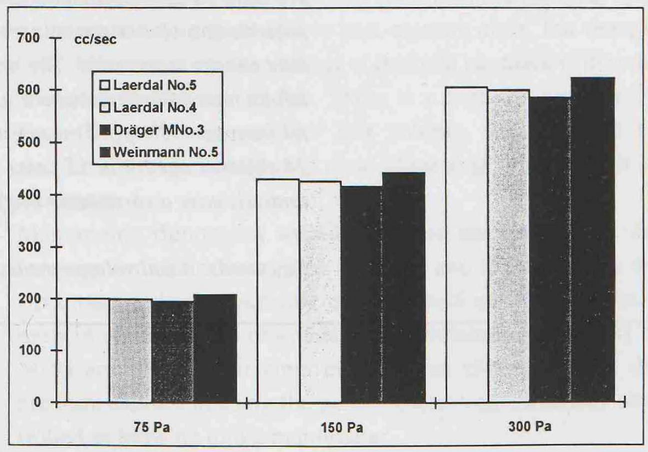

Figure 3. Means of the data series at 75, 150, and 300 Pa (n=20).

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