As educators, we are continually designing new methods and procedures to enhance learning. During this process, good ideas are frequently generated and tested, but the extent of such activities may not be adequate for a full manuscript. Nonetheless, the ideas may be quite beneficial in improving the teaching and learning of physiology. Illuminations is a column designed to facilitate the sharing of these ideas (illuminations).

An Improved Model for Simulating Obstructive Lung Disease

Pulmonary function testing with the use of spirometers is useful for enhancing students’ understanding of normal lung volumes, capacities, and flow rates. Furthermore, the spirogram can be an excellent tool for understanding how lung diseases alter pulmonary function parameters. For example, physiology programs at several schools have students determine their normal lung volumes, capacities, and flow rates by means of standard spirometry procedures (1). Subsequently, these programs have students simulate obstructive and restrictive lung diseases and repeat the procedures for pulmonary function testing. To simulate an obstructive impairment, a rubber stopper, with a small hole drilled through the center, is placed securely into the spirometer tubing. The stopper adds resistance to both inspiration and expiration, and the resulting spirogram closely resembles a typical obstructive curve (3).

However, individuals with obstructive lung impairments experience less airflow resistance during the inspiratory phase due to the effects of radial traction and increased transmural pressure than during the expiratory phase. Importantly, the rubber stopper with the small hole drilled through the center adds equal resistance to both the inspiratory and expiratory phases. To address this concern, we modified the model so that students experience most of the resistance during expiration. The modification consists of altering a one-way valve [Rescuer, CPR Pro (2)] (Fig. 1). The original one-way valve had a small resistance to inflow ($R_{IF}$) provided by the radius of the opening in the valve and an infinite resistance to outflow ($R_{OF}$) provided by a stopper that blocked flow. By making a hole (with a smaller radius than the internal radius of the inflow valve, e.g., with a heated drill bit of 1/8-in. diameter) in the outflow stopper, outflow was allowed. In addition, it was important to block the valve side opening with glue from a glue gun (Fig. 1). Since the hole in the stopper was smaller than the radius of the inflow valve, it offered more resistance during expiration. Thus, $R_{OF}$ was higher than $R_{IF}$ ($R_{OF} > R_{IF}$). With this modification, students are able to feel the differences in resistance between inspiration and expiration (higher resistance during expiration, which simulates the pathological state). The spirometry exercise enhances students’ understanding of pulmonary physiology and pathophysiology and allows them to experience the difficulty, discomfort, and apprehension associated with lung disease.

Fig. 1. Left: one-way valve with rubber stopper and side opening. The stopper prevents air from flowing out. Expired air passes through the side opening. Right: modified one-way valve with rubber stopper that now has a small hole to allow air to flow out. Note that the small hole in the rubber stopper is much smaller than the radius of the inflow opening. This modification provides significant resistance to expiration without adding resistance to inspiration. Also note that the side opening has been filled with glue from a glue gun.

REFERENCES


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