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CORRESPONDENCE

Rapid chest compression and flow limitation

To the Editor:

The interesting findings of Kerem *et al.* [1], published in The Journal, raise important questions on how forced expiratory manoeuvres using rapid chest compression (RCT) are best performed. The authors attempt to compare the flow-volume curves obtained under different conditions (traditional, muscle relaxation by end-inspiratory occlusion, elevated lung volumes by breath-stacking), and conclude that flow limitation is not achieved with the RCT technique, because flows at isovolume points are not identical.

There are several physiological reasons why flows can be different among their test conditions:
1. It is well-established that a deep inspiration (*e.g.* after breath-stacking) preceding a forced exhalation reduces the amount of bronchomoter tone present during tidal breathing [2]. Recoil pressure is at a minimum immediately after a full inflation, increases after a period of breathholding, and further increases after a full exhalation to residual volume [3]. The time course of the preceding inspiration also influences forced expiratory flows [4].
2. Conformational chest wall changes will be reflected, to some extent, in length changes of the airways; thereby, influencing factors determining local airway tube wave speed [5]. Compression of a relaxed or unrelaxed chest wall may result in differences in chest wall shape.
3. The authors overlap the curves with the anchor point at end-exhalation, thereby assuming that the lungs exhale to the same end-point independent of the technique. However, it is likely that muscle relaxation achieved by RCT with end-inspiratory occlusion allows a deeper exhalation.
4. The volume axis was also not fixed at the inspiratory end. This could have been achieved by standardizing end-inspiratory pressure. This uncertainty about lung volume precludes a true comparison of flows at isovolume points.
5. The documentation of flow-limitation requires the measurement of driving pressure (*e.g.* transpulmonary pressure). Pressure transmission across the chest wall may be higher when respiratory muscles are relaxed.
6. It has been demonstrated that control over volume history reduces the intrasubject variability of flow measurements by RCT [6]. It is possible that the breath-stacking technique reduced the scatter of the flow data. This remains unclear because coefficients of variation of repeated measurements are not reported.

All these factors allow forced expiratory flows to differ among different manoeuvres even when wave speed (flow-limitation) conditions are achieved by each technique, and could explain the reported flow differences. Unfortunately, this study cannot resolve the ongoing flow-limitation debate in RCT, but demonstrates that standardization of forced expiratory manoeuvres is essential for flow comparison; a fact well-known in adult lung function laboratories.

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REPLY

From the authors:

In their letter J. Hammer and C.J.L. Newth indicated some of the problems which arise with the measurement of maximal flows obtained by the rapid compression technique. These points are relevant to our paper and to measurements of maximal flows in general. Flows are measured at different sleep stages, different lung volumes, and different bronchomotor tone. If factors such as expiratory muscle braking, and chest wall resistance to compression, are influenced by different techniques, or different lung volumes, then the measured flows are not limited only by the intrinsic properties of the airways, as our study suggests. These might be the reasons for different normal standards obtained in different laboratories, and to the wide variability of normal values obtained in each laboratory.

We agree with the issue of where to anchor the curves, and lack of volume standards, and we discussed this in the manuscript in detail. Compression of the chest at stacked volumes, as has been suggested in our manuscript, in addition to increased respiratory muscles relaxation, may standardize for lung volume (TLC). We hope that this manuscript will stimulate more studies in this area which will improve the current unsatisfactory technique.

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