Effect of NCPAP Prong Size on Flow Resistance
Bridging the Gap Between Static and Dynamic Simulations

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What effect does the size of NCPAP prongs have on flow resistance during spontaneous breathing?

Investigating this simple question with traditional testing is very difficult.

Flow-pressure graphs solve this problem and allows comparisons on the effect of prong size.

Background

Short bi-nasal prongs are the recommended nasal interface for NCPAP. The choice of prong size and type is likely to affect the imposed resistance of breathing. Resistance has previously been examined with static flows. Lung model simulations are an alternative but are traditionally performed with fixed tidal volumes. This approach has limited clinical relevance when investigating prongs since size should affect the tidal volumes used. We hypothesize that flow-pressure plots could be a way to solve this problem and produce clinically relevant information. This may also confirm that conclusions drawn from static simulations are applicable in dynamic situations such as breathing. The aim of this study is to compare flow resistance of prongs using flow-pressure plots under dynamic conditions.

Methods

Five types of prongs and one ET-tube were examined in a lung simulator (ASL 5000 using sinusoidal flow pump -6 to 6 l/min). Flow-pressure plots were obtained using a flow meter and pressure transducer. Hysteresis was examined by increasing respiratory rate (90 RR).

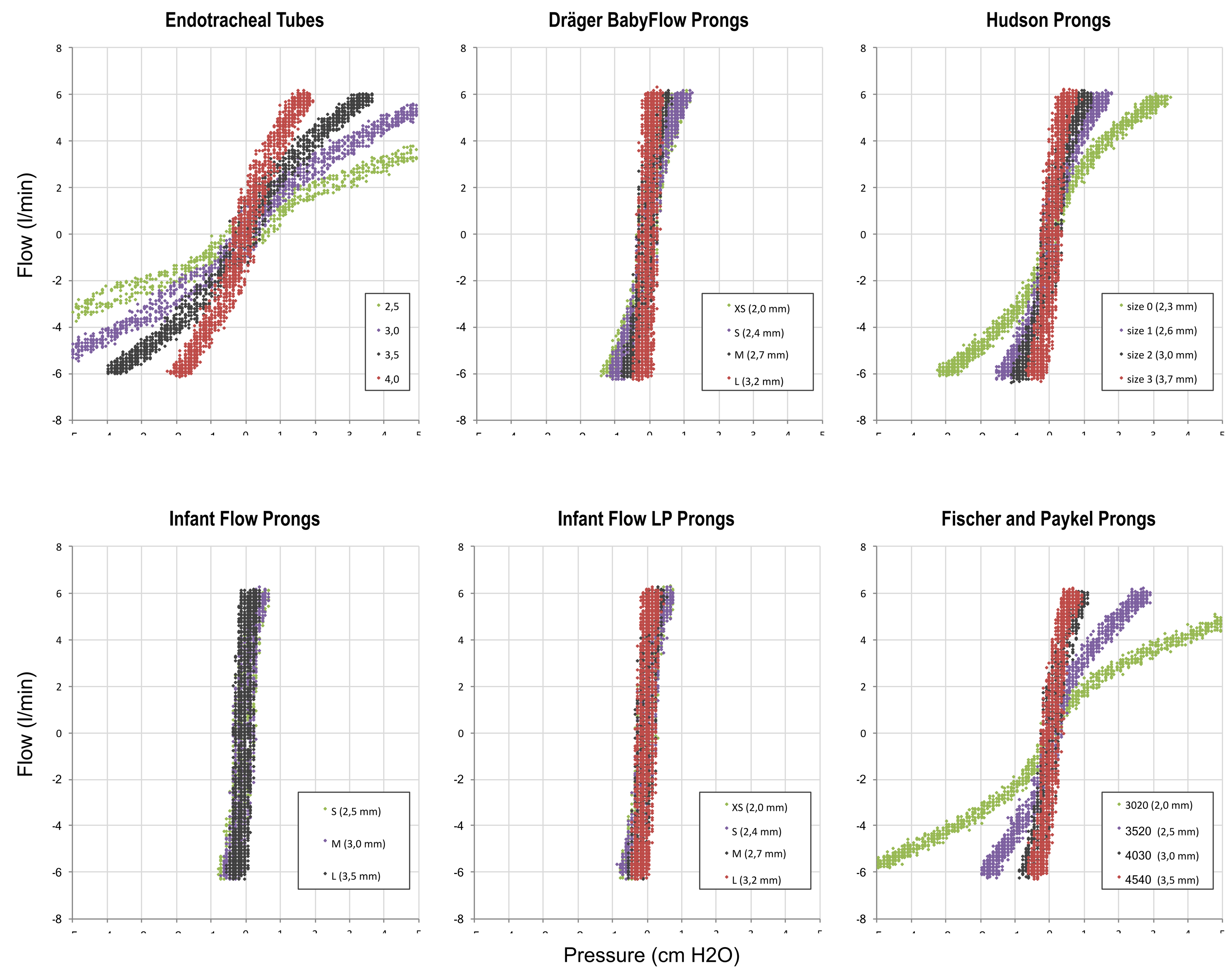

Fig 1: Flow-pressure graphs of different prongs. The slope of the curve reflects increase in resistance. Simulations using 32 ml TV and RR 60 (flowmax 6 l/min, sinusoidal pattern. I:E 1:1).

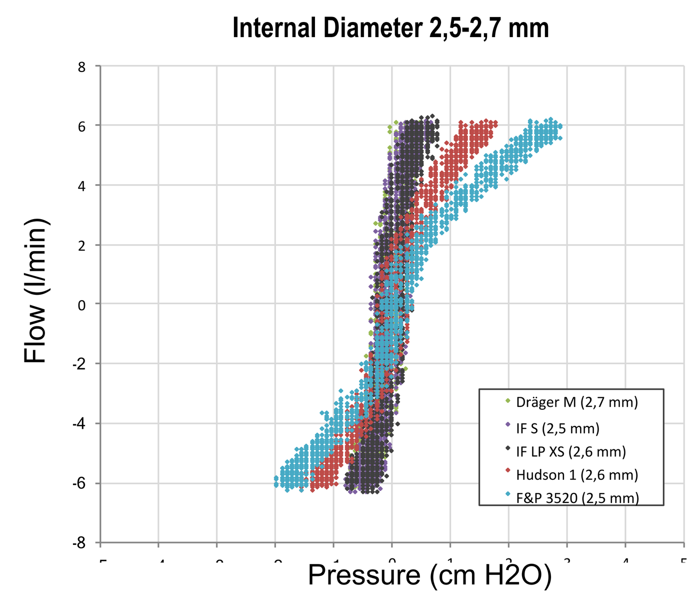

Fig 2: Compiled prongs with internal diameter 2,5-2,7 mm.

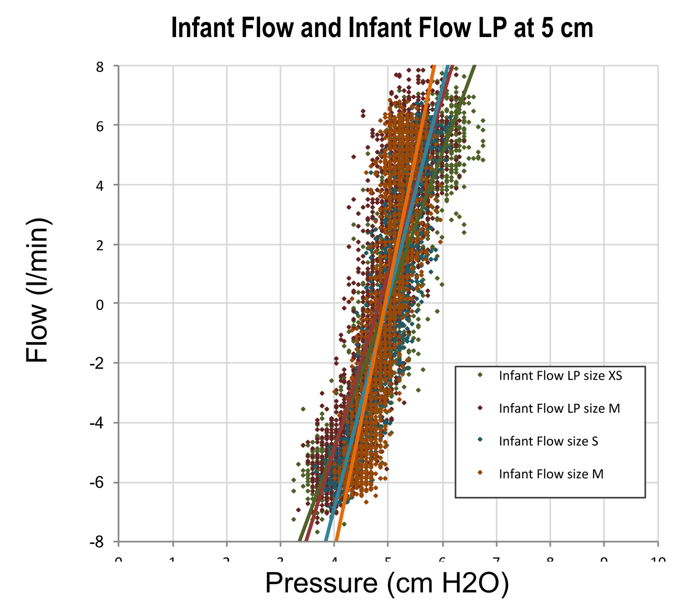

Fig 3: Example of two variable flow generators (at 5 cm CPAP) and effect of prong size .

Results and Conclusion

The resistance varied with prong design and size. The slightly longer prongs had a more marked increase in resistance with reduced size compared to the shorter prongs. For short prongs a reduction in size has minor effects on resistance.

For the tested prongs the graph shape did not change with higher respiratory rates (data not shown) and no hysteresis could be identified. The consistency in shape implies that the results are valid for a wide range of breathing patterns. The flow-pressure graphs bridge the gap between static and dynamic simulations.

Challenge

Flow-pressure graphs solve some of the problems associated with choosing appropriate tidal volumes in mechanical lung simulations.

Our challenge:

How can these graphs be further analyzed?

The flow-pressure graph may be used to describe factors other than prongs (e.g. leakage and CPAP-level), if the graphs can be analyzed and compared.

All traditional variables of performance, such as PTP, iWOB and P-V loops, can probably be derived from these graphs.

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