Reviewer’s report

Title: Role of tube size and intranasal compression of the nasotracheal tube in respiratory pressure loss during nasotracheal intubation: a laboratory study

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Reviewer: Alexander Kuo

Reviewer's report:

This is a focused investigation of the resistance of nasal tracheal tubes using in-vitro bench top experimentation based upon clinical anatomic measurements.

The authors present their study in 3 parts:

The first part is an observational study in which they measure in vivo and use CT scan data in a small patient cohort to evaluate the size of the compression nasal tracheal tubes in the patient's nasal passage. They then relate this to a force of compression with a bench-top force vs deformation tests of NTT.

The second part involves bench top testing of pressure loss across various sizes of NTT with deformations based upon data from part 1. Unfortunately, they seem to evaluate only the static pressure by having the NTT exit into the atmosphere in their experimental setup, and they make the assumption that there will be no recovery of the dynamic pressure after the flow de-accelerates after exiting the NTT in the tracheal bronchial tree. Further, they seem to attribute this loss in pressure to the "slip joint" rather than conversion of static pressure to dynamic pressure as flow velocity increases upon entry into a small cross-sectional area of the NTT.

While there is turbulent loss at the exit of the NTT, it is likely there is also significant static pressure recovery from the dynamic pressure base upon the Bernoulli principle. This is why other studies have used a fake tracheal at the exit of the tracheal tubes to include the pressure loss at the tube-to-trachea transition. For example, see:


Or

Please see the specific comments below for more details.

For the third part, the authors make fluid dynamic calculations to evaluate the theoretical pressure loss through a tube of a similar size. They then attribute the difference between their calculated and measured bench top results to losses in transition to the compressed intra-nasal part of the NTT. I find this assumption to be unsupported and I believe merely present the pressure loss as measure in their in-vitro testing to be compelling enough without the additional complexity of theoretical calculations.

Finally the authors conclude, that intra-nasal compression could increase the work of breathing, however, their reported values are very small 82 - 9.3 Pa (0.84 - 0.09 cm H2O) and this seems clinically insignificant to me.

Overall I feel the manuscript could be restructured to provide a more clear concept of the 3 parts of their study, and that the data/analysis presented should take in to account dynamic pressure recover or provide a compelling reason not to account for dynamic pressure recovery. Please see specific comments below.

Specific Comments:

Pg 2 Ln 10 "Rheological Simulation" - Rheology tends to refer to fluid and non-newtownian fluids like blood. Fluid dynamics is a better term. Also it seems you are calculating theoretical pressure drops rather than performing complex simulation. Thus, "theoretical calculation" may be a more accurate term.

Pg 2 Ln 30 "Median minor axes": Typo "Axes" should be "Axis". Also it should be clarified that this is the "Internal axis."

Pg 2 Ln 39: Units: "cm H2O" are also frequently used for airway pressures. It would be helpful for many readers to provide results also in cm H2O as well Pascals.

Pg 2 Ln 45: Conclusion, even if the author's numbers are taken at face value, a pressure loss of 82 Pa (0.8 cm H2O) is neglible in clinically practice, thus I feel intra-nasal compression does NOT significantly add to nasal tracheal tube resistance.

Pg 4 Ln 39: The slip joint does not significantly contribute the resistances. Examining reference 8, the authors only calculate the static pressure change with the Bernoulli principle. However, in a real system like the tracheal bronchial tree, the static pressure would be recovered from the dynamic pressure as flow decelerates in the tracheal bronchial tree as it branches. Based upon the data presented in Reference 8 the difference measure and Bernoulli calculated difference is at most 50 Pa loss in Total Pressure (dynamic + static), or approximately 0.5 cm H2O, when the dynamic pressure is accounted for.
If Daiken Medical Co Ltd is a commercial entity, this should be declared as material support for the study.

This does not seem to be an "Experiment," rather an observational study.

Did the patients "wavier consent" or did they "provide consent" for the study?

It would be more clear to describe the point of measurement as 2 cm "into" the nostril. Also it would be helpful that be clear it is the internal diameter minor axis being measured.

Again it would be helpful to clarify it is the "Internal" minor axis being measures.

The first sentence is difficult to read. Consider separating in to separate clauses or sentences.

I would explain here that "30 L/min" is the flow rate based upon TV 500 x RR 20, I:E ratio 1:2, and that's why that value was chosen for the bench top experiments. This way it is more clinically relatable.

Again please see above comments regarding of recovery of dynamic pressure as flow decelerates in a normal tracheal bronchial tree.

This does not seem "experimental" rather theoretical calculations.

Instead of "estimated" it would be more clear to say that the authors "calculated" the theoretical pressure loss in this third portion of their study.

"The pressure loss through the curvature of the NTT…was assumed ot be the difference between measured and predicted losses." This seems like a very dangerous assumption. It is very possible if there is a difference between calculated predicted values and measured values, that the assumptions that go into a calculation are inaccurate.

It would be much better if the authors directly measured a straightened tube, and a curved tube to evaluate the contributions of curvature in the tube to pressure loss.

Consider putting all parameters for calculations in 1 table for ease of readability.

Again, assuming the entire difference between experimental measurements and theoretical calculation is due to a specific difference is a weak assumption. It would be better to directly measure the difference between

The authors should make it clear they got the values of the "tubular parts" by simply subtracting the the values from their prior study, from their actually measured values in this study.
Pg 13 Ln 36: It appears in figure 6 the relationship between minor axis internal diameter and pressure loss is non-linear, rather polynomial. The term "proportional" may mislead readers that it is a linear relationship.

Pg 14 Ln 4: Rather than "predicted" "calculated" may be a clearer term.

Pg 14 Ln 33: It would be more clear if the authors restated that "pressure loss due to the curvature" was specifically the difference between calculated and measured pressure loss. Again, looking at figure 8, this appears to be a non-linear polynomial relationship to minor axis internal diameter.

Pg 17 Ln 32: Again, based upon the reported values, compression of the intra-nasal even in the worst case scenario causes only 100 Pa (1 cmH2O) increase in pressure loss. Thus it seems to me this would be negligible in clinical practice.

**Are the methods appropriate and well described?**
If not, please specify what is required in your comments to the authors.

Yes

**Does the work include the necessary controls?**
If not, please specify which controls are required in your comments to the authors.

Yes

**Are the conclusions drawn adequately supported by the data shown?**
If not, please explain in your comments to the authors.

No

**Are you able to assess any statistics in the manuscript or would you recommend an additional statistical review?**
If an additional statistical review is recommended, please specify what aspects require further assessment in your comments to the editors.

I am able to assess the statistics

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