Author's response to reviews

Title: Haemodynamics and oxygenation improvement induced by High Frequency Percussive Ventilation in a hypoxic cardiac surgery patient.

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Version: 4 Date: 29 April 2010

Author's response to reviews: see over
To reviewer Christian Gernoth

It is with great pleasure that we resubmit our manuscript, for consideration of publication in Journal of Medical Case Reports. We appreciate the excellent input of the expert reviewers. In all the authors have reviewed the paper and have approved of its resubmission. None of the data are submitted elsewhere for consideration.

Reviewer writes

*In the described case lung function decreases more from day to day until day 10 with the result of severe hypoxemia. Can you give more details about the mentioned recruitment manoeuvre you did and why not using the ARDS-network mentioned 6-7 ml/kg tidal volume (described here with 7.5 ml/kg).*

We would like to thank the reviewer for identifying this missing information. Recruitment manoeuvre was performed in which the patient underwent ventilation for two minutes in the pressure-controlled mode at an inspiratory plateau pressure of 45 cm of water, a PEEP of 5 cm of water, a respiratory rate of 10 breaths per minute, and a 1:1 ratio of inspiration to expiration. After the recruitment manoeuvre, PEEP at a level of 14 cm of water was applied.

We appreciate the reviewer identifying this important piece of information missing from the manuscript. We perform protective lung ventilation, focused on dynamic compliance and to maintain plateau pressure below 30 cm of water. We appreciate the reviewer identifying this important information missing form our manuscript. We forgot to report on the manuscript the plateau pressure due to our focus point on the mean airway pressure. We refer to the ARMA trial and the revision of Katherine Deans et al in Crit Care 2005 vol 33, n5 pag 1141-43 in which Patients with more compliant lungs did poorly if tidal volumes were lowered. In contrast, those with relatively less compliant lungs did well if tidal volumes were lowered. Identification of this interaction indicates that the overall survival benefit reported in the ARMA trial is not applicable to all ARDS/ALI patients. This finding is consistent with the philosophy that parameters of mechanical ventilation should be titrated based on surrogates of disease severity.

Reviewer writes

*How did you set up PEEP to 14 mbar, please explain this.*

We thank the reviewer for identifying this shortcoming information in the
manuscript.
Peep level of 14 cm of water reflect the upper inflection point on the Deflation Limb of the P/V curve can be used to prevent alveolar re-collapse and instability

Reviewer writes

Why did you stay on the I: E ratio of 1:1.5 and didn’t try to lower the peak inspiratory pressure (target < 30 cmH2O).
The blood gas samples you mentioned in your tables showed hyperventilation (pH 7.51), which is not conform with lung-protective ventilation strategy

We try to lower the expiratory time but we have severe problem with the carbon dioxide washout and so we maintain this I: E range.

Reviewer writes

Another question is whether you used kinetic therapy ("swimmer position", prone positioning)?

In this particular patient we don’t use kinetic therapy because he had a instability of sternum fracture

Reviewer writes

The use of hfpv showed fast improvement in oxygenation while reducing mean airway pressure. In the text you mentioned first MArP with 16, than later on you described the reduction from 24 to 20 which is inconsistent. Please explain this.

This is an insightful comment and an excellent input.
We noted a reduction in MArP after the HFPV treatment, from 24 to 20 cm of water.
The tidal volume before the HFPV therapy was 600 ml with a MArP of 24 cm of water.
The MArP during the HFPV treatment was 16 cm of water.
The tidal volume after HFPV therapy was 750 ml but with a MArP of 20 cm of water.
This higher TV was probably releatd with an increased lung compliance.

Reviewer writes

Another detail that need to be explained a little further is whether RVSWI decreased after improved oxygenation, which could be due to reduced pulmonary vascular resistance and not directly to reduced MArP.
Please comment on this.
We would like to thank the reviewer for identifying this missing information. A lower MArP means a reduced intrathoracic pressure and a reduced PAP, so we think that this may be correlated with the lower value of RVSWI during HFPV ventilation.

To reviewer Umberto Lucangelo

The reviewer writes:

1) The author should specified the preoperative gas exchange and hemodynamic values.

We agree with the reviewer. We appreciate the reviewer identifying this shortcoming in our manuscript. We do not have these data and have acknowledged this in the limitations section. The text has been edited to read:

- “Lastly, we do not have the data regarding preoperative gas exchange data and hemodynamic data, we only have preoperative lung function test which explain a moderate obstructive disease”.

The reviewer writes:

2) It's not clear if the patient has been mechanically ventilated for ten days continuously and which respiratory mechanics adjustments has been made during this period.

We would like to thank the reviewer for identifying this missing information. The patient was ventilated for 4 days in Pressure regulated volume controlled modality. In day 3 and 4 we started with recruitment manoeuvre those was performed for two minutes in the pressure-controlled mode at an inspiratory plateau pressure of 45 cm of water, a PEEP of 5 cm of water, a respiratory rate of 10 breaths per minute, and a 1:1 ratio of inspiration to expiration. After the recruitment manoeuvre, PEEP at a level of 14 cm of water was applied. Peep level of 14 cm of water reflect the upper inflection point on the Deflation Limb of the P/V curve can be used to prevent alveolar re-collapse and instability; after that we prove to switch into pressure support ventilation but with a non satisfactory gas exchange. Day 6 we restart with pressure regulated volume-controlled modality for two days. Day 8 to 10 we start with bipap ventilation but without satisfactory result.
The reviewer writes:

3) The authors reported any significative increase in respiratory parameters after IPRV modality of conventional ventilation. How the authors define a patient responder to ventilatory treatment?

- We appreciate the reviewer identifying this important information missing form our manuscript. We take in exam gas exchange parameters, (paO$_2$ should be greater than 200 for a weaning) and Murray score. After conventional ventilation we do not have any significative improvement in any of these parameters.

The reviewer writes:

4) The fast response to 12 hour of HFPV and the subsequent extubation after 10 hours of conventional mechanical ventilation allow two considerations: a) the patient was undertreated during the first ten days b) the clinical status has been abruptly improved for a consequence change in pharmacological therapy (antibiotics, steroids, etc..) not mentioned in the manuscript. Authors should be comment this point.

This is an insightful comment and an excellent input. We agree with the reviewer. We have tried to keep low plateau pressure but sometimes peak pressure alone or peak pressure + plateau pressure increased due to excessive stiff bronchial secretion and reduced lung compliance. The worst clinical situation we had on the 9.th day and so we keep on with HFPV whose make really the difference. After few hours we note an important incremental of retrograde secretion in the tracheal tube (see: third law of Newton), this permit us to have a good lung recruitment and a continuous gas exchange improvement.

The reviewer writes:

5) Figure 1 and 2 are redundant and should be taked off from the work. For the interested reader, the figures are available on the Percussionaire Corp. website.

We would like to thank the reviewer for identifying this information and we agree with him. We have done so and we have removed this figure out from the manuscript.
The reviewer writes:

6) **Author should be explain the rationale of the starting setting of HFPV that use a I: E of 1:7. It was used oscillatory CPAP during a so long expiration phase? Please specified.**

We totally agree with the reviewer concerns regarding this point: the inspiratory-expiratory rate of conventional ventilation in HFPV of I: E was so modify due to an excessive CO$_2$ washout. So we had maintained these unconventional setting in an ARDS ventilation strategy only to reduce the CO$_2$ washout. And it was used a oscillatory CPAP of 14 cm of water during the expiratory pause.

The reviewer writes:

7) **It will be very useful for the reader a deep physiopathological comment concerning the results.**

We thank the reviewer for identifying this shortcoming information in the manuscript.
In an ARDS ventilated patient the intrathoracic pressure is grater then a normal ventilated lung.
An augmented intrathoracic pressure increased afterload and decrease the stroke volume of the right ventricle with an increased systolic pulmonary pressure due to an augmented pulmonary vessels resistance.
An important endpoint is to reduce the mean airways pressure, so to reduce the interference to the cardiac cycle.
With HFPV mean airway pressure is lower than the conventional ventilation, so it may improve the right ventricle function like we see with the RVSWI; but is only one patient and we need more study to confirm this data.