

LETTER



Variability of reverse triggering in deeply sedated ARDS patients

Jeremy Bourenne^{1*}, Christophe Guervilly², Malika Mechati¹, Sami Hraiech², Megan Fraisse¹, Magali Bisbal³, Antoine Roch², Jean Marie Forel², Laurent Papazian² and Marc Gainnier²

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Dear Editor,

Reverse triggering (RT) is an under-recognized form of patient–ventilator asynchrony detectable at the bedside [1, 2]. RT can promote ventilator-induced lung injury (VILI) by producing double triggering and stacked breaths resulting in an increase of tidal volume (V_t) and transpulmonary pressure (P_L) [2]. Pendelluft contributes by inducing a redistribution of gas during RT leading to a local increase of P_L . The aim of this study was the screening of RT phenomenon in deeply sedated, mechanically ventilated ARDS patients either receiving or not neuromuscular blocking agents (NMBA).

This is an ancillary physiologic study derived from a prospective randomized study [3]. We retrospectively analysed the continuous recordings of airway pressure, flow, volume and oesophageal pressure (P_{es}) over time in a subgroup of 21 ARDS patients ventilated with a PaO_2/FiO_2 ratio below 150 mmHg. Other inclusion criteria are detailed in the electronic supplementary material (ESM).

Oesophageal pressure measurements were performed via a specific nasogastric feeding tube (SmartCathG[®], VIASYS Healthcare, Palm Springs, CA, USA) equipped with an oesophageal balloon. Analysis was manually performed from the recordings using Acknowledge[™] (Biopac) software by two intensivists (MM and MG). When RT was identified, the characteristics were analysed over the following 1-h period in order to describe its rate and duration.

For every patient and every recording in which we found the RT phenomenon, characteristics (frequency, entrainment ratio (ER), phase difference) were described or computed according to the methodology described by Akoumianaki et al. [2].

Continuous recordings of airway pressure, flow, volume and P_{es} were obtained in 21 moderate-to-severe ARDS patients (NMBA group, $n = 11$; control group not receiving NMBA, $n = 10$). Recording time totalled 10,920 min (182 h) in the NMBA group and 16,440 min (274 h) in the control group. Sedation consumption is reported in the ESM.

No RT phenomenon was observed in the NMBA group. Three out of 10 patients (33%) in the control group had evidence of RT ($p = 0.09$). In this group, RT was observed during 0.33–17.88% of the 60 min of the analysis. Characteristics of RT for each patient are detailed in Table 1. Consequences on V_t and P_L depend on the time of respiratory cycle in which the RT occurs. The dominant pattern of entrainment was not stable (1/2, 1/3 or minus).

Akoumianaki et al. [2] reported that RT observed in eight deeply sedated ARDS patients was characterized by a stable ER described as 1:1, 1:2 and 1:3. In our study, the ER was not stable. The major difference between the two studies is the duration of analysis i.e. 60 min vs 6–27 min.

Inspiratory efforts generated by the RT caused ample variations of the level of lung pressures (delta P_{aw} , plateau pressure, P_{es} and P_L). We observed evidence of double triggering with stacked breaths leading to potential consequences: increase of the P_L and, consequently, the increase of stress and strain on the lungs leading to VILI [4, 5].

We confirmed the existence of RT in deeply sedated ARDS patients not receiving NMBA. Our study supports

*Correspondence: Jeremy.bourenne@ap-hm.fr

¹ Assistance Publique, Hôpitaux de Marseille, Hôpital Timone, Service de Médecine Intensive Réanimation, Réanimation des Urgences, Centre d'Études et de Recherche sur les Services de Santé et la Qualité de Vie, CEReSS, EA 3279, Aix-Marseille Université, Faculté de Médecine, Marseille, France

Full author information is available at the end of the article

Table 1 Analysis of reverse triggering asynchrony for the three patients in the control group

Patient no.	Total recording time (min)	Duration of analysis (min)	Ventilator cycle/h (n)	RT per hour (n)	Percentage of entrainment (%)	Phase angle (°)	Vt set on ventilator (ml)	Inspiratory P _L with-out RT (mean ± SD)	Vt max during RT (mean ± SD)	Inspiratory P _L during RT (mean ± SD)
1	306	60	1800	6	0.33	25 ± 14	480	9 ± 0.9	606 ± 90	19 ± 11
2	1150	60	1560	279	17.88	126 ± 69	420	20 ± 1.5	792 ± 19	25 ± 1.2
3	2547	60	1260	13	1.03	101 ± 117	460	22 ± 2	552 ± 25	45 ± 3.5

The data show the duration of recording the characteristics of RT phenomena (phase angle, entrainment, frequency per hour) and the consequences on tidal volume and transpulmonary pressure during RT. RT reverse triggering, Vt tidal volume, Vt transpulmonary pressure

the experimental data of deleterious effects of strong spontaneous efforts in the early phase of severe ARDS.

Electronic supplementary material

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Author details

¹ Assistance Publique, Hôpitaux de Marseille, Hôpital Timone, Service de Médecine Intensive Réanimation, Réanimation des Urgences, Centre d'Études et de Recherche sur les Services de Santé et la Qualité de Vie, CEReSS, EA 3279, Aix-Marseille Université, Faculté de Médecine, Marseille, France. ² Assistance Publique, Hôpitaux de Marseille, Hôpital Nord, Réanimation des Détresses Respiratoires et Infections Sévères, Centre d'Études et de Recherche sur les Services de Santé et la Qualité de Vie, CEReSS, EA 3279, Aix-Marseille Université, Faculté de Médecine, Marseille, France. ³ Département d'Anesthésie-Réanimation, Institut Paoli-Calmette, 13009 Marseille, France.

Compliance with ethical standards

Conflicts of interest

The authors have no conflicts of interest.

Ethical approval

An approval by an ethics committee was not applicable.

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