Pulmonary ventilation and perfusion assessed by electrical impedance tomography

Experimental studies in pigs

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Anneli Fagerberg
Leg. läkare

Fakultetsopponent:

Professor Claes Frostell
Avdelningen för Anestesiologi och Intensivvård
Karolinska Institutet, Stockholm, Sverige

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II Fagerberg A, Stenqvist O, Åneman A. Electrical impedance tomography applied to assess matching of pulmonary ventilation and perfusion in a porcine experimental model
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III Fagerberg A, Søndergaard S, Karason S, Åneman A.
Electrical impedance tomography can be used to assess heterogeneity of pulmonary ventilation and perfusion during acute lung injury in pigs
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IV Fagerberg A, Søndergaard S, Casselbrant A, Åneman A.
Angiotensin-converting enzyme inhibition during endotoxinaemic acute lung injury in pigs does not affect ventilation/perfusion changes monitored by electrical impedance tomography
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Anneli Fagerberg

Dept of Anaesthesiology and Intensive Care, Institute of Clinical Sciences, Sahlgrenska Academy, Gothenburg University, Sweden

ABSTRACT

Pulmonary ventilation and perfusion and ventilation/perfusion (V/Q) matching determine gas exchange in every lung unit in the healthy state and in the pathologically altered lung. Mismatch of V and Q lead to hypoxaemia and hypercapnia and monitoring of V/Q relations are thus important in critical illness.

This thesis focuses on electrical impedance tomography (EIT) to monitor pulmonary perfusion and its relation to ventilation in physiological conditions and in endotoxinaemic acute lung injury (ALI) in a porcine experimental model.

EIT is a non-invasive, non-radiant continuous monitoring technique generating images of impedance distribution changes within the thorax. Blood and air differ considerably in impedance properties, resulting in characteristic distribution images of pulmonary ventilation and perfusion respectively.

The methodology of assessing global perfusion by EIT was evaluated in the healthy state during interventions resembling acute hypovolaemia and recruitment manoeuvres. The pulse synchronous amplitude of systolic impedance change, measured during apnoea, correlated to a wide range of stroke volumes measured by the pulmonary artery catheter, as an estimate of pulmonary perfusion.

The methodology was expanded to include regional perfusion and its relation to ventilation by combined measurements during apnoea and ventilation, generating estimates of V/Q relations. Global EIT measurements correlated significantly to venous admixture and alveolar dead space calculated by standard methods. Regional EIT measurements of V and Q provided physiologically relevant results under dynamic conditions.

The monitoring technique was applied in pigs subjected to endotoxinaemic ALI to assess changes in regional V and Q and V/Q matching. V/Q mismatch developed primarily as a result of dorsal redistribution and increased heterogeneity of perfusion.

Finally, pre-treatment with the angiotensin-converting enzyme (ACE) inhibitior enalapril to reduce angiotensin II levels and attenuate inflammation and V/Q mismatch in endotoxinaemic ALI was examined, employing EIT monitoring. The investigation failed to provide support for the hypothesis that ACE inhibition could improve V/Q mismatch and thus gas exchange.

In conclusion, this thesis described that the EIT technique could be used to assess global and regional pulmonary perfusion and its relation to ventilation in physiological as well as pathological conditions

Key words: electrical impedance tomography, pig, V/Q matching, endotoxinaemic ALI, ACE inhibitor

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