Introduction

Burns represent one of the most severe types of trauma with important socio-economic implications. In the USA almost 100,000 patients are admitted annually to hospital owing to burns, while the corresponding number for our country, Greece, is estimated to be 2500 patients. Improvement in local treatment during the last decade has caused a significant reduction in morbidity and mortality due to infections and local complications. On the other hand this has raised systemic complications in burns, the main cause of acute respiratory failure, to being among the most important contributors of morbidity and mortality in patients with severe burns.

Besides optimal ventilation management, there is little else to do in the treatment of the lung with post-burn injury. Exogenous surfactant administration has been considered a potential therapeutic approach, and a few anecdotal reports have been published. Questions regarding the dosing scheme, side effects, and efficacy have not been answered through large-scale clinical trials. We report our clinical experience with this approach in a patient with both severe inhalation injury and thermal injury.

Method and results

A 35-yr-old man was admitted to hospital after an industrial accident. He had sustained a 60% total body surface area full-thickness burn covering the face, both hands, and the trunk. He was intubated on the scene, and in the emergency department it was very difficult to ventilate him (a tidal volume of 600 ml of 100% O₂ resulted in a peak
inspiratory pressure of 55 cm H₂O and a PaO₂ of 48 mm Hg), in the presence of full sedation and paralysis. The chest radiography showed bilateral alveolar infiltrates.

Fiberoptic bronchoscopy revealed severe blisters and ulcers of the bronchial mucosa. In the light of these findings, a diagnosis was made of severe inhalation injury. A pressure volume curve of the respiratory system revealed a lower inflection point of 12 cm H₂O and an upper inflection point of 22 cm H₂O, and ventilator settings were adjusted to the above. On day 3 post-burn refractory hypoxaemia persisted (PaO₂ of 56 mm Hg with a FiO₂ of 100%), followed by poor mechanical properties of the respiratory system (compliance of 26 ml/cm H₂O and inspiratory resistance of 14 ml/cm H₂O).

To treat the above, an initial dose of natural bovine surfactant (Alveofact) of 50 mg/kg body weight was administered by intrabronchial instillation on day 3 post-burn. To prevent coughing, deep sedation and relaxation were ensured prior to surfactant administration. Rotation of the bed was used to facilitate the homogenous spread of surfactant. Transient hypoxaemia (less than 30 min) was the only noteworthy pathophysiological change, while circulatory parameters remained unchanged. A significant improvement in oxygenation was observed 1 h after administration. On day 3 post-burn refractory hypoxaemia persisted (PaO₂ of 56 mm Hg with a FiO₂ of 100%), followed by poor mechanical properties of the respiratory system (compliance of 26 ml/cm H₂O and inspiratory resistance of 14 ml/cm H₂O).

To prevent coughing, deep sedation and relaxation were ensured prior to surfactant administration. Rotation of the bed was used to facilitate the homogenous spread of surfactant. Transient hypoxaemia (less than 30 min) was the only noteworthy pathophysiological change, while circulatory parameters remained unchanged. A significant improvement in oxygenation was observed 1 h after administration, reaching its peak at 5 h (PaO₂ 126 mm Hg/FiO₂ of 100%), followed by poor mechanical properties of the respiratory system (compliance of 26 ml/cm H₂O and inspiratory resistance of 14 ml/cm H₂O).

Twelve hours after administration, the oxygenation index PaO₂/FiO₂ improved from 56 mm Hg prior to administration to 194 mm Hg. Respiratory mechanics also demonstrated a significant improvement (compliance increased from 26 ml/cm H₂O prior to administration to 41 ml/cm H₂O at 12 h, while inspiratory resistance decreased from 14 ml/cm H₂O initially to 11 cm H₂O/lps). Gas exchange and respiratory mechanics remained practically unchanged, and the same dose of surfactant was repeated 48 h later (day 5 post-burn) to prevent potential deterioration.

A tracheotomy was performed on day 6 post-burn, while gas exchange and lung mechanics remained unaffected. On day 8 the patient suffered a severe attack of septic shock, which despite intensive support caused his death on day 9 post-burn.

Discussion and conclusion

The aetiology of acute respiratory failure, acute lung injury (ALI), and adult respiratory distress syndrome (ARDS) in burn patients is multifactorial and the incidence varies according to diagnostic criteria and patient populations. In a recent retrospective study of 469 burn patients, 45% of mechanically ventilated patients were diagnosed with ARDS according to currently held criteria. The group of patients who developed ARDS had a mortality rate of 42%, while the group that did not develop ARDS had a mortality of 32%. The current definition of ALI requires severe impairment of oxygenation with a PaO₂/FiO₂ < 300 mm Hg, while ARDS requires a PaO₂/FiO₂ < 200 mm Hg. Our patient fulfilled the ARDS criteria.

In ALI/ARDS the damage is to the alveolar capillary membrane, which in burn patients may be affected on both sides. In patients with inhalation injury there is direct damage to the alveolar epithelium. Inhalation injury, by damaging both the bronchial mucosa and the alveolar epithelium, triggers a local cascade of inflammatory reactions, causing pulmonary oedema, surfactant alteration, lipid peroxidation, decrease in antioxidant activity, and infiltration by neutrophils. In patients with extensive skin thermal injury, a systemic inflammatory reaction may also be triggered. This systemic inflammatory reaction may affect the alveolar capillary membrane on the lung capillary side. In both cases the permeability of the alveolar capillary membrane is impaired, resulting in severe alterations in the alveolar environment. Surfactant alterations, both quantitative and qualitative, have been demonstrated in ALI/ARDS patients.

Surfactant replacement has been considered beneficial in the treatment of patients with ARDS in preliminary studies. Although the rationale supporting its use is quite strong, things are not that simple for burn patients. Mechanical ventilation per se seems to affect many aspects of the surfactant system, even when the lung is intact and modest ventilator settings are employed. Recent clinical data also imply that the response to exogenous surfactant replacement may differ according to the pathophysiological mechanism that primarily affects the lung. Direct lung injury seems to be associated with better clinical results than indirect lung injury. In burn patients with coexisting inhalation injury this pathophysiological distinction is difficult to make. Consequently, exogenous surfactant replacement requires the recognition of some kind of threshold or indication that could guide its use, and the identification of specific situations that could justify such a costly approach. The attractive theoretical background and the promising early clinical data indicate the need of clinical trials to confirm the role of exogenous surfactant in inhalation injury therapeutics.
RÉSUMÉ. Les lésions dues à l’inhalation représentent une cause importante du décès des grands brûlés. L’administration de surfactant exogène paraît être pleine de promesses pour le traitement de l’insuffisance respiratoire aiguë. Les Auteurs décrivent leur expérience clinique avec cette approche. Un homme âgé de 35 ans a été hospitalisé dans leur unité de brûlés après un accident du travail. Il a été atteint de brûlures à toute épaisseur en 60% de la surface totale corporelle associées à des lésions sévères dues à l’inhalation. La bronchoscopie fibroptique a confirmé le diagnostic, démontrant des ampoules et des ulcères sévères de la muqueuse bronchiale. L’hypoxémie réfractaire (PaO₂/FiO₂ 56 mm Hg, où PaO₂ est la tension de l’oxygène du sang artériel et FiO₂ est la fraction de l’oxygène inspiré) a été traitée avec le support ventilateur mécanique optimal; en outre, une dose initiale de surfactant bovin naturel (Alveofact) de 50 mg/kg poids corporel a été administré par instillation intrabronchiale le jour 3 après la brûlure. Une amélioration significative de l’oxygénation a été observée 12 h après l’administration (de 56 mm Hg initialement jusqu’à 94 mm Hg), suivie par une amélioration de la compliance dynamique (de 26 ml/cm H₂O initialement jusqu’à 41 ml/cm H₂O) et de la résistance inspiratoire (de 14 cm H₂O/lps initialement à 11 cm H₂O/lps). La même dose de surfactant a été répétée après 48 h pour prévenir la possibilité de détérioration, ce qui maintenait l’échange gazeux et la mécanique pulmonaire aux niveaux précités. Aucune complication associée à l’administration du surfactant n’a été observée. Pourtant le patient est décédé le jour 9 après la brûlure pour des causes extrapulmonaires. Les résultats présentés démontrent une amélioration significative de l’échange gazeux et de la mécanique pulmonaire dans un patient brûlé atteint de lésions sévères dues à l’inhalation après l’administration répétée de surfactant exogène. Il faudra effectuer d’autres études pour éclaircir l’impact clinique de l’administration du surfactant et les complications liées à son emploi dans le traitement des lésions dues à l’inhalation.

BIBLIOGRAPHY