Pulmonary gas exchange during orthotopic liver transplantation


Summary
The aim of this study was to evaluate the efficiency of pulmonary gas exchange during the course of liver transplantation. We studied 25 adult cirrhotic patients undergoing transplantation, performed with venovenous bypass. A significant increase in $P_{A0}$ and a significant decrease in physiological shunt and alveolar–arterial partial pressure difference were observed just before the start of venovenous bypass. These changes were probably caused by modifications in respiratory mechanics, such as an increase in functional residual capacity. There were no other respiratory changes during the anhepatic and post-anhepatic phases. (Br. J. Anaesth. 1994; 73: 695-696)

Key words

Anaesthesia causes important changes in respiratory function and is associated with reduced pulmonary gas exchange [1]. As low oxygen tension is common in cirrhosis, it is important to analyse changes in pulmonary gas exchange during liver transplantation [2].

In this study we have evaluated arterial oxygen tension ($P_{A0}$), physiological shunt ($Q_s/Q_t$) and alveolar–arterial oxygen tension difference ($P_{A0}-P_{Ao}$) in the course of liver transplantation.

Methods and results
Haemodynamic, respiratory and metabolic data were recorded in 25 consecutive transplantations, all performed in cirrhotic patients with the aid of venovenous bypass. All patients were in a stable condition, staying at home but unable to work (Child's B). Mean age was 33 (range 16-43) yr.

All patients underwent ventilation with an air-oxygen mixture ($F_{O2}$ 0.55 (sd 0.1)). A tidal volume of 12-15 ml kg$^{-1}$ was maintained together with a ventilatory frequency of 12 b.p.m.; PEEP of 5 cm H$_2$O was always added. Patients underwent extensive haemodynamic monitoring including pulmonary artery catheterization. Data were collected at constant time intervals. Haemodynamic and oxygen transport variables were calculated by means of standard formulae; online calculation of derived variables was obtained by specifically designed software. Statistical analyses of results were carried out with ANOVA and regression analysis; Bonferroni correction was performed for multiple testing.

The main haemodynamic variables are reported in table 1. We observed a significant increase in $P_{A0}$ just before the start of venovenous bypass compared with after induction of anaesthesia ($P < 0.05$) and after laparotomy ($P < 0.05$). ($PAO_{2}-P_{AO}$) and $Qs/Qt$ values are illustrated in table 1: both these decreased to a statistically significant extent just before the start of venovenous bypass compared with after induction of anaesthesia ($P < 0.05$ for both) and then remained unchanged until the end of surgery. Regression analysis showed during the pre-anhepatic phase an inverse correlation between minute ventilation and both $Qs/Qt$ and ($PAO_{2}-P_{AO}$) ($r = -0.52$, $P < 0.05$ and $r = -0.42$, $P < 0.05$, respectively); in the first phases compliance correlated with $P_{AO}$ ($r = 0.68$, $P < 0.001$). Furthermore, $Qs/Qt$ exhibited an inverse correlation with $P_{AO}$ ($r = -0.48$, $P < 0.0001$).

Stepwise regression analysis showed that $P_{AO}$ and minute ventilation accounted for 52% on the variability in $P_{AO}$ ($r^2 = 0.52$, $P < 0.001$) during the initial phases.

Comment
Cirrhosis is characterized by an abnormal tendency to arterial hypoxaemia, related mostly to an increase in pulmonary venous admixture [3]. Moreover, patients with cirrhosis may have a restrictive respiratory defect, not only because of ascites and pleural effusions, but also because of respiratory muscle weakness and diffuse lung disease [4].

The physiological shunt fraction (about 10% in anaesthetized healthy patients) represents the “gold standard” for assessing variations in pulmonary gas exchange [5]. In our study $Qs/Qt$ at the beginning of liver transplantation was about twice that of normal values during anaesthesia and therefore it is likely that this further impairment in pulmonary gas exchange resulted from end-stage liver failure. However, just before the start of venovenous bypass, $Qs/Qt$ decreased significantly, reaching normal values, and then remained unmodified during the anhepatic and post-anhepatic phases.

V. Perilli, MD, L. Sollazzi, MD, S. Bradariolo, MD, G. Pelosi, MD (Department of Anaesthesiology and Intensive Care); A. W. Avolio, MD, S. Agnes, MD, S. C. Magalini, MD, M. Castagneto, MD (Department of Surgery); Catholic University, Largo A. Gemelli, 8, 00168 Roma, Italy. Accepted for publication: May 5, 1994.
The change in FRC is a reasonable explanation for the variation in \( \Delta P_{aO} \) and it is likely that the difference between our data and Burchett's during the post-anhepatic phase may reflect different ventilation, such as the use of PEEP, or a different tidal volume, or both, that may prevent a decrease in FRC in the late phases of liver transplantation. Alternative explanations are differences in patient populations and different surgical approaches (we have always used venovenous bypass, while this device was not used in Burchett's series).

In conclusion, the increase in \( P_{aO} \) observed just before the anhepatic phase may have been caused by an improvement in ventilation (such as an increase in FRC) and this improvement was maintained until the end of surgery. Nevertheless further studies are required to evaluate the importance of venovenous bypass.

### References