TITLE : EFFECTS OF THORACIC EXTRADURAL BLOCK ON DIAPHRAGMATIC ACTIVITY AFTER UPPER ABDOMINAL SURGERY

AUTHORS : J.L. Pansard, M.D., Y. Philip, M.D., A. Bahnini, M.D., J.F. Brichant, M.D., M. Delima M.D., B. Mankikian, M.D., P. Viars, M.D.

AFFILIATION : Département d'Anesthésie-Réanimation - Département de Chirurgie Vasculaire - C.H.U. Pitié-Salpétrière - Université Paris VI
83, boulevard de l'hôpital 75651 Paris Cédex 13 - France

INTRODUCTION : It has been demonstrated that diaphragmatic dysfunction observed after upper abdominal surgery (UAS) was not related to a decrease in diaphragmatic contractility (1). Thus, inhibition of phrenic nerve activity by reflexes arising from the abdominal compartment (abdominal wall and/or viscera) can be a determining factor of this dysfunction. Partial reversal of the diaphragmatic dysfunction after a thoracic extradural block (2) suggests that inhibitory afferents are conducted by medullary pathways. However, no direct information on diaphragmatic activity after UAS is available. Therefore, this study was designed to assess the effects of thoracic extradural block on diaphragmatic electrical activity and efficiency after UAS.

METHODS : 13 ASA II patients, undergoing elective abdominal aortic surgery with a xypho-pubic incision were studied. Their mean age was 55 ± 10 yrs (X ± SD). Mean body mass index 22.6 ± 3.7kg.m-2. All were smokers, with normal FVC and FEV_1. None was hypercapnic. Individual informed consent and institutional approval for the study were obtained. A thoracic epidural catheter was inserted at T8-T9 level prior to general anesthesia. Anesthetic drugs used during surgery included : thiopental, fentanyl, pancuronium, N_2O/O_2 and halothane in standard doses. The following measurements were performed during quiet breathing in the supine 30° head-up position :

-> Changes in rib cage (ΔXrc) and abdominal (ΔXab) circumferences were simultaneously measured with two differential linear transformers.

-> Swings in gastric (ΔPgas) and esophageal (ΔPes) pressures were measured with two balloon catheters connected to Validyne MP 45 transducers. Swings in transdiaphragmatic pressures (ΔPdi) were obtained by summation of gastric and esophageal signals (Gould SP 110 A).
The ratio ΔPgas/ΔPdi and ΔXab/(ΔXab+ΔXrc) were taken as an index of the diaphragmatic contribution to tidal breathing.

-> Electrical activity of the diaphragm (Edi) was recorded by 2 pairs of electrodes surgically inserted in the costal and the crural parts on the left hemidiaphragm. Electrodes are multifilament steel wires, 40cm long, insulated with polyethylene, except for their terminal 3cm which were inserted in the muscle and spaced 1cm apart. They were returned to the abdominal surface through the abdominal wall. Crural and costal Edi signals were amplified, filtered (200-2000Hz) and integrated (DISA 15 C01 EMG amplifier). The peak inspiratory amplitude of integrated crural and costal electrical signals were used for assessement of diaphragmatic electrical activity (Edi-crur, Edi-cost). The ratio ΔPdi/Edi was calculated by simultaneously recording ΔPdi and Edi and taken as an index of diaphragmatic efficiency. Electrodes were easily drawn out at the end of the study.

-> Functional residual capacity (FRC) was measured by the helium dilution method.
Respiratory variables were obtained 24h before surgery (T0) except Edi. After surgery, measurements including Edi were repeated before (T1) and one hour after (T2) a segmental block, up to T4 segment, achieved with 0.5% plain bupivacaine (mean dose : 55±14mg). Respiratory variables were calculated as the mean of 30 cycles. Values are given as mean ± SD. Statistical analysis was an analysis of variance.

RESULTS : are summarized in table 1 and 2. Between T0 and T1 : there was a significant decrease in ΔXab/(ΔXab + Xrc), ΔPgas, ΔPdi and ΔPgas/ΔPdi. FRC decreased significantly. Between T1 and T2, the segmental block was responsible for a significant increase in ΔXab/(ΔXab + ΔXrc), Pgas, ΔPdi and ΔPgas/ΔPdi. Both Edi-cost and Edi-crur increased significantly. ΔPdi/Edi values were unchanged.

DISCUSSION : This study demonstrates that both costal (+60%) and crural (+49%) diaphragmatic electrical activities are increased by a thoracic extradural block after UAS. Therefore, the partial reversion of the diaphragmatic dysfunction can be related to the increase in diaphragmatic electrical activity. Diaphragmatic efficiency does not appear to be modified. These results suggest that extradural 0.5% bupivacaine may interrupt phrenic inhibitory afferents conducted by medullary pathways. Direct stimulation of respiratory centers by local anesthetic after its vascular resorption from the epidural space may also be involved.

REFERENCES
1. DUREUIL B. et al : J.Appl.Physiol. 61:1775-1780,1986
2. MANKIKIAN B. et al : Anesthesiology 63, A516, 1985

TABLE I : Sequential changes in respiratory variables

	T0	T1	T2
ΔPgas (cmH_2O)	2.53 ± 0.70	- 0.01* ± 1.35	2.11+ ± 0.90
ΔPdi (cmH_2O)	8.90 ± 1.93	6.88* ± 2.72	9.26+ ± 3.76
ΔPgas/ΔPdi (%)	0.29 ± 0.07	- 0.01* ± 0.24	0.26+ ± 0.09
ΔXab / (ΔXab +ΔXrc) (%)	0.73 ± 0.08	0.04* ± 0.08	0.39*+ ± 0.20
RR ($c.min^{-1}$)	13.84 ± 2.23	17.76* ± 2.58	14.76+ ± 1.96
FRC (l)	2.6 ± 0.5	2* ± 0.5	2.2*+ ± 0.5

TABLE 2 : Edi changes after UAS
(Values are given in arbitrary units)

	Edi-cost	Edi-crur	ΔPdi/Edi-cost	ΔPdi/Edi-crur
T1	14.66 ± 4.82	12.65 ± 5.02	0.53 ± 0.30	0.62 ± 0.30
T2	23.69+ ± 9.68	18.58+ ± 6.90	0.51 ± 0.27	0.55 ± 0.29

* = p < 0.05 vs T0 + = p < 0.05 vs T1