

Title: EFFECT OF SMOKING ON THE OXY-HEMOGLOBIN DISSOCIATION CURVE

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Introduction. Cigarette smoking is said to be associated with increased levels of carboxy-hemoglobin in the blood (1). There is evidence that carboxy-hemoglobin will shift the oxy-hemoglobin dissociation curve to the left (1). The present study is to demonstrate [1] the presence of carboxy-hemoglobin in the blood of human volunteers who smoke one or more packs of cigarettes per day and the effect of carboxy-hemoglobin on the oxy-hemoglobin dissociation curve; and [2] the effect on carboxy-hemoglobin level and oxy-hemoglobin dissociation curve after smoking is stopped for about 12 hours.

Methods. Ten informed volunteers who smoked one or more packs of cigarettes a day were included in this study. With the approval of the Committee for the Protection of Human Subjects, 5 ml of venous blood was drawn into a heparinized syringe from each of the ten subjects. 50 ml of this blood was used to measure carboxy-hemoglobin level by using deoxygenation capillary tube and an OSM2 Hemoximeter*. The remaining blood sample was equilibrated in an IL 237 Tonometer with gas mixtures containing 3.5% and 4% oxygen, 5.6% carbon dioxide, and the balance nitrogen at 37°C. Total hemoglobin and percent oxygen saturation of the hemoglobin were measured in an OSM2 Hemoximeter*. The blood gases were measured in a Corning 168 pH/Blood Gas Analyzer. All the patients were asked to stop smoking for about 12 hours and the above procedure was repeated and data collected. The measured PO₂ data were corrected to pH 7.40 by using the IL PO₂/pH nomogram. Since the uniform carbon dioxide in the gas mixtures gave a normal PCO₂ of 40 mmHg and the blood gas measurements were made at 37°C, no PCO₂ or temperature corrections were needed. Two point saturation curve was plotted in the linear portion of the oxy-hemoglobin dissociation curve by using the IL P-50 sheet and P-50 was obtained from the saturation curve for both control and fasting samples.

Results. Table 1 contains the values of total hemoglobin, carboxy-hemoglobin, corrected PO₂, percent oxygen saturation, and P-50 of blood samples collected before and after fasting. Carboxy-hemoglobin while smoking was 6.56 (± 1.86)% and the P-50 was shifted to the left 4.15 mmHg from a normal of about 27 mmHg. After smoking was stopped, the carboxy-hemoglobin levels were reduced to 0.96 (± 0.34)% (p < 0.001) and the P-50 shifted towards normal, 26.29 (± 0.67) mmHg (p < 0.001).

Discussion and Conclusions. The release of oxygen to the tissues is influenced by the affinity of the hemoglobin for oxygen. This characteristic affinity of the hemoglobin for oxygen is commonly expressed as P-50. P-50 is the partial pressure of oxygen at which 50 percent of the hemoglobin is saturated at a pH of 7.4, PCO₂ of 40 mmHg, and

temperature of 37°C. The volume of oxygen that can be unloaded to the tissues is increased with a higher P-50 (shift to the right) and decreased with a lower P-50 (shift to the left). Our data show that while smoking, there is increased levels of carboxy-hemoglobin present in the blood which resulted in decrease in available hemoglobin for oxygen transport. Carboxy-hemoglobin also interferes with unloading of oxygen from the hemoglobin by shifting P-50 to the left. After smoking is stopped for about 12 hours, there is a significant decrease in carboxy-hemoglobin level and increase in P-50 of the oxy-hemoglobin, thereby increasing the oxygen carrying capacity of the blood and enhancing the release of oxygen from the hemoglobin. We conclude that it is beneficial for chronic smokers to abstain from smoking for as little as 12 hours prior to surgery.

References.

1. Castledan CM, Cole PV: Variations in carboxy-hemoglobin levels in smokers. *Br Med J* 4:736, 1974.
2. Roughton FJW, Darling RC: The effect of carbon monoxide on the oxyhemoglobin dissociation curve. *Am J Physiol* 141:17, 1944.

Table 1

	Mean	S.D.	t*	p
CONTROL (smoking)				
Hgb, g/dl	15.69	0.65		
Co-Hgb, %	6.56	1.86		
3.5% O ₂				
PO ₂ , mmHg	23.85	0.44		
O ₂ Sat, %	52.25	3.11		
4.0% O ₂				
PO ₂ , mmHg	27.58	0.55		
O ₂ Sat, %	60.95	3.35		
P-50, mmHg	22.85	1.21		
FASTING (smoking stopped for 12 hours)				
Hgb, g/dl	15.53	0.67	1.49	< 0.2
Co-Hgb, %	0.96	0.34	11.18	< 0.001
3.5% O ₂				
PO ₂ , mmHg	24.07	0.24	1.61	< 0.2
O ₂ Sat, %	44.49	2.32	11.25	< 0.001
4.0% O ₂				
PO ₂ , mmHg	28.00	0.34	1.85	< 0.1
O ₂ Sat, %	54.19	1.54	7.26	< 0.001
P-50, mmHg	26.29	0.67	13.39	< 0.001

* Paired t-test used.