Clinical Workshop

S. G. HERSHEY, M.D., *Editor*

Blood Gas Studies during Laparoscopy under General Anesthesia

ROBERT A. BARATZ, PH.D., M.D.,* AND JOANNES H. KARIS, M.D.*

Although laparoscopy was introduced by Kelling[1] in 1902, the procedure had not received much attention until recently.[2-4] The reasons for the renewed interest are twofold: improvements in instrumentation and technic make the procedure both safer and more rewarding, and second, the use of general anesthesia makes laparoscopy more acceptable to the patient and allows immediate definitive surgery.[5, 6] The primary use of laparoscopy has been as a diagnostic aid to eliminate the need for laparotomy, with which complications are more common and hospitalization is considerably longer. Its use has been extended to diagnostic biopsies, aspiration of fluid, visualization of dye (hysterosalpingogram) and tubal ligations.

The procedure involves insufflation of carbon dioxide into the peritoneal cavity to give a pneumoperitoneum. The peritoneoscope is then inserted through a small subumbilical incision. The pressure in the peritoneal cavity is maintained at 30 cm water by an automatic flow–pressure regulator. The patient is put in the Trendelenberg position (20°) for full visualization of the pelvic organs.

The combination of a tensely distended abdomen and the Trendelenburg position directed our attention to the effects of this procedure on the arterial blood gases, in particular: (1) what is the effect of carbon dioxide in the peritoneal cavity on arterial P_{CO_2} and *p*H; and (2) whether the head-down position together with an elevated immobile diaphragm can cause a significant change in arterial P_{O_2} or oxygen saturation.

METHODS

The subjects of the study were 20 patients hospitalized for laparoscopy. All were in good general health. Their ages ranged from 17 to 60 years, and 17 were less than 40 years old.

All patients received preanesthetic medication consisting of a short-acting barbiturate and belladonna agent with or without a narcotic. Anesthesia was induced with thiopental and the trachea was intubated with the aid of succinylcholine.

The patients were divided into three groups: I. Controlled respiration, 1–2 per cent halothane in oxygen; II. Spontaneous respiration, 1–2 per cent halothane in oxygen; and III. Controlled respiration, 1 per cent halothane, 74 per cent nitrous oxide, 25 per cent oxygen.

The total flow of gases into the semiclosed system varied from 5 to 7 l/min, and was not changed during any procedure to keep the inspired concentration constant. Throughout the study the patient remained in a 20° head-down position.

An 18-gauge teflon needle was placed in the brachial artery. The first arterial blood for gas analysis was not drawn until at least 15 minutes after intubation. Samples were obtained just before insufflation of carbon dioxide, 15 minutes after insufflation and, finally, 15 minutes after the carbon dioxide was removed from the peritoneal cavity.

Blood gases were analyzed with the Clark electrode for O_2 tension and with the Severinghaus electrode for CO_2 tension at 37 C.

* Assistant Professor of Anesthesiology.

Received from the Department of Anesthesiology, Columbia University College of Physicians and Surgeons, and The Presbyterian Hospital, New York, N. Y. 10032. Supported in part by NIGMS No. 5-POI-GM 09069.

TABLE 1. Mean Blood Gas Values before, during and after Laparoscopy

Group	No. Pts.		Age (years)	$Paco_2$			pH			Pao_2			Minute Vol. (l/min)		
				Before	During	After	Before	During	After	Before	During	After	Before	During	After
I	10	Mean	26.5	24.5	25.6	25.2	7.542	7.504	7.531	624	592	591	—	—	—
		SE		2.3	2.3	3.3	0.030	0.025	0.043	19	27	29	—	—	—
II	5	Mean	32	44.4	49.2	45.9	7.342	7.296	7.323	531	508	515	5.6	6.9	7.1
		SE		1.8	1.2	1.6	0.008	0.013	0.014	31	30	33	0.5	1.1	0.8
III	5	Mean	30.8	30.5	37.3	31.8	7.450	7.371	7.430	92	81	87	8.2	7.9	9.4
		SE		3.2	2.4	2.8	0.024	0.016	0.024	7.4	9.5	1.1	0.9	1.1	1.1

Minute volume was measured with a Wright meter, and the concentration of oxygen delivered to the anesthetic circuit with a Pauling oxygen analyzer.

RESULTS

Table 1 gives the mean blood gas values in each group of patients just before laparoscopy, after 15 minutes of carbon dioxide insufflation, and 15 minutes after the carbon dioxide was removed. In group I mean Pa_{CO_2} was maintained at about 25 mm Hg before, during, and after carbon dioxide insufflation. The mean Pa_{O_2} fell during laparoscopy, but the change was not statistically significant.

In the second group, mean Pa_{CO_2} rose from 44.4 to 49.2 mm Hg during the procedure ($P < 0.05$) and fell to 45.9 mm Hg after removal of carbon dioxide. Pa_{O_2} was consistently lower as compared with those in group I, but did not change significantly during laparoscopy.

In group III mean Pa_{CO_2} rose from 30.5 to 37.3 mm Hg after insufflation of carbon dioxide. It fell to 31.8 mm after the procedure. Mean Pa_{O_2} decreased from 92.2 mm to 81.4 mm Hg during laparoscopy and returned to 87.2 mm Hg afterwards.

DISCUSSION

The data indicate that with adequate controlled respiration the Pa_{CO_2} does not rise significantly in spite of the presence of carbon dioxide in the peritoneal cavity at a pressure of 50 cm water. In the patients breathing spontaneously the Pa_{CO_2} rose during laparoscopy despite an increased minute volume. Uptake of carbon dioxide from the peritoneal cavity is presumably the basis for these changes. However, the magnitude of carbon dioxide uptake is such that Pa_{CO_2} can be kept at or below normal levels with adequate ventilation.

Arterial oxygen tension in the patients with controlled respiration and using 1–2 per cent halothane in oxygen was significantly higher ($P < 0.02$) than in the group spontaneously breathing the same inspired concentration. This may be attributed to the decreased ventilation of the lung bases in the latter group.

During laparoscopy the arterial oxygen tension did not fall significantly in any of the three groups. However, those patients ventilated with 25 per cent oxygen had a mean Pa_{O_2} of 81 mm Hg, and in two cases Pa_{O_2} fell to 62 and 65 mm Hg, despite the fact that none of these patients had obvious cardiopulmonary abnormalities. We believe, therefore, that patients undergoing laparoscopy should breathe a gas mixture containing at least 50 per cent oxygen, while ventilation is controlled with an endotracheal airway in place.

REFERENCES

1. Kelling, G.: Uber Oesophagoskopie, Gastroskopie und Colioskopie, Munchen. Med. Wschr. 49: 21, 1902.
2. Creasy, R. K., and Neuwirth, R. S.: Preliminary experience wiht laparoscopy, Bull. Sloane Hosp. Women 14: 54, 1968.
3. Fear, R. E.: Laparoscopy: A valuable aid in gynecologic diagnosis, Obstet Gynec. 31: 297, 1968.
4. Steptoe, P. C.: Laparoscopy in Gynecology. London, E. T. S. Livingstone, Ltd., 1967.
5. Cohen, M. R.: Culdoscopy vs. peritoneoscopy, Obstet. Gynec. 31: 310, 1968.
6. Steptoe, P. C.: Gynecological endoscopy, laparoscopy and culdoscopy, J. Obstet. Gynaec. Brit. Comm. 72: 535, 1965.