

Photoplethysmogram change by Trendelenburg position and insufflation of abdominal carbon dioxide

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To the Editor:

Laparoscopic surgery has an inherent risk of complications because of increased abdominal pressure (IAP) and intra-abdominal carbon dioxide inflation [1]. We report a case where venous pulsation was detected in finger photoplethysmogram (PPG) during laparoscopic surgery in the head-down position (HDP).

A 32-year-old woman (height 160 cm, weight 64 kg) was scheduled for laparoscopic right ovarian cystectomy. Preoperatively, she had no significant medical history except for a previous caesarian section. Before induction of anesthesia, the blood pressure was 125/74 mmHg and the heart rate was 90/min. The patient's status was monitored by routine protocols. The PPG probe (DS 100ATM; Nellcor, Pleasanton, CA) was placed on the right index finger and connected to a patient monitor (Solar 8000MTM; GE Medical System, Milwaukee, WI). PPG data were stored via a 12-bit analog-digital converter (EZAD-512TM; EL-BIO, Seoul, Korea) at a rate of 100 Hz.

After induction of anesthesia, the patient was placed in the lithotomy position with the right arm abducted at 90° and the left arm attached to the side of body. Initial PPG was normal (Fig. 1a) and pulse oximetry values (SpO₂) were 99 %. After carbon dioxide was insufflated at a pressure of 12 cmH₂O, the operating table was tilted to 30° in the HDP. The SpO₂ was 95 % and the waveform of PPG showed unexpected peaks and high amplitude (Fig. 1b). Arterial blood pressure changes were within 20 mmHg during the position change. When the PPG probe was moved to the patient's other finger, the same SpO₂ and PPG were observed. However, when the PPG probe was placed on a finger of one of the authors, normal PPG was obtained, thereby confirming that the PPG probe was functioning well.

A tourniquet (tourniquet 4500TM; VBM, Sulz, Germany) was applied to the right upper arm at a pressure of 20, 30, 40, and 50 mmHg to confirm the venous origin of the abnormal waveform (Fig. 1c) [2], with subsequent increase in the SpO₂ to 97 %. The amplitude of abnormal peaks in PPG was slightly reduced when abdominal CO₂ was deflated in the HDP, but its waveform was still different from that of normal PPG (SpO₂ 96 %). Normal SpO₂ (99 %) and PPG similar to that in Fig. 1a were displayed when the patient was placed in the supine position without tourniquet application. It is possible that the pressure of the tourniquet could block the venous effect resulted from mild tricuspid regurgitation (around 20 mmHg), HDP (around 20 mmHg), and IAP (12 mmHg).

The implication of this case report is that venous pulsation in PPG could be induced by IAP and HDP. The possible mechanism is that mild tricuspid regurgitation aggravated by HDP may cause a high degree of variability in the PPG. In this case, HDP significantly contributed to the formation of venous pulsation in PPG; however, IAP

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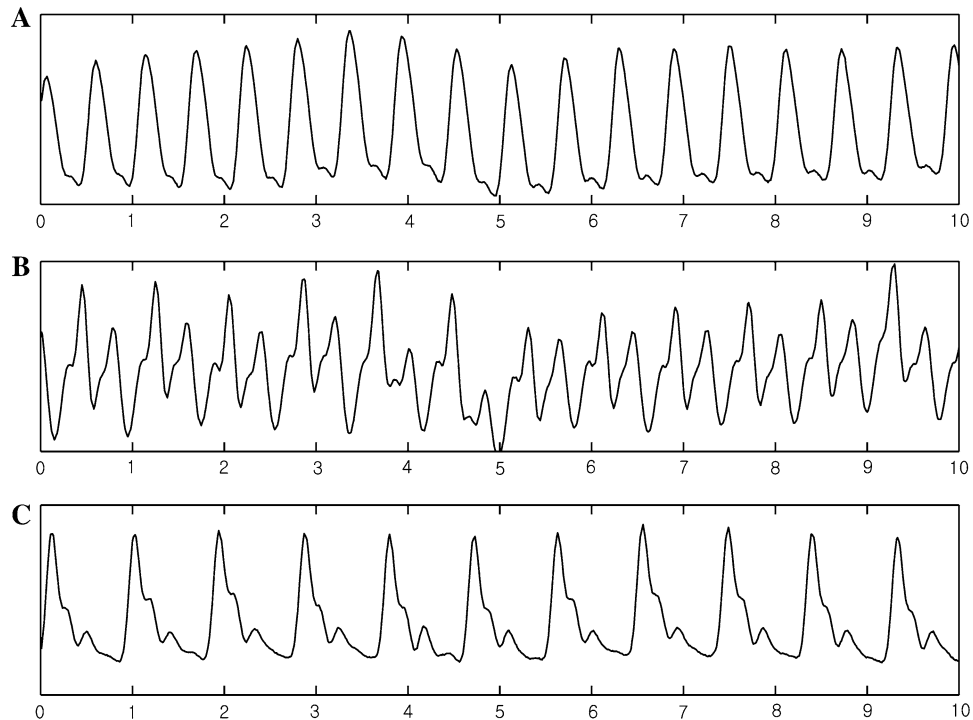


Fig. 1 Photoplethysmogram (PPG) during laparoscopic surgery. The *x-axis* is given as time in seconds, and the *y-axis* is PPG amplitude in an arbitrary unit. **a** Normal PPG in the supine position without abdominal gas insufflation; the pulse oximetry values (SpO_2) were

99 %. **b** PPG showing venous pulsation in the head-down lithotomy position with abdominal gas insufflation; SpO_2 was 95 %. **c** Almost normal PPG at a tourniquet pressure of 40 mmHg after tourniquet was applied to the patient's upper arm; SpO_2 was 97 %

had no overt effect on PPG. This case report provides some information on the impact of HDP and IAP during laparoscopic surgery, and on the development of a more accurate pulse oximetry.

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