Chapter 8.13
The Study of Transesophageal Oxygen Saturation Monitoring

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ABSTRACT

In this chapter, the transesophageal oxygen saturation (SpO_2) monitoring system was proposed based on the early experiments, to provide a new program of SpO_2 acquisition and analysis and avoid the limitation of traditional methods. The PPG (photoplethysmographic) signal of descending aorta and left ventricular was monitored in the experiment. The analysis of the peak-to-peak values, the standard deviation and the position of peaks in signal waveforms showed that in vivo signal was more stable and sensitive; and the physiological information was reflected in the left ventricular PPG waveform. Therefore, it can be concluded that the transesophageal SpO_2 monitoring technology has better guidance in clinical applications.

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INTRODUCTION

Oxygen saturation (SpO_2) is the percentage of oxyhemoglobin (HbO_2) with respect to the sum of hemoglobin (Hb) and HbO_2 in blood, which is an important physiological parameter to assess human health condition. Therefore, oximetry has become an indispensable guardianship and diagnostic equipment and there is a wide range of applications in clinical practice, such as surgery, anaesthesia and intensive care units (ICU) (Kyriacou, 2006). There are some reports that Oximeters are placed in fingers, foreheads (Kim et al., 2007), tongues (Jobes & Nicolson, 1988), faces (O'Leary et al., 1992) and other parts of body surface to monitor oxygen saturation. However, in some cases, such as trauma (burn), surgery, or the unstable peripheral circulation, there are some limitations in clinical applications (Kyriacou et al., 2002; Ahrens, 1999; Pal et al., 2005).

Before this study, Zhu et al. (2005) had verified the feasibility of transesophageal pulse oximetry through the animal experiments, then, the human experiments that monitoring pulmonary artery through trachea could be achieved (Wei et al., 2005). In this work, based on the anatomical relationship that the esophagus was close to the descending aorta (Kyriacou et al., 2003), a method of transesophageal SpO_2 monitoring was proposed, to provide a new method for in vivo monitoring. As the blood vessels of descending aorta and left ventricular are larger than surface vessels, which means that the light absorption of internal vessels is larger, so we expected that the signals from these parts would be more stable and sensitive, to make the SpO_2 monitoring accurate and timely. Also, more biological information was expected to be obtained from the signal waveforms.

SPO_2 MONITORING SYSTEM

Theoretical Principle of SpO_2 Monitoring

Timely monitoring of blood oxygen saturation is an important indicator to determine human respiratory system, circulatory system, or whether there are anoxic obstacles in the surrounding environment. The measurement of SpO_2 is based on the Hb and HbO_2 with different light absorption characteristics (Sola et al., 2006), as shown in Figure 1.

Studies have shown that human blood is sensitive to the light in the range of 600 nm to 1000 nm wavelength (Sola et al., 2006). In Figure 1, HbO_2 and Hb have different light absorption coefficients in different wavelength regions. In

Figure 1. The light absorption coefficients of HbO_2 and Hb in the red and infrared spectrum