INTRODUCTION: Maintaining adequate oxygen supply to vital organs and tissues is quite important in caring for the critically ill patient. The non-invasive technique of measuring transcutaneous oxygen tension permits to afford arterial oxygen measurements at a peripheral vascular bed. However, the technique suffers from errors induced from high transcutaneous oxygen diffusion gradients and artifacts induced from high thermal heating required to maintain arterialization. Good results are obtained only in neonates and healthy homeostatic adults. (1) Improvement in non-invasive oxygen monitoring can be made if a more advantageous peripheral vascular bed is used. The palpebral conjunctiva is an easily accessible canillary bed not covered by a thick layer of oxygen-consuming tissue, inherently displays a low oxygen diffusion gradient since its usual function is to supply oxygen to the cornea, and requires no supplemental heat for arterialization. An oxygen sensor placed between the sclera and the palpebral conjunctiva is exposed to near arterial oxygen tension. A polarographic technique using a Clark electrode with a platinum cathode and a silver anode can be miniaturized for this application. (2,3) Because both the Clark electrode reaction rate and the oxygen-hemoglobin dissociation curve are temperature-dependent, significant error is introduced with temperature changes of the electrode and conjunctiva. Measuring the local temperature with a thermometer allows some error correction. The miniaturized Clark electrode and thermometer are placed in a conformer ring which maintains them in direct contact with the tarsal portion of the palpebral conjunctiva.

METHODS: Fourteen patients with informed consent and institutional approval were studied at the Stanford University Hospital. A radial intra-arterial line was placed in each patient. The transcutaneous sensor was inserted in the right eye, the eyelids closed, but not taped shut. The F102 was set for each patient without being altered during the study. When the transcutaneous sensor readings appeared stable, a heparinized arterial blood gas sample was drawn, immediately placed in ice, and analyzed in a Corning 165 analyzer within ninety minutes. A normal oxygen-hemoglobin dissociation curve for each patient was assumed and was justified in that all patients were relatively healthy acute patients. Corrections in oxygen tensions for deviations from 37 °C were made using the nomogram of Severingshaus.

RESULTS: Transcutaneous values trend well with arterial values, but read consistently lower. A multilinear regression analysis was performed on each sample case and on the pooled data. Correlation of transcutaneous oxygen tension (PctO2) versus arterial oxygen tension (PaO2) varied from .27 to .93 for individual cases. For the pooled data, the correlation was .75 for 180 samples with an intercept of 120.8 mmHg and the standard error of the estimate was 54.7 mmHg (Figure 1). A P value of < 0.005 for the pooled data was calculated using Student's t test.

FIGURE 1

Eye exam results showed that no patient suffered any eye damage except for mild hyperemia or chemosis.

DISCUSSION: The transcutaneous oxygen sensor is the least disruptive peripheral vascular bed monitor yet developed for clinical monitoring. Because the technique is not dependent on supplemental heat, changes in peripheral vascular tone, perfusion, and oxygen delivery are not disrupted. The transcutaneous oxymeter values are consistently lower than arterial values and are effective in reflecting trends in arterial oxygenation to the vascular bed. Correlation with arterial oxygen tension levels is good provided peripheral tissue perfusion is not compromised.

REFERENCES