Tilte : TRACHEAL ECG MONITORING VS SURFACE AND ESOPHAGEAL ECG MONITORING

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INTRODUCTION. Monitoring electrocardiographic activity (ECG) is a standard practice for surgery, intensive care, and emergency transport. Current strategies involve placing prejelled ECG electrodes on the chest for monitoring ECG activity. In many clinical settings, surface ECG monitoring is compromised by movement artifacts, surgical site, massive burns, or chest trauma. Many of these patients require an endotracheal tube and ventilatory support. A novel approach to monitoring ECG activity from within the trachea was developed and compared to conventional surface ECG and esophageal ECG in anesthetized animals on mechanical ventilation.

Methods. Twelve animals (10 dogs, 18-36 kg, and 2 sheep, 47-53 kg) were induced with sodium thiopental (20 mg/kg) and anesthesia maintained with halothane-N2O-Oxygen. Mechanical ventilation was adjusted to maintain arterial blood gases within physiological limits. The animals were intubated with a custom-made endotracheal tube. Each tube resembled a commercially available endotracheal tube with the exception that each tube was longer and the occluding balloon contained two longitudinal metalized conductors (active electrodes) opposed by approximately 90° for transduction of the ECG signal. The indifferent electrode was placed in a spiral fashion 10 cm distally from the connector over the external surface of the endotracheal tube shaft. Each animal was placed in the supine position and instrumented with a central arterial catheter, surface ECG electrodes (Lead II), and an esophageal ECG catheter. The surface, esophageal, and tracheal ECG electrodes were each connected to individual ECG amplifiers. The tracheal ECG cabling was connected in the following manner: RA and LA to individual cuff electrodes and RL and LL connected together and attached to the indifferent electrode. All ECG recordings were made with the ECG amplifiers in Lead II. The endotracheal tube was advanced approximately 2-3 cm above the carina and rotated until an optimal ECG waveform resulted. ECG recordings (surface, esophageal, and tracheal) were recorded (50 and 100 mm/s) simultaneously as the animal's heart rate was randomly increased (Isoproterenol) or decreased (Esmolol or Neostigmine) from basal rates. ECG data collected at specific periods were hand-measured by dividing the individual 1-millivolt calibration signal for surface, esophageal, and tracheal recordings into the respective P, Q, R, S, J, and T components then analyzed (analysis of variance) to determine if the signal quality (i.e., magnitude of P, Q, R, S, and T waves and duration of PR, QRS, and QT intervals) obtained from tracheal recordings were consistent with those from surface and esophageal recordings. The null hypothesis was rejected if $p < 0.05$.

RESULTS. Incorporating metalized conductors along the occluding balloon of the endotracheal tube allowed monitoring of the animal's ECG activity and gave clear definition of the individual components comprising the ECG waveform. Figure 1 shows a comparison between surface, esophageal, and tracheal ECG at a heart rate of 100 bpm. Statistical analysis for the measured intervals (i.e., PR, QRS, and QT) showed no significant difference between the surface ECG and esophageal and tracheal recordings as the animals heart rate was modified (Figure 2). The magnitude of the individual components were often reduced in tracheal recordings when compared to surface ECG's.

DISCUSSION. The results obtained from this study indicate that the general waveform morphology and intervals obtained from the tracheal ECG recordings during normal and abnormal rhythms over a wide range of heart rates were comparable with surface ECG recordings. The reduction in magnitude of the individual components (i.e., P, Q, R, S, J, and T) during tracheal recordings was due to the anatomical positioning of the tracheal electrodes in relationship to the heart and the spatial separation of the active tracheal electrodes. This study demonstrates the usefulness of tracheal ECG monitoring for a variety of clinical applications, particularly intubated emergency transport patients.

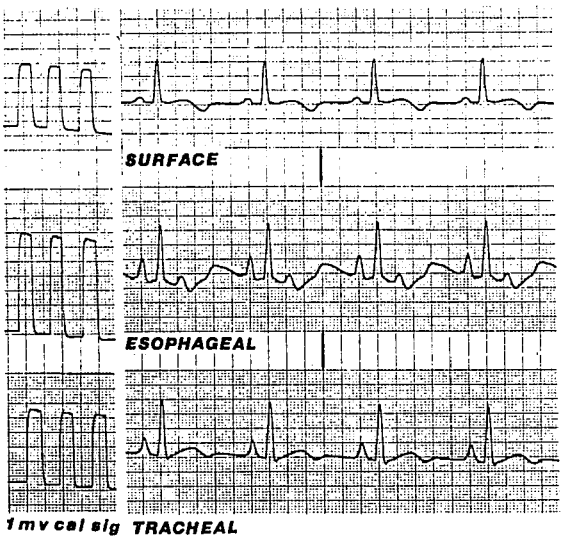

Figure 1

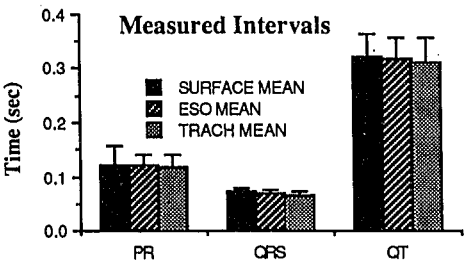

Figure 2