hyperglycemia, and electrolyte abnormalities."[1]

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Perforation of the Tympanic Membrane, A Complication of Tympanic Thermometry during Anesthesia

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There has been a renewed interest in better and more effective methods of temperature monitoring during anesthesia since the advent of the syndrome known as malignant hyperpyrexia. Tympanic thermometry has been advocated as a practical method of monitoring temperature during anesthesia. Since 1969 there have been numerous articles attesting to the ease of insertion and placement, sensitivity and accuracy, and safety and comfort of the tympanic membrane sensors, without serious complications being reported.[1,2,3] We wish to report a serious complication.

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We have utilized tympanic thermometry in more than 100 cases at the 500-bed Medical University Teaching Hospital since December 1972. Recently we experienced two cases of perforation of the tympanic membrane following the use of a tympanic membrane sensor.

Report of Two Cases

The first patient, a 46-year-old woman, had a vaginal hysterectomy performed under general anesthesia. After induction of anesthesia a commercially available tympanic membrane temperature sensor was placed in the right external auditory canal. Pre-insertion otoscopic examination was not performed, but gross visual examination of the external auditory canal revealed no abnormality. The technique used for insertion was that recommended by the manufacturer and consisted of placing the sensor in the ear canal, pulling down the ear lobe and gently inserting

the sensor with a twisting motion until the tympanic membrane (resistance) was reached. Care was taken not to force the sensor into the ear canal. When the sensor was removed at the end of the operation, the cotton tip of the tympanic probe was noted to be bloody, although still intact. Examination of the right external auditory canal revealed a fresh blood clot covering the posterior half of the tympanic membrane. When the clot was removed, a 3-mm fresh traumatic perforation in the posterior inferior quadrant of the tympanic membrane was present. The skin of the external auditory canal was undamaged.

The second patient, a 57-year-old woman, underwent a partial gastrectomy under general anesthesia. After induction of anesthesia, a tympanic membrane temperature sensor was placed in the right external auditory canal using the technique described above. Prior to its complete insertion and with no abnormal resistance being perceived, sanguineous oozing was observed. This sensor was withdrawn and another sensor was placed in the opposite external auditory canal. This patient, who admitted to having had slightly impaired hearing in the left ear for many years, complained of pain, bleeding, and decreased hearing in the right ear postoperatively. Examination of the right external auditory canal revealed dried blood with a longitudinal laceration of the posterior inferior canal skin and a 3-mm traumatic perforation in the posterior inferior quadrant of the tympanic membrane. Examination of the left ear revealed impacted cerumen with an intact tympanic membrane.

Both of these patients were examined and followed by otorhinolaryngologists. The tympanic membrane perforations healed spontaneously and the patients' hearing returned to the preoperative states.

Discussion

Considering the anatomic locations available for temperature monitoring, tympanic thermometry has much to recommend it. Because the sensor is positioned near the internal carotid artery (the main arterial supply to the hypothalamus in which the central thermoregulatory center is located) and because the blood supply to the tympanic membrane comes from the external carotid artery, one can assume that tympanic membrane temperature closely reflects hypothalamic temperature.[1,2,4] This concept, however, has been challenged.[5]

The only reported complications of tympanic thermometry have been relatively minor and have occurred in patients who were anticoagulated for extracorporeal circulation. Webb[4] reported trauma to the external auditory canal with subsequent otitis externa. Dickey[1] reported oozing from the ear in two children for 48 hours after the use of a larger prototype probe. He did not describe otoscopic findings. From our experience, perforation of the tympanic membrane should be considered a possible complication of tympanic thermometry.

It is obvious that the placement of any foreign body in the external auditory canal can lead to traumatic injury, and that care must be used during insertion of a temperature sensor to avoid tympanic membrane perforation. Yet, using what we feel was reasonable care, tympanic membrane perforation did occur during insertion in the second case. The time of injury in the first case is less clear, but here, too, perforation could have occurred during insertion. Another possibility is movement of the sensor after insertion by mask straps, by hands holding a mask, or by the operating room table if the head was turned to one side.

Methods to help avoid traumatic injury while using a tympanic sensor during anesthesia might include otoscopic inspection of the canal and drum prior to insertion,[6] extreme care to stop insertion when resistance is met, and care to avoid sensor movement after insertion. Insertion by the patient before induction of anesthesia and a safer sensor design might also help prevent this complication. Perhaps the best use for tympanic thermography will be in the awake patient in intensive care and burn units, with its use in the anesthetized patient reserved for the occasional individual in whom the use of a rectal, esophageal, or nasopharyngeal probe is not feasible.

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