Early translaryngeal tracheostomy in patients with severe brain damage

Abstract  Objectives: To describe the effects of early translaryngeal tracheostomy on intracranial pressure (ICP), cerebral perfusion pressure (CPP), and jugular bulb saturation (SjO₂); to identify the main mechanisms affecting ICP during tracheostomy; and to evaluate the long-term effects of tracheostomy on tracheal anatomy and function. Design: Prospective, observational, clinical study. Setting: Neurosurgical intensive care unit in a teaching hospital. Patients: 20 patients admitted to the ICU because of head injury, sub-arachnoid hemorrhage, or brain tumor with a Glasgow Coma Scale less than 8. Interventions: Patients underwent translaryngeal tracheostomy under strict neuromonitoring. Measurements and results: ICP rose significantly (p < 0.05) at the critical time of cannula placement while all other parameters remained stable. At this time five patients suffered intracranial hypertension (ICP > 20 mmHg). In one of them CPP dropped below 60 mmHg. Arterial CO₂ tension (PaCO₂) did not rise significantly. No other major complications were recorded during the procedures. Three months after tracheostomy normal findings were detected by tracheoscopy in all cases (11 patients could be examined). Conclusions: Translaryngeal tracheostomy, performed in selected patients when the risk of intracranial hypertension was reduced to the minimum, was well tolerated in the majority of cases and did not induce persistent intracranial disorders. However, ICP is affected by tracheostomy, and careful monitoring and patient selection is necessary. At follow-up no severe anatomical or functional damage was detected.

Key words  Brain damage  · Cerebral extraction of oxygen  · Cerebral perfusion pressure  · Intracranial pressure  · Tracheostomy

Introduction

Tracheostomy is often necessary as part of the management of patients with severe brain damage to reduce pulmonary morbidity; it may also shorten ICU and hospital stay [1]. Tracheostomy is performed in the case of prolonged ventilatory support and to protect the airways since the airway protective reflexes of gagging and coughing are often lost because of brain damage [2]. New techniques, such as percutaneous dilatational tracheostomy under endoscopic guidance [3], are increasingly being used in the ICU as an alternative to standard surgical tracheostomy [4, 5, 6]. Translaryngeal tracheostomy (TLT) [7] has recently been introduced as a further dilatational method and appears safe and easy. However, these procedures, such as fiberoptic bronchoscopy and tube suctioning, carry a high risk of neurological complications, particularly in patients

Received: 24 November 1999
Final revision received: 20 April 2000
Accepted: 30 May 2000

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with intracranial hypertension [8, 9, 10, 11, 12]. Patients with exhausted intracranial compensatory mechanisms are at higher risk because any increase in their intracra- nial volume leads to a marked increase in intracranial pressure (ICP) and potentially to a reduction in cerebral perfusion pressure (CPP) [12, 13].

We investigated the effects of early TLT on ICP and CPP with two main aims: (a) to assess its safety in a preliminary series of neurosurgical patients, and (b) to improve the technique in order to minimize any harmful effects.

**Materials and methods**

Twenty comatose patients (Glasgow Coma Scale $<$ 8) with acute brain damage, admitted to the Neuro-Intensive Care Unit because of head injury, subarachnoid hemorrhage, or tumor, were evaluated in a prospective, descriptive study. Indications for tracheostomy were the likelihood that mechanical ventilation would be needed, and/or that protection of the airways would be compromised for more than 2 weeks [2, 14]. Exclusion criteria were: (a) age less than 16 years; (b) unstable ICP, defined as ICP greater than 20 mmHg lasting more 5 min and requiring additional active treatment, such as mannitol infusion and withdrawal of cerebrospinal fluid (when a ventricular catheter was used) 24 h before inclusion in the study; (c) coagulation abnormalities; (d) tracheal axis dislocations; (e) previous tracheotomy. Written informed consent was always obtained from the patients' relatives. All procedures were performed at the bedside in the Neuroscience Intensive Care Unit of the Policlinico Hospital of Milan, between 1 September, 1996 and 30 September 1997. Formal approval of the study was obtained from the institutional Ethics Committee.

**Translaryngeal tracheostomy**

The procedure was carried out with a commercial kit (Mallinckrodt Medical, Mirandola, Italy) according to the technique described by Fantoni and Ripamonti [10]. Briefly, a wire was introduced into the trachea through a needle and advanced to the oral cavity. A cannula was then threaded to the mouth-end of the wire and positioned in the trachea by traction on the neck-end of the wire (Figs. 1, 2). Before the tracheal wall was punctured, the endotracheal tube was replaced by a smaller one (5 mm i.d.), to maintain ventilation throughout the procedure [15]. The entire procedure was performed under fiberoptic control (BF P2OD, 5.0 mm o.d.; Olympus; Melville, N.Y., USA).

**Monitoring**

Patients were continuously monitored for electrocardiogram, arterial oxygen saturation, end-tidal CO$_2$ (EtCO$_2$), and mean arterial pressure (MAP) through a catheter inserted in a radial artery, ICP through a ventricular catheter in 5 cases and through a subdural catheter in 15, and internal jugular pressure (IJIP) through a catheter inserted in the right jugular bulb. ICP and MAP transducers were set to zero and referenced to the tragus. Central venous pressure was measured intermittently and kept within normal limits by careful fluid management.

An arterial sensor for continuous in-line blood gases monitoring (Paratrend 7, Biomedical Sensors, UK) [16] was used in ten cases, obtaining continuous pH, PaCO$_2$ and arterial tension of O$_2$ (PaO$_2$) tracings before, during, and after the procedure. Analog data for ICP, MAP, CPP (ICP-MAP), IJIP and EtCO$_2$ were sent to an analog-digital converter (MacLab Word Precision Instruments, New Haven, Conn., USA) and stored in digital form in a computer. Five main time points were identified during the procedure: (a) baseline, after positioning the patient but before inducing