ORIGINAL ARTICLE

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# Experience with two different techniques of percutaneous dilational tracheostomy in 54 neurosurgical patients

**Abstract** We report 54 patients with critical neurosurgical diseases (16 females, 38 males, age 21–84 years, mean 63.2 years) who were treated with bedside percutaneous dilational tracheostomy (PDT) because of respiratory insufficiency due to their cerebral disease. Bronchoscopically guided PDT was performed after stabilisation of the acute stage of neurosurgical disease. In 15 cases, Ciaglia's multiple dilation technique was used, and in 39 patients the dilational forceps technique according to Griggs was performed. In 14 cases (five Ciaglia's method, nine Griggs technique), intracranial pressure (ICP) was monitored throughout the procedure. Fifty-two procedures were completed. In two cases, PDT had to be aborted because of inability to puncture the trachea. No death occurred. There was a total complication rate of 16.7%, including the aborted procedures, with 3.7% of the complications classified as severe. No increase in ICP was noted. We conclude that bedside PDT, especially with the Griggs system, is safe and effective if done under bronchoscopic control. With the standard narcotic regimen used in our patients, no increase in ICP occurred.

**Keywords** Percutaneous dilational tracheostomy · 0Neurosurgical intensive care · Griggs system · Ciaglia system

## Introduction

Percutaneous dilational tracheostomy (PDT) for intensive care patients with respiratory insufficiency of various origins has found wide acceptance since its introduction in 1985, when Ciaglia presented his system [1, 2]. Different systems have evolved and been used clinically since then [3, 4, 5, 6, 7, 8]. One of the most favourable advantages is the possibility to perform the tracheostomy at the bedside, obviating transport to the operating theatre and thus related time, costs, and complications [4, 9, 10]. An impressive fund of data already exists in the literature about the clinical use in different specific intensive care disciplines [11, 12, 13, 14, 15, 16]. Moreover, follow-up studies demonstrate good outcome concerning tracheal function, wound healing, and cosmetic results [15, 17].

The subgroup of neurosurgical patients who need prolonged ventilation therapy or airway protection has only rarely been studied in the setting of bedside PDT [5, 11]. We therefore present this observational study to add information to the specific field of neurosurgical intensive care medicine.

## Clinical material and methods

Patients

Fifty-four patients treated at our neurosurgical intensive care unit for various diseases underwent the bedside percutaneous tracheostomy procedure. Fifteen patients were operated upon with the Ciaglia system (Cook critical care kit, Bloomington, Ind., USA) between November 1996 and December 1997, and 39 were treated with a Griggs system (Portex kit, UK) from 1997 to December 1999. The mean duration of preoperative orotracheal or nasotracheal intubation was 8 days (range 6–13). In 14 patients, we obtained intraoperative intracranial pressure (ICP) values, in five cases by intraparenchymal monitoring and in nine with a ventricular catheter system. Intraoperative bronchoscopic control was performed in all patients (Fig. 1) and an intraoperative $FiO_2$ level of 1.0 was established with continuous $SaO_2$ monitoring. For specific patient data, see Table 1.

Surgical technique

The technique of percutaneous tracheostomy is described in detail elsewhere [1, 2, 7]. Briefly, after preoxygenation, induction of

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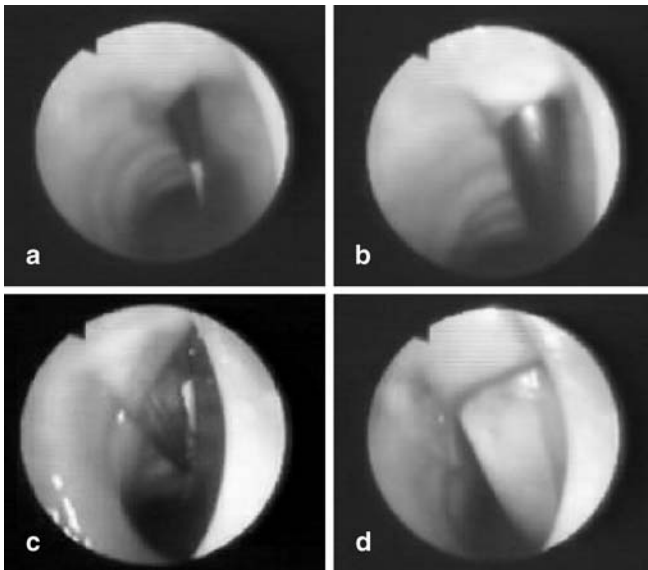Tel.: +49-8221-952252, Fax: +49-8221-962110

**Fig. 1a–d** Video prints from bronchoscopic views of the percutaneous tracheostomy procedure (Griggs method). **a** Insertion of the predilator over the already placed guide wire, **b** progression of the predilator tube, **c** insertion and spreading of the dilation forceps with guide wire still in situ, and **d** final appearance of the tracheostomy tube in place

general anaesthesia with fentanyl and midazolam, and relaxation with atracurium, additional subcutaneous local anaesthesia is applied in the region of the planned incision down to the trachea with 3 ml to 5 ml of a 1% solution of scandicain.

A small vertical skin incision (2–2.5 cm) is made about 2–3 cm above the jugulum and the subcutaneous tissue is separated bluntly. The flexible bronchoscope is introduced through an adapter device and, after positive diaphanoscopy, the tracheal tubus is repositioned as needed for an unobstructed puncture of the trachea. After puncture, a guide wire is inserted, then the dilation procedure is carried out, and finally the tracheal cannula is inserted and connected to the ventilator. If needed, some approximating skin stitches are done. At the end of the procedure, bronchoscopic control of cannula positioning is done through the tracheostomy

cannula. The two methods used here differ in the instruments used for dilation: with the Ciaglia method, seven bougies of ascending size are introduced consecutively to create an adequate trachea opening, and the Griggs method uses a specially designed dilation forceps that is introduced and then spread only once.

## Results

The procedure was completed in 52 of the 54 patients. In two patients, one in each study group, the procedure had to be aborted because of inability to puncture the trachea. Both patients had extensive hypertrophy of the thyroid gland, and no external anatomical landmarks were palpable. These patients went to open tracheostomy without any further problems.

Mean operation time differed in the two study groups, with 10.5 min (range 8–20) for the Ciaglia method and 7 min (range 5–13) for the Griggs method. Additional time is needed for disinfection and draping of the patient, which takes on average 10 min. Mean ICP at operation was 14 mmHg for the Ciaglia group (five patients measured) and 13 mmHg for the Griggs group (nine patients measured), with no increases above 20 mmHg during the tracheostomy (Fig. 2).

No death occurred. Besides the two aborted procedures, seven further complications were noted. In the Ciaglia group, one major venous bleeding from the pretracheal tissue was controlled by compression. One patient developed a rapid decrease in oxygen saturation during dilation with the bougies that required us to interrupt the operation, withdraw the introduced bronchoscope, and ventilate him for some minutes. After stabilisation, the operation could be finished without further problems. Four weeks after otherwise unremarkable PDT, another patient developed a life-threatening tracheomalacia detected by acute obstruction of the airway after withdrawing the introduced tracheal cannula for the purpose of changing it. The new cannula could not be

**Table 1** Data of 54 neurosurgical patients undergoing two different methods of bedside percutaneous tracheostomy (*ICH* intracerebral hemorrhage, *SAH* subarachnoid hemorrhage, *ICP* intracranial pressure)

|  | Ciaglia system | Griggs system |
|---|---|---|
| No. of patients | 15 | 39 |
| Mean age (years) | 59.7 | 64.5 |
| Diagnosis |  |  |
| Spontaneous ICH/SAH | 8 | 26 |
| Head injury | 6 | 10 |
| Tumor surgery/cranial nerve palsy | 1 | 2 |
| Infection | 0 | 1 |
| Mean operation time in minutes (range) | 10.5 (8–20) | 7 (5–13) |
| Mean ICP at operation in mmHg | 14 (5 patients) | 13 (9 patients) |
| Complications |  |  |
| Major bleeding | 1 | 1 |
| Emphysema | 0 | 2 |
| Ventilation problems | 1 | 1 |
| Aborted procedure | 1 | 1 |
| Tracheomalacia | 1 | 0 |
| Total complications (%) | 4 (27) | 5 (13) |
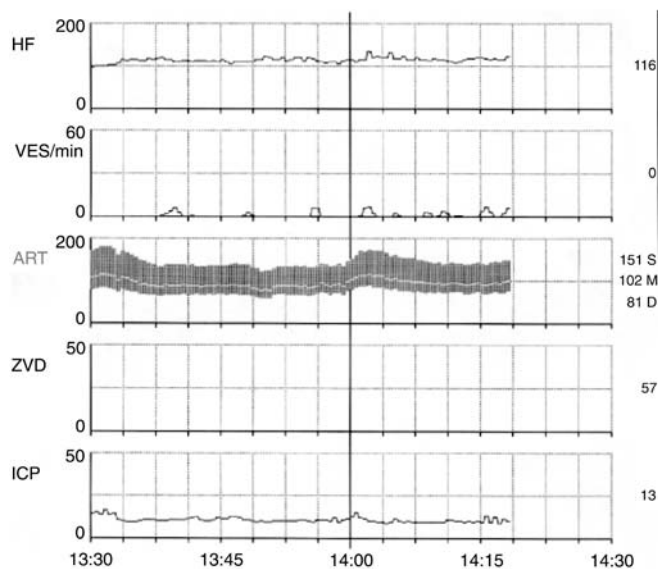
**Fig. 2** Printout of the monitor data obtained during bedside percutaneous tracheostomy. The procedure was carried out in 15 min, including postoperative bronchoscopic control and draping. No increase in ICP is noted, with a mean of 13 mmHg

placed. The patient needed emergency orotracheal intubation and was then revised at the stoma site by an otolaryngologist.

In the Griggs group, one major venous bleeding was stopped by ligation, and we saw two cases of subcutaneous emphysema spreading from the stoma site. After changing the size of the cannula, one emphysema resolved spontaneously. Obviously there had been a defect in the first cannula or its cuff had not been adequately fitted to the tracheal lumen. The other emphysema spread subcutaneously over the whole neck down to the abdomen, despite changing the cannula size and incising the skin at the stoma site. The patient needed multiple surgical skin incisions for decompression and conversion of the PDT into an open mucocutaneous tracheostomy. In one patient there was an intraoperative ventilation problem noted with decreased oxygen saturation. The situation was managed by withdrawing the bronchoscope without interrupting the procedure because the cannula could be rapidly inserted at that time.

There was no postoperative wound infection. We performed decannulation in six patients while they were still being treated in our department. In all cases, wound healing was without complications and only small scars remained. The total complication rate for the whole study group was 16.7%, including the aborted procedures. Only two of the complications (3.7%) had severe sequelae, namely reoperations. Differentiation between the methods reveals a 27% complication rate (20% major) for the Ciaglia method and 13% (5.1% major) for the Griggs method. Statistical analysis revealed no significant difference (Fisher's exact test). See Table 1 for complications.

## Discussion

Since its introduction, PDT has been considered simple, safe, and cost-effective [2, 4, 9, 10]. Review of the literature shows growing interest in PDT with patients needing intensive care for various diseases, and there are also case reports of its use in emergency situations [18]. Reported complication rates are low, and long-term follow-up studies revealed no functional problem in terms of tracheomalacia or good cosmetic results [15, 17]. In their review, Powell et al. found an overall complication rate of 15.8% in 1,684 patients treated with four different percutaneous methods, additionally indicating that the procedure is safer with endoscopic guidance [10]. Winkler et al. reported a 5.6% complication rate in their series of 71 patients, with only minor complications, and cumulated data from 834 patients revealing an overall complication rate of 9.7% [16]. Mortality ranges between 0.5% and 1.5%. Crofts et al. compared the mortality and complication rates of percutaneous and standard open tracheostomy and found no differences [9].

A steep learning curve is noted by most authors, with most of the more severe complications occurring in the first surgical procedures. This is probably the case with our complication rate in the Ciaglia group, in which we treated only 15 patients with a complication rate of 27%. Escarment et al. found that competence is usually satisfactory after 20 PDT procedures [5].

Concerning costs, PDT is considered to be less expensive than open tracheostomy. Powell and colleagues calculated about $1,300 vs $3,200, mostly due to the absence of anaesthesia and operating room fees [10]. Besides the savings in time and personnel with bedside procedures, it is also clear that obviating additional transport of critically ill patients will reduce complications, as was shown recently in a study of mobile computed tomography in a neurosurgical intensive care unit by Gunnarsson et al. [19].

We strongly advise the use of intraoperative endoscopic guidance (Fig. 1). This adjunct especially helps inexperienced surgeons in placing the puncture cannula and guide wire safely, and it ensures nonpenetration of the posterior tracheal wall. Concerning this particular serious complication, we feel that using the dilational forceps of the Griggs technique is significantly safer than the Ciaglia method, in which the dilation procedure can not be overseen at every surgical step, despite endoscopic control. Additionally, with the Ciaglia technique it is necessary to repeat the dilation at least four times, while with the Griggs forceps only one dilation is sufficient in nearly all cases [8].

Especially in the need to obviate increases in ICP, only a few recent reports have confirmed the benefits of PDT in neurosurgical patients. Gumprecht et al. reported 38 patients treated with the Ciaglia method and experienced no major complication. They noted, without detailing further, no rise in ICP above 20 cm $H_2O$ [11]. Escarment et al. reported nonsignificant ICP increases at the time of cannulation, with a mean value of 24 mmHg

in 13 patients, but found no changes in cerebral perfusion pressure [5].

To the best of our knowledge, this study represents the largest series to date dealing exclusively with neurosurgical PDT patients, following that of Gumprecht et al. [11]. Additionally, we provide information on the use of two different standard percutaneous tracheostomy sets that may be of interest for neurosurgeons intending to perform this procedure in the future. It is not our intention to criticise that tracheostomy is performed in many neurosurgical departments by specialised otorhinolaryngologists rather than by neurosurgeons, but a growing number of neurosurgeons are specialising in intensive care medicine. We are convinced that these data, especially concerning the measurement of intraoperative ICP, are useful for them.

We confirm with our study that, with an adequate narcotic regimen, no critical rise in ICP is to be expected (Fig. 2). This is true in stabilised patients, i.e. those not in the acute phase of neurosurgical disease. As suggested by Koh et al., tracheostomy, either percutaneous or open, should be performed after days 5 to 7 in cases where the patient clearly requires mechanical ventilation for a longer period of time [20].

## Conclusions

A large series of bedside percutaneous tracheostomy procedures in neurosurgical patients is presented. Bedside PDT in neurosurgical patients is safe and cost-effective if done under endoscopic control and with an adequate narcotic regimen. No rises in ICP need be expected if the procedure is done under elective conditions. The authors prefer the Griggs forceps technique because of the better endoscopic supervision and shortened dilation procedure.

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