Correspondence

Adrenergic blockade with phenoxybenzamine and propranolol in a cohort of 60 patients undergoing surgery for phaeochromocytoma

EDITOR:

Phaeochromocytomas are rare adrenal tumours. Intraoperative tumour manipulation can trigger uncontrolled release of large amounts of catecholamines into the systemic circulation, which can cause potentially lethal cardiovascular instability [1]. Medical pre-treatment aims to obtund the consequences of such intraoperative catecholamine release. Phenoxybenzamine is considered by many to be the drug of choice for treating the hyperkinetic, vasoconstrictive, hypovolaemic form of hypertension associated with phaeochromocytomas. However, it is argued that the long duration of action of phenoxybenzamine may lead to refractory hypotension postoperatively once the catecholamine drive from the phaeochromocytoma has been removed, and hence such patients could need several days of support with vasopressor agents. For this reason, it has been suggested that the drug should be stopped for 48 h before surgery, and most centres advocate routine postoperative admission to intensive treatment unit (ITU) [2].

The optimum dose and the duration of preoperative preparation with phenoxybenzamine have been debated. While some consider that 10 days treatment provides adequate α-blockade [1], others found that even higher doses of phenoxybenzamine (median 160 mg day^{-1}) for a median of 3 weeks achieved only a partial adrenergic blockade [3]. This debate is also fuelled by the observation that severe intraoperative hypertension occured in most patients whether or not α-blockade had been instituted [4] and that similar perioperative results could be achieved whether or not patients received preoperative α-antagonists [5]. In an attempt to avoid such problems, others have used doxazosin [6] or calcium channel blockers [7,8] in the preoperative period. It has even been suggested that preoperative blood pressure (BP) control is no longer necessary at all because there are drugs available to correct sudden changes in cardiovascular dynamics in an era when anaesthetic monitoring is highly advanced [9].

This retrospective review of clinical notes analyses the medical pre-treatment and perioperative haemodynamic events in a cohort of 60 consecutive unselected patients (M : F, 21 : 39; age 22–81 yr) with phaeochromocytoma who underwent an adrenalectomy after adrenergic blockade using a standardized protocol between January 1998 and May 2007.

Patients were started on oral phenoxybenzamine as soon as the biochemical diagnosis of phaeochromocytoma was confirmed. The dose of phenoxybenzamine was titrated until normotension was achieved (mean ± SD dose 40 ± 23 mg day^{-1}). β-Blockade with propranolol was then added to control the heart rate (HR). Patients remained on their individualized drug combination for 6–42 weeks (median 14 weeks) while awaiting surgery. Three groups of patients were identified based on whether the daily dose of phenoxybenzamine tolerated was <30 mg ($n = 13$), 30 mg ($n = 25$) or >30 mg ($n = 22$) (Table 1). These increasing doses of phenoxybenzamine paralleled an increase in the highest systolic BP recorded at the time of diagnosis, levels of 24-h urinary normetepinephrine and metepinephrine and dose of propranolol used (Table 1). Despite these trends, none of these differences reached statistical significance with analysis of variance and Kruskal–Wallis tests.

Patients were admitted 4 days prior to the operation for intensification of the α-blockade.

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Table 1. Biochemical, clinical and intraoperative data (mean $\pm$ SD (range)) or number of patients.

Phenoxybenzamine dose	<30 mg day^{-1} ($n = 13$)	=30 mg day^{-1} ($n = 25$)	>30 mg day^{-1} ($n = 22$)
Preoperative management			
Normetepinephrine 0–3.0 μmol 24 h^{-1}	16.5 $\pm$ 15.6 (1.1–49.5)	21.5 $\pm$ 19.9 (4.3–71.9)	25.6 $\pm$ 22.5 (3.1–87.0)
Metepinephrine 0–14 μmol 24 h^{-1}	8.7 $\pm$ 9.9 (0.1–33.5)	18.3 $\pm$ 24.5 (0.5–83.1)	19.1 $\pm$ 18.7 (0.8–56.8)
Blood pressure (BP) at diagnosis (mmHg)	167 $\pm$ 40 (120–260)	186 $\pm$ 58 (120–350)	190 $\pm$ 34 (140–250)
Phenoxybenzamine oral dose (mg)	18 $\pm$ 4 (5–20)	30	80 $\pm$ 50 (40–240)
Propranolol oral dose (mg day^{-1})	110 $\pm$ 70 (40–240)	123 $\pm$ 47 (60–240)	150 $\pm$ 87 (60–360)
BP on admission (mmHg)	139 $\pm$ 23 (110–185)	133 $\pm$ 20 (88–170)	140 $\pm$ 32 (96–190)
Heart rate on admission (beats min^{-1})	69 $\pm$ 12 (60–96)	74 $\pm$ 14 (50–100)	73 $\pm$ 19 (50–116)
Propranolol dose on preoperative day (mg)	170 $\pm$ 130 (40–480)	182 $\pm$ 78 (80–360)	209 $\pm$ 128 (60–480)
Intraoperative BP control			
Intraoperative fluid (mL)	2100 $\pm$ 775 (1000–3500)	2590 $\pm$ 1610 (1000–8000)	2700 $\pm$ 750 (1500–4000)
Drugs[*]			
Sodium nitroprusside, 9.5 (1–42) mg	7	19	18
MgSO$_4$, 6 (2–13) mg	4	12	12
Phentolamine, 7 (1–25) mg	3	15	12
Labetalol, 50 (2–100) mg	3	8	4
Metaraminol, 6 (1–11) mg	2	6	5
Isoprenaline (5–200 μg)	1	1	1

[*]For each drug, the median (range) or range dose is given in column 1 and the number of cases in which each drug was used in the other columns.

In that time, they were converted from oral to intravenous (i.v.) phenoxybenzamine starting as a once-daily infusion of 50% of their daily oral dose or 0.5 mg kg^{-1} (whichever was the greater) and increasing as necessary in order to achieve normotension at rest with postural hypotension. In all, 53 patients needed 0.5 mg kg^{-1} day^{-1} and 7 patients needed 1 mg kg^{-1} day^{-1}. Oral intake of fluids was encouraged and, if needed, i.v. fluids were used to compensate for the possible increase in intravascular volume. The daily dose of propranolol was increased to a mean $\pm$ SD of 185 $\pm$ 70 mg (range 40–480 mg) aiming to achieve a slow resting pulse without postural change (Table 1).

On admission to hospital, patients had similar systolic BP (median 130 mmHg) and HR (median 70 beats min^{-1}). On the morning of the operation patients had similar systolic BP when lying down (124 $\pm$ 18, range 65–165 mmHg) and standing (114 $\pm$ 18, range 65–150 mmHg) and HR (67 $\pm$ 10 beats min^{-1}, range 50–90 beats min^{-1}). Patients were anaesthetized by one of two anaesthetists who used a similar anaesthetic technique. All patients had invasive monitoring of radial arterial pressure and central venous pressure (CVP) before induction with fentanyl 3–5 μg kg^{-1}, propofol 1–2 mg kg^{-1} and rocuronium 0.5 mg kg^{-1}. Patients were intubated and ventilated with isoflurane and N$_2$O in O$_2$. Further increments of fentanyl were given as required to maintain analgesia (50–600 μg, median 250 μg).

Increments of vasoactive agents were used intraoperatively in 52 patients (Table 1). No antihypertensive treatment was needed once the adrenal vein had been clamped. All patients received i.v. fluid as crystalloid only or crystalloid plus colloid (1000–7000 mL, median 2400 mL). There was no correlation between the preoperative dose of phenoxybenzamine and the volume of fluid given or the dose and variety of vasoactive drugs used intraoperatively (Table 1). Severe intraoperative hypertension (systolic BP > 180 mmHg) was recorded on the anaesthetic charts of 16 patients (26%). All episodes were transient and lasted no more than 5 min. The maximum BP recorded was 230 mmHg. Severe intraoperative hypotension (systolic BP < 80 mmHg) was recorded in 32 patients (52%) and lasted up to 15 min. The lowest BP recorded in these patients was 50 mmHg. There was no correlation between the preoperative dose of phenoxybenzamine and the severity or duration of intraoperative episodes of hyper- or hypotension. Laparoscopic adrenalectomy was undertaken in 54 patients and open adrenalectomy was performed in six patients. The operating time ranged from 55 to 290 min (median 120 min).

Postoperatively, patients remained in the post-anaesthesia care unit for a median time of 150 min (range 60–330 min). Invasive monitoring of arterial BP and CVP was discontinued. Patients were transferred to a general surgical ward once BP had remained stable for 60 min (systolic BP > 100 mmHg) in the absence of vasoactive drugs or

volume expansion. Only two patients needed to be admitted to the ICU. One of them needed inotropic support and invasive monitoring for 36 h for persistent hypotension and one needed observation of fluid balance following intraoperative haemorrhage and blood transfusion. Postoperative stay was 1–8 days (median 3 days). In that time, all antihypertensive medication was discontinued and patients remained haemodynamically stable (systolic BP > 100 mmHg with good urine output). No patient developed refractory hypotension. There was no perioperative mortality.

Comparison of our data with other studies is hampered by the variety of definitions of intraoperative hypertension (e.g. ≥170 mmHg, ≥200 mmHg or using a 20% change from preoperative values) and hypotension (e.g. <80 mmHg or <60 mmHg). In our series, 26% patients experienced BP > 180 mmHg and 52% patients experienced BP < 80 mmHg. These figures compare well with previously published data. For example, in a series of 80 patients treated during a 10-yr period in North Carolina, 53% of patients had intraoperative hypertension (>170 mmHg) and 28% of patients had hypotension (<90 mmHg) [10].

None of our patients experienced sustained hypertension. This compares favourably with data from a large series of 143 patients treated at the Mayo Clinic where 36 had sustained hypertension (>180 mmHg for >10 consecutive minutes) [11]. In our practice, adrenergic blockade is titrated to the clinical end-points of symptomatic postural hypotension and resting bradycardia and patients are encouraged to reach the limit of their ability to tolerate their medication in the days leading to surgery. Despite this, most patients still needed a multimodal pharmacological approach to achieve intraoperative haemodynamic control. This may be a reflection of the fact that the effects of unpredictable intraoperative surges of catecholamines cannot be prevented or controlled by preoperative adrenergic blockade alone. Also, it demonstrates that it is not possible to produce a complete sympathetic block even after long-term phenoxybenzamine pre-treatment because patients retain the capacity for adrenergic responses. This may explain why patients can return to the ward environment safely without the need for routine ITU admission.

These data illustrate that patients undergoing adrenalectomy for phaeochromocytoma have minimal perioperative haemodynamic disturbance following pre-treatment with oral and i.v. phenoxybenzamine in association with propranolol.

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A non-airway management use of the video laryngoscope (GlideScope®)

EDITOR:
We report a case in which we used the GlideScope® to facilitate the successful insertion of nasogastric tube.

A 66-yr-old male was scheduled for an elective left-sided hemi-mandibulectomy with radial free flap reconstruction for squamous cell carcinoma of the oral cavity. On assessment, the patient's airway was Mallampati 2 and mouth opening was three finger-breadths wide. We induced anaesthesia and intubated the trachea (Cormack & Lehane grade 2 on direct laryngoscopy). We attempted and failed to insert a nasogastric tube with digital manipulation as well as under direct vision with a MacIntosh blade. At this point, we inserted the video laryngoscope (Glide-Scope®). The view was Cormack & Lehane grade 1 of the laryngeal inlet with an endotracheal tube *in situ*. We lifted the epiglottis with the GlideScope tip, which improved the view of entrance to the oesophagus. We could insert the nasogastric tube under direct vision with digital manipulation. The position was confirmed with gastric contents on aspiration and the appropriate pH of the aspirate.

The GlideScope has been designed to facilitate tracheal intubation by achieving a clear view of the anterior segment of the glottis without the need for a direct line sight. Even in difficult intubations, the GlideScope achieves Cormack & Lehane view I and II in 99% of patients [1]. It requires less force than conventional laryngoscopy, hence it is less traumatic and minimizes the laryngoscopic stress response. Its slim blade provides a good working space not only for intubation, but also for nasogastric tube placement. It is easy to learn, use and master the technique.

Even though there are no clinical trials available to support this use, it may be a useful technique to use the GlideScope to insert a nasogastric tube, especially in intubated patients. It may also theoretically reduce the stress response to laryngoscopy as it requires less force than the traditional laryngoscope.

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Lactate gap and ethylene glycol poisoning

EDITOR:
We assayed lactate levels in plasma using point-of-care analysers and obtained a fallaciously high value when compared to the value obtained from the central laboratory. The divergence in the lactate values suggested the possibility of ethylene glycol poisoning, but due to the limited information valuable time was lost in initiating treatment.

A 36-yr-old male was brought to the hospital in an unconscious state with a core temperature of 32.9°C. Glasgow coma score on arrival in the accident and emergency department was 3. Clinical evaluation and an urgent computed tomography (CT) scan of the head ruled out intracranial pathology. The patient was moved to the critical care unit for further management.

Blood gas analysis breathing 50% oxygen showed a pH of 6.8, PCO_2 1.4 kPa, PO_2 34 kPa, HCO_3^- 1.0 mmol L^{-1}, base excess -26 mmol L^{-1} and lactate 33 mmol L^{-1}. Routine blood tests showed a lactate of 15.8 mmol L^{-1}. Past medical history revealed a suicidal tendency with previous admission to the hospital with paracetamol overdose. Toxicology screening was sent. A portable ultrasound of the abdomen was performed and contrast CT was planned to rule out intra-abdominal conditions. Fluid resuscitation,

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haemodynamic support, respiratory support and later renal replacement therapy were initiated. There was no improvement in acidosis despite treatment.

All the arterial blood gas samples analysed from the critical care unit using a Radiometer ABL 725 (Radiometer Medical A/S, Bronshoj, Denmark) blood gas analyser showed consistently high levels of lactate despite a sodium bicarbonate infusion and haemofiltration. Thus the cause of the metabolic acidosis remained obscure. The lactate levels from the clinical chemistry laboratory taken at the same time did not match those from the ICU analyser. These differing results aroused the suspicion of ethylene glycol poisoning and further samples were sent for methanol/ethylene glycol detection to the regional toxicology laboratory. It was not before another 6 h that 333 mg L^{-1} of ethylene glycol was detected in the blood and appropriate treatment (4-Methylpyrazole) was instituted. Within an hour of this treatment the acidosis began to improve and the cardiovascular support could be reduced. The patient's condition progressively improved and the lactate had fallen to 0.5 mmol L^{-1} by the 4th day. He was discharged to a tertiary care unit for further management of his renal failure.

We analysed some samples of plasma with a known quantity of glycolic acid and compared the results obtained from our ICU blood gas analyser with those from our central clinical chemistry laboratory (Cobas Integra 400 plus analyser; Roche Diagnostics, Basel, Switzerland). The levels of glycolic acid added and the discrepancies in the two sets of observations are shown in Table 1. This clearly demonstrates the lactate gap in all the readings, which increases linearly as the glycolic acid levels in plasma increased.

The delay in diagnosing this case of ethylene glycol poisoning could have been possibly averted by awareness of this artifactual elevation of lactate levels by our point-of-care analyser and facilities for the prompt detection of ethylene glycol in blood. The lactate gap has been described as divergent lactate levels obtained from a single sample when measured using two different modalities. Recently an erroneous reading by a Radiometer 700 analyser (Radiometer Limited, Crawley, UK) resulted in the patient having an emergency laparotomy [2]. Our patient presented to us approximately 12 h after ingestion of anti-freeze, an interval corresponding with high levels of toxic metabolites. Clearly, ethylene glycol metabolites were causing falsely elevated lactate levels. This was attributed to the large dose of ethylene glycol consumed and delay in the time of arrival at the hospital.

The turning point in the diagnosis and subsequent management in our case were two different lactate values measured from the analyser in our critical care

Table 1. Glycolic acid measured as lactic acid.

Glycolic acid	Radiometer ABL725 lactate reading	Cobas Integra lactate reading
0	1.0	1.1
3	6.9	2.6
6	12	4.2
9	18	6.0
12	24	7.2
18	34	10.2
24	43	12.6
30	51	14.9

A known concentration of glycolic acid was added to a sample of plasma and then measured as lactate by the two systems. Data are all mmol L^{-1}.

unit and that in the clinical chemistry laboratory. The method for lactate measurement in the latter equipment utilises a lactate oxidase method [3]. This enzyme converts lactate to pyruvate and produces hydrogen peroxide (H_2O_2). The peroxide reacts with 4-aminoantipyrine and other unspecified reactants to form a coloured product that is quantified colorimetrically. This method has the practical advantage of having improved reagent stability when compared to alternative methods based on lactate dehydrogenase. However, lactate oxidase may be less specific for the substrate lactate than lactate dehydrogenase. The L-lactate analyser such as that in our ICU, which is widely used to monitor lactate levels in critical care units, measures lactate using the L-lactate oxidase method. However, it uses an electrochemical principle. Lactate determination is accomplished by the enzymatic reaction of lactate oxidase and the detection of H_2O_2 [4]. It seems that most lactate oxidase-based systems respond to glycolate. The difference in response probably depends on the way in which the reaction is monitored. The false-positive results from the ICU equipment occur because ethylene glycol metabolites are substrates for L-lactate oxidase. In contrast, ethylene glycol metabolites cause minimal lactate elevation with the Bayer, iSTAT and Vitros devices [3].

Metabolites of ethylene glycol cause a worse acidosis than the parent compound itself. These may continue to remain in blood for a variable period of time. Increased glycols are measured as lactate in blood [1]. However, despite the equipment being used so frequently for blood gas analysis in the critical care unit, it has not been an object of attention for its erroneously high lactate readings in the presence of glycolic acid. Glycolic acid may account for as much as 96% of the anion gap in patients poisoned with ethylene glycol [5]. Point-of-care test systems may not mark the reaction course as atypical or erroneous. Therefore, having

the local laboratory check a high lactate value is prudent, particularly if the diagnosis is not firmly established. In this regard it is useful to have previously established the response to glycolate of both point-of-care and laboratory systems. This case has highlighted the fact that more understanding of equipment and its mechanisms of action are critical in interpreting the data.

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Low bispectral index values in a 2-yr-old with a large bifrontal porencephalic cyst

EDITOR:
Bispectral index (BIS) is routinely used as a monitor of depth of anaesthesia. Unusually low BIS values may be seen during cerebral ischaemia [1], in neuroradiology during glue embolization [2], in patients with dementia [3] and in persons with genetically determined low-voltage electroencephalographic (EEG) signals [4]. Recently, we detected persistently low BIS values in a patient diagnosed with large porencephalic cysts in the frontal lobes.

A 2-yr-old male child, weighing 12 kg, was admitted to our neurosurgical ward with major complaints of increasing head size since 4 months of age, two episodes of generalized tonic-clonic seizures a week ago and delayed milestones. The child responded to commands, recognized his mother but had difficulty in holding his head with a tendency to fall while walking. Contrast-enhanced computed tomography showed two large cystic intraparenchymal lesions in the frontal lobe, suggestive of porencephalic cysts with paucity of periventricular matter and prominent ventricles. Magnetic resonance imaging showed bilateral communicating frontal lobe porencephalic cysts with secondary aqueductal stenosis and secondary corpus callosal hypoplasia (Fig. 1). He

was scheduled for an elective frontal craniotomy and fenestration of frontal porencephalic cyst with right cystoperitoneal shunt. In the operating theatre, routine monitors (electrocardiogram, non-invasive blood pressure and pulse oximetry) were attached. A BIS monitor (A-2000; Aspect Medical Systems, Newton, MA, USA) was also attached. The BIS sensor (paediatric) was applied to the forehead and left temporal area. A low BIS value of 39 was observed. Lower values persisted till induction of anaesthesia. General anaesthesia was induced with thiopental sodium 40 mg after fentanyl 20 μg. Rocuronium 10 mg facilitated tracheal intubation. Anaesthesia was maintained with sevoflurane in an oxygen and nitrous oxide mixture (1 : 2). Intermittent boluses of fentanyl and rocuronium were given to facilitate mechanical ventilation to target an end-tidal carbon dioxide value of 32 ± 1 mmHg. Throughout the surgical procedure, the BIS values remained between 30 and 40 with a signal-quality index (SQI) of more than 90%. Due to the low BIS values, the sevoflurane concentration was reduced from inspired concentration of 1–0.2%. Still, no changes in the BIS values were observed. No burst and suppression pattern was observed and the electromyography value remained below 30. At the end of an uneventful surgery, the anaesthetics were discontinued and neuromuscular block reversed. The trachea was extubated and the child cried actively. The BIS value continued to remain low, even 6 h later in the neurosurgical ICU.

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Figure 1.
Magnetic resonance imaging showing bilateral communicating frontal lobe porencephalic cyst.

BIS monitoring has been largely used to monitor the depth of anaesthesia. However, nothing has been published regarding the role of BIS monitoring and its validity in neurosurgical patients with raised intracranial pressure. Since the BIS algorithm analyses the EEG signals of the patient, it should be expected to vary or else alter the values displayed, to some extent, especially in patients with grossly elevated intracranial pressure.

Schnider and colleagues [4] reported a case in which, due to the patient's EEG amplitude being genetically very low, the BIS value was 40 during consciousness. This EEG pattern occurs with an incidence of approximately 10% of the population. It has also been suggested that emotional tension may induce low-voltage EEG activity. In our patient, an increase in intracranial pressure as a result of the cyst may have resulted in decreased cerebral perfusion pressure and thereby caused global cerebral ischaemia over a long period. This may have been responsible for the lower BIS values. A large prospective study may be needed to validate the role of the BIS monitor in neurosurgical patients with signs of raised intracranial pressure as in cases of gross hydrocephalus or patients with large intracranial cysts. Lower BIS values in these patients may not reflect the true hypnotic state and could be a result of cerebral ischaemia or even low-voltage EEG signals. To adjust the level of anaesthesia based entirely on BIS could be erroneous and inappropriate.

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Perioperative outcome of pacemaker patients undergoing non-cardiac surgery

EDITOR:
There has been a remarkable evolution in the technology of cardiac pacemakers since the first implantation in the 1950s. Apart from the basic functions of cardiac pacing and sensing, some pacemakers are now able to preserve atrio-ventricular synchronization (dual-chamber pacemaker) and/or to adjust heart rate to metabolic demand (rate-responsive pacemaker). All currently implanted pacemakers have some programmable features that have made pacemaker devices more dependable and more complex [1]. On the

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other hand, population aging, along with broader indications for implantation, has lead to growing numbers of pacemaker patients presenting for surgery. Literature regarding the perioperative period in patients with an implanted pacemaker is limited either to review and guidelines for perioperative management or to case reports of pacemaker dysfunctions, mostly related to electromagnetic interferences generated by electrical devices used in the operating theatre [2,3].

A prospective study was undertaken over a 30-month period to evaluate the perioperative outcome of pacemaker patients undergoing non-cardiac surgery in one university institution. In accordance with French Bioethics Law, all patients gave informed consent to participate in the study, but as it was only observational and did not modify current diagnostic or therapeutic strategy, written consent was not mandatory. All pacemaker patients undergoing non-cardiac surgery or invasive diagnostic or therapeutic procedure unrelated to the cardiac device, performed under general or regional anaesthesia, were included. Exclusion criteria included refusal to participate or age less than 18 yr.

Patients were managed according to the same clinical protocol that is currently being used for pacemaker patients at our institution. Data regarding patient characteristics and past medical history were collected prospectively. Preoperative evaluation focused on underlying cardiac disease, indication for pacing, and pacemaker characteristics and set up. Physical signs of pacemaker dysfunction were assessed, and a resting 12-lead surface electrocardiogram (ECG) was performed preoperatively. Except for case of emergency surgery, the cardiac device was checked preoperatively by telemetry, by either the patient's attending cardiologist or a cardiologist at our institution. Program changes were made if necessary to optimize cardiac pacing, but no change was done specifically for the perioperative period. Choice of the anaesthetic technique and agents were left to the decision of the anaesthetist in charge of the patient. Intraoperative monitoring included at least ECG for cardiac rhythm, non-invasive arterial pressure measurement, pulse oximetry and capnography in case of general anaesthesia. Invasive monitoring of arterial pressure was undertaken in cases of high-risk surgery. Postoperatively, cardiac adverse events were assessed by daily clinical examination until hospital discharge, and both 12-lead surface ECG and plasma cardiac troponin I (cTnI) assays (automated immunoenzymatic assay, Access Cardiac Troponin-I; Beckman Instrument, Chaska, MN, USA) were performed on postoperative day 1 and 3 or when clinically indicated. Telemetric check of the pacemaker was carried out before hospital discharge. The primary end-point was a composite of death from cardiac causes, non-fatal acute myocardial infarction, congestive heart failure and arrhythmia requiring antiarrhythmic therapy during hospitalization. Death was considered to be of cardiac cause if the patient died from myocardial infarction, cardiac arrhythmia or congestive heart failure. The diagnosis of myocardial infarction required elevated cTnI concentration above the normal upper value, set as $0.1 \, \mu g \, mL$. Quantitative variables are presented as mean $\pm$ SD or median (interquartile range) for variables not normally distributed.

In all, 65 patients aged 76 ± 11 yr (36 male, 29 female) were enrolled in the study. Past medical history of coronary artery disease, congestive heart failure and diabetes mellitus were present in 37%, 32% and 12% of the patients in each of those groups, respectively. Previous coronary artery revascularization had been performed in 12.3% of the patients. A pacemaker device, of which 69% were dual-chamber, had been implanted 1.7 (3.1) yr before surgery (data available in 61 cases). Thirty-six percent of the pacemakers were rate responsive. Indications for pacing were symptomatic sinus bradycardia, sinus node disease and symptomatic atrio-ventricular block in 39%, 11% and 38% of the cases, respectively. Preoperative pacemaker dysfunction was noted in seven of the 60 devices tested: dual-chamber DDD pacing mode was found inadequate because of atrial fibrillation in three patients, leading to reprogramming in either VVI (two cases) or DDI (one case) mode [4]. Pacemaker output amplitude was modified in three cases and sensing parameters in one. A low-voltage battery was noted in three cases, but preoperative device change was not considered mandatory by the cardiologist.

Vascular, orthopaedic, intra-abdominal surgery, neurosurgery and miscellaneous procedures were performed in 34%, 25%, 18%, 9% and 14% of the patients, respectively. Emergency surgery was performed in 23% of the patients. General anaesthesia, regional anaesthesia and combined general and regional anaesthesia were used in 83%, 14% and 3% of the cases, respectively. No major dysfunction of the pacemaker device occurred in the perioperative period. Composite adverse outcome was met in 11 patients, including postoperative myocardial infarction in seven patients, left ventricular failure in two and arrhythmia in two. Two patients died of cardiac causes during hospitalization.

Postoperative pacemaker control, performed in 52 patients, revealed no change in pacemaker

program, but allowed for optimization of cardiac pacing in five cases (change in pacing mode in two cases, pacing or sensing parameters changes in three cases).

The results of this observational study showed that severe cardiac complications were frequent in pacemaker patients, but that these complications were mainly related to underlying cardiac disease, and not directly to the pacemaker device. Because of unique characteristics of cardiac diseases that lead to cardiac pacing, we found it impossible to perform a case–control study to compare outcome between patients that differ only by cardiac pacing. However, as current data available on pacemaker patients are limited to case reports of intraoperative dysfunction, we think that our results may help to have a global view on perioperative risk in these patients.

Preoperative pacemaker dysfunction was frequent in our series, and in 12% of the cases pacemaker programming was modified, some of these changes being major alterations, indicated because of evolution of the underlying cardiac disease. Whether a complication linked to a pacemaker dysfunction would have occurred in the absence of reprogramming is not known, but our results reinforce the current recommendation, based on a simple assumption, to check pacemaker program before surgery.

The incidence of cardiac complications was high in our series. Two patients died of cardiac causes, but no death was related to a dysfunction of the cardiac pacemaker device. This is in accordance with the fact that cardiac pacing was not identified as an independent risk factor of cardiac complication in the perioperative period. This also suggests that preoperative evaluation should not only focus on pacemaker evaluation but also consider recent guidelines for preoperative optimization of underlying cardiac disease.

Postoperative pacemaker check revealed that adaptation of pacing mode or parameters were necessary in five patients. In two cases, this was related to alteration in the patients' cardiac rhythm, but in three cases, ventricular output amplitude was changed. The precise mechanism of these alterations was unclear and may require further investigation. This finding is in accordance with the study by Rozner [5], which showed a postoperative increase in pacing output threshold in 4.3% of pacemaker patients exposed to intraoperative electromagnetic interference.

In conclusion, this study showed a poor perioperative outcome of pacemaker patients, mainly related to the underlying cardiac disease, and confirmed the necessity to check the cardiac device in both the preoperative and postoperative period.

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A comparison of esmolol and dexmedetomidine for attenuation of intraocular pressure and haemodynamic responses to laryngoscopy and tracheal intubation

EDITOR:

Laryngoscopy and tracheal intubation may cause undesirable increases in blood pressure (BP), heart rate (HR) and intraocular pressure (IOP). Esmolol, a short-acting β_1-adrenoceptor antagonist, and dexmedetomidine, a selective α_2-adrenoceptor agonist, have been used to modify the IOP increases and cardiovascular responses after laryngoscopy and tracheal intubation. However, data comparing the aforementioned effects of these drugs to each other are not available in the literature. Here we present the data comparison of the effects of a single pre-induction intravenous (i.v.) dose of dexmedetomidine vs. esmolol on IOP and haemodynamic changes due to tracheal intubation.

After obtaining Hospital Ethics Committee approval and informed written consent from the patients, we studied 60 ASA Grade I–II patients, aged 18–60 yr, who required tracheal intubation for elective non-ophthalmic surgery. Exclusion criteria included any known allergies or contraindications to the drugs used, pre-existing eye disease, predicted difficulty in intubation and pregnancy.

After routine monitoring, patients were pre-medicated with midazolam $0.03\,\mathrm{mg\,kg}^{-1}$ 30 min before induction of anaesthesia. Patients were assigned randomly, in a double-blind fashion, to receive either saline as placebo (20 mL) (Group P, $n = 20$), esmolol ($0.5\,\mathrm{mg\,kg}^{-1}$) (Group E, $n = 20$) or dexmedetomidine ($0.5\,\mu\mathrm{g\,kg}^{-1}$) (Group D, $n = 20$) diluted in saline, using 20 mL syringes, 2 min before anaesthesia induction. Anaesthesia was induced with fentanyl ($2\,\mu\mathrm{g\,kg}^{-1}$), rocuronium ($0.6\,\mathrm{mg\,kg}^{-1}$) and propofol (titrated until the eyelash reflex was lost), and maintained with sevoflurane and nitrous oxide 50% in oxygen. HR, mean arterial pressure (MAP) and IOP values were recorded before and 2 min after the administration of the drug, 1 min after induction, and at 1, 3, 5 and 10 min after intubation.

After topical application of local anaesthetic, IOP was measured with a Tono-pen® XL hand-held tonometer (Medtronicsolan, Jacksonville, FL, USA).

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Possible adverse effects during and after administration of esmolol or dexmedetomidine and during the postoperative period such as arrhythmia, bradycardia, tachycardia, hypotension or hypertension were recorded.

The decision to include 20 patients in each group was based on a power analysis ($\alpha = 0.05$, $\beta = 0.1$), which revealed that at least 19 patients should be included in each group. Differences between three groups were compared with the Mann-Whitney U-test. Differences from baseline within groups were evaluated using the Wilcoxon signed rank test. Categorical variables were analysed using the χ^2-test. Statistical analysis was performed using SPSS version 10.0 for windows (SPSS, Chicago, IL, USA). Statistical significance was accepted as $P < 0.05$. All the 60 patients who were recruited completed the study.

Patient characteristics were comparable in all groups. The induction dose of propofol at which the eyelash reflex was lost was lower in the dexmedetomidine group ($61.3 \pm 10.2\,\mathrm{mg}$) than in the esmolol ($137.5 \pm 16.3\,\mathrm{mg}$) and placebo ($144.0 \pm 14.1\,\mathrm{mg}$) groups ($P < 0.001$ for both groups). None of the patients needed active treatment for cardiac problems during the study period.

After administration of study drugs, IOP, MAP and HR were lower in Groups D and E when compared with Group P (IOP: $P < 0.001$ for Groups D and E; MAP: $P < 0.001$ for Group D, $P = 0.028$ for Group E; HR: $P < 0.001$ for Group D and $P = 0.014$ for Group E). Following induction, there were no differences in IOP values among groups but MAP was significantly decreased in Group D compared with Group P ($P = 0.043$), while HR was lower in Groups D and E than in Group P ($P < 0.001$ for both groups). The amount of reduction in HR in Group D was higher than that in Group E ($P = 0.046$). IOP and HR at 1, 3, 5 and 10 min after intubation were lower in Group D compared with Groups E and P (IOP: $P < 0.001$ for all variables; HR: $P < 0.001$, $P < 0.001$, $P < 0.001$ and $P = 0.020$ for Group E and $P < 0.001$, $P < 0.001$, $P < 0.001$ and $P = 0.005$ for Group P, respectively). Additionally, in patients receiving esmolol, decreases in IOP at time points of 1, 3 and 5 min after intubation were higher when compared with the patients in Group P ($P = 0.001$, $P < 0.001$ and $P = 0.008$, respectively). MAP at 1 min after intubation in Group D was significantly

Table 1. Changes in intraocular pressure, mean arterial pressure and heart rate.

	Baseline	After pretreatment	After induction	After intubation			
				1 min	3 min	5 min	10 min
IOP (mmHg)							
Group D ($n = 2020$)	13.5 ± 2.9	$10.9 \pm 2.4^{\ddagger}$	9.4 ± 2.1	$10.4 \pm 2.5^{*\ddagger}$	$9.4 \pm 1.8^{*\ddagger}$	$8.7 \pm 1.8^{*\ddagger}$	$8.1 \pm 1.5^{*\ddagger}$
Group E ($n = 20$)	13.3 ± 3.4	$11.5 \pm 2.8^{\sharp}$	9.7 ± 2.9	$15.2 \pm 3.6^{\dagger}$	$12.4 \pm 2.7^{\ddagger}$	$11.2 \pm 2.5^{\dagger}$	10.3 ± 2.3
Group P ($n = 20$)	13.3 ± 2.8	13.2 ± 3.2	9.8 ± 2.3	19.0 ± 3.5	16.3 ± 3.0	13.7 ± 2.6	11.1 ± 2.5
MAP (mmHg)							
Group D ($n = 20$)	89.8 ± 13.2	$81.9 \pm 11.4^{\ddagger}$	$76.3 \pm 11.2^{\sharp}$	$80.5 \pm 12.7^{\S\dagger}$	77.4 ± 10.1	76.7 ± 10.0	76.6 ± 8.4
Group E ($n = 20$)	93.8 ± 13.1	$87.7 \pm 9.8^{\sharp}$	79.6 ± 10.3	91.9 ± 7.7	86.1 ± 10.1	84.6 ± 9.0	80.3 ± 7.5
Group P ($n = 20$)	91.1 ± 8.8	90.6 ± 8.8	82.1 ± 8.2	90.4 ± 9.9	83.8 ± 8.2	83.2 ± 5.8	82.1 ± 8.2
HR (beats min^{-1})							
Group D ($n = 20$)	83.4 ± 7.5	$69.5 \pm 8.1^{\ddagger}$	$65.7 \pm 8.4^{\S\ddagger}$	$72.6 \pm 8.5^{*\ddagger}$	$71.3 \pm 6.4^{*\ddagger}$	$70.4 \pm 7.2^{*\ddagger}$	$67.8 \pm 11.6^{\S\dagger}$
Group E ($n = 20$)	81.8 ± 10.9	$71.5 \pm 10.3^{\ddagger}$	$71.1 \pm 9.8^{\ddagger}$	88.1 ± 8.4	83.5 ± 7.9	81.9 ± 8.3	75.5 ± 5.1
Group P ($n = 20$)	86.6 ± 11.2	87.6 ± 12.2	83.0 ± 13.9	97.2 ± 14.1	89.4 ± 11.1	88.2 ± 12.3	86.9 ± 9.8

IOP: intraocular pressure; MAP: mean arterial pressure; HR: heart rate.
Data are presented as mean $\pm$ SD.
$^{\S}P < 0.05$ and $^{*}P < 0.001$ vs. Group E; $^{\sharp}P < 0.05$, $^{\dagger}P < 0.01$ and $^{\ddagger}P < 0.001$ vs. Group P.

less than that in Groups E and P ($P = 0.012$ and $P = 0.005$, respectively) (Table 1).

Both esmolol and dexmedetomidine have been used for the attenuation of the adrenergic response to laryngoscopy and tracheal intubation. There is a dose-dependent risk of hypotension and bradycardia before laryngoscopy when esmolol and dexmedetomidine are combined with anaesthesia induction agents. We preferred single-bolus low doses for both drugs in our study instead of an infusion or higher dose administration in order to prevent the potential risk of bradycardia or hypotension. However, especially for esmolol, no consensus has been reached regarding the optimum dose nor the mode and timing of its delivery [1]. Bensky and colleagues [2] suggested that small doses of esmolol (0.2 or 0.4 mg kg^{-1}) may block the increases in HR and BP resulting from laryngoscopy and intubation. Nevertheless, Kovac and colleagues [3] reported that esmolol 1.5 mg kg^{-1} given 30 s prior to induction was found to blunt the maximum increase in HR but not MAP or IOP. Regarding dexmedetomidine, Jaakola and colleagues [4] have reported attenuation of the increase in the HR and arterial pressure during intubation by a bolus injection of 0.6 µg kg^{-1} dexmedetomidine, 10 min before anaesthesia induction, which also decreased intra-operative IOP and anaesthetic requirements for thiopentone and isoflurane. The continuous i.v. infusion of dexmedetomidine has been shown to decrease propofol requirements in volunteers and patients [5,6]. In our study, single i.v. dose of dexmedetomidine (0.5 µg kg^{-1}) blunted the haemodynamic and IOP responses to tracheal intubation. Secondarily, the single-bolus dose administration of dexmedetomidine in contrast to the continuous i.v. infusion used in previous studies also proved to reduce the propofol requirements for induction of anaesthesia. However, esmolol, with the dose of 0.5 mg kg^{-1} used in this study, was shown to be ineffective in the attenuation of IOP and haemodynamic responses to tracheal intubation.

In conclusion, the results of this study emphasise that dexmedetomidine is more effective than esmolol in preventing the haemodynamic and IOP responses to tracheal intubation in ASA I–II patients. In order to further evaluate the effects of esmolol, additional studies should be planned to assess the optimum dose, mode and delivery timing of this drug. Furthermore, it should be noted that this study included only healthy patients and does not reflect the effects of these drugs on patients with a history of hypertension or glaucoma.

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Postoperative deep venous thrombosis in a woman with congenital afibrinogenaemia treated with fibrinogen concentrates

EDITOR:

Congenital afibrinogenaemia is a rare coagulation disorder with an estimated prevalence of one in one million [1]. The risk of abnormal bleeding during a surgical procedure is high but can be avoided by the administration of fibrinogen concentrates [2,3]. The administration of coagulation proteins in patients deficient in coagulation factors can be complicated by venous or arterial thrombosis [1]. We describe the case of a patient with congenital afibrino-genaemia admitted for enucleation of her right eye whose postoperative course was complicated by a deep venous thrombosis.

Case report

A 30-yr-old Algerian female (height 1.62 m, weight 56 kg), known to have congenital afibrinogenaemia, was referred to the ophthalmology department for the enucleation of her right eye. At birth she had suffered from an umbilical cord haemorrhage. The diagnosis of congenital afibrinogenaemia had been made at the age of 5 yr when she presented with a large musculocutaneous haematoma. The parents were asymptomatic. The patient had seven siblings: one sister died from haemorrhage at birth, two brothers were affected with the same haemorrhagic disease and one brother and three sisters were asymptomatic. In 1986, 1997 and 2006 the patient underwent dental extractions without complication after administration of fresh frozen plasma. She was being treated for menorrhagia with normegestrol and an oral iron preparation for the associated iron-deficiency anaemia. At the age of 5 yr she had suffered trauma to the right eye complicated by intraocular haemorrhage. Since then her vision had been poor and in recent months she had suffered from chronic pain. The ocular pain was not relieved by the usual analgesics and enucleation was suggested and accepted by the patient.

The preoperative haematological tests' results are shown in Table 1. Fibrinogen, determined by a functional assay (von Clauss method), was $<0.30\,\mathrm{g\,L^{-1}}$, and the level determined by an immunological assay was $<0.50\,\mathrm{g\,L^{-1}}$. The plasma concentrations of the other coagulation factors were normal. Immediately before the surgical procedure, the patient received 4.5 g of fibrinogen (Clottagen®; LFB, Lille, France), the target being a plasma concentration of fibrinogen $\geqslant 1\,\mathrm{g\,L^{-1}}$.

The enucleation of the right eye was carried out under general anaesthesia. The eye content was replaced by a polymer-coated hydroxyapatite implant. The surgical procedure was uneventful, without abnormal surgical bleeding. She received a further 1.5 g of fibrinogen on the first and the second postoperative days (Table 1). On the fourth postoperative day, she complained of pain in her left calf. Compression ultrasound examination of the lower limb veins revealed thrombosis of the left fibular veins at the mid-calf extending over 3 cm. Contrary to proximal thrombosis, the therapeutic

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Table 1. Coagulation profile during hospital course.

	16 May 2007	22 May 2007, 12.00a.m.	22 May 2007, 8.00p.m.	23 May 2007, 8.00a.m.	23 May 2007, 6.00p.m.	24 May 2007, 8.00a.m.	25 May 2007, 8.00a.m.	26 May 2007, 8.00a.m.	27 May 2007, 8.00a.m.	28 May 2007, 8.00a.m.	29 May 2007, 8.00a.m.
Prothrombin time (s)	>60	15.8	16.0	16.9	16.7	17.2	16.9			19.2	
Activated partial thromboplastin time (s)	>120 (34)	34 (35)	28 (34)	32.5 (34)	32.8 (35)	36.9 (34)	35.1 (34)			40.4 (34)	
Fibrinogen* ($G\,L^{-1}$)	<0.30	1.30	1.25	1.08	1.58	1.12	1.46	1.08	0.71	0.53	0.38
Platelet ($g\,L^{-1}$)	326	259									
Haemoglobin ($g\,dL^{-1}$)	14.7	13.1									
Fibrinogen infused (Clotagen®)		4.5 g		1.5 g		1.5 g					

* Immunological assay.

approach to distal deep vein thrombosis remains controversial. Distal clots appear to have a much lower thromboembolic potential, so we chose not to administer anticoagulants and treated the patient with compressive stockings. The compression ultrasound examination was repeated on the fourth and seventh postoperative day and showed no extension of the thrombosis. The patient was authorized to mobilize on the seventh postoperative day and left hospital on the ninth postoperative day. After discharge from hospital, the postoperative course was uneventful.

Discussion

Fibrinogen is a plasma glycoprotein with a central role in the haemostatic process both as an adhesion protein essential to platelet aggregation and as a precursor of insoluble fibrin that forms the haemostatic clot. Fibrinogen is produced in the liver and its half-life is about 4–5 days. Fibrinogen is composed of six polypeptide chains ($\alpha_2/\beta_2/\gamma_2$) and is encoded by three separate genes (FGA, FGB and FGG) located on chromosome 4 [4]. A number of different mutations have been detected in all three genes in association with afibrinogenaemia, although the majority involve truncations of Aα chain. Patients can be homozygotes with the complete absence of endogenous fibrinogen or heterozygotes with mild-to-moderate hypofibrinogenaemia. Congenital afibrinogenaemia is inherited as an autosomal recessive disorder. Patients are usually offsprings of a consanguineous marriage and are very rare among European populations. A large series of 55 afibrinogenaemic patients has been reported from Iran [1].

The bleeding manifestations in congenital afibrinogenaemia are different from and less severe than that in haemophilia A and B. The severity of bleeding varies from patient to patient. Afibrinogenaemia is in general not characterized by profuse spontaneous bleeding. It is thought that the presence of functional von Willebrand factor allows for platelet aggregation and adhesion to form loose thrombi. Umbilical cord haemorrhage (unusual in haemophilia) is often the first bleeding episode in afibrinogenaemic patients, whereas spontaneous haemarthroses, muscular haematomas and mucosal bleeding occur with a varying severity. Bleeding in the central nervous system is relatively rare but can be life-threatening. The mucosal-type haemorrhages such as nose bleeding and menorrhagia are relatively frequent. Recurrent miscarriages are not uncommon. Management of haemorrhage in afibrinogenaemic patients is based on the administration of fibrinogen concentrates, if available, or of

cryoprecipitates [2,3]. Inactivated plasma-derived concentrates of fibrinogen are available in France (Clottagen®; LFB, Lille, France) and Germany (Haemocomplettan® P; ZLB Berhring, Marburg, Germany). The target fibrinogen plasma levels considered adequate to control bleeding are not well defined. Recent guidelines support recommended target fibrinogen levels of approximately $1\,\mathrm{g\,L^{-1}}$ in the perioperative period, and $2\,\mathrm{g\,L^{-1}}$ during labour [5].

Arterial or venous thrombosis have been reported to occur spontaneously or after infusion of fibrinogen-containing preparations [1,5,6]. The puzzling association of a severe coagulation defect such as afibrinogenaemia and thrombosis has no definitive explanation. It has been suggested that thrombotic events are related to thrombin-induced platelet aggregation *in vivo* due to poor neutralization of this enzyme, in turn due to lack of its adsorption on fibrin. Aggregation of platelets is induced by thrombin in patients with afibrinogenaemia. During the activation of the coagulation cascade, the relative absence of fibrinogen results in an increase in 'free' thrombin as a result of the lack of the antithrombin activity of fibrin. Because fibrin inactivates thrombin, patients with a lack of fibrinogen may be at risk for thrombosis because of the constant presence of thrombin. Abnormal elevated thrombin generation was described in a case report by Dupuy and colleagues [7]. In that case, the thrombin–antithrombin complexes as a measure of thrombin generation only normalized with fibrinogen replacement.

Fibrinogen replacement therapy is considered to be one of the risk factors for thrombosis in afibrinogenaemic patients. It has been proposed that in the absence of fibrinogen, the small traces of thrombin usually formed, remain longer in the circulation as no absorption on circulating fibrinogen occurs. Such traces of circulating thrombin could clot some fraction of the infused fibrinogen [6]. Indeed, several reports have suggested a possible link between the infusion of fibrinogen-containing preparations and the development of thrombosis [5]. However, it is also apparent that in the majority of patients no known risk factors including the infusion of fibrinogen are present. In a recent review of all reported cases of thrombosis, both arterial and venous, which occurred in rare congenital bleeding disorders, 16 (20%) out of 81 patients had afibrinogenaemia. Among those 16 patients with afibrinogenaemia associated with thrombosis, only seven had possible link with the infusion of fibrinogen-containing preparations [6]. In our patient, the maximum level of fibrinogen after infusion was $1.58\,\mathrm{g\,L^{-1}}$, and we chose to repeat the infusion of fibrinogen due to the high risk of bleeding immediately after the right eye enucleation.

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Abnormal anatomy and airway management

EDITOR:

Anaesthesiologists still face severe airway disasters that may lead to permanent disability and even death. Numerous guidelines for difficult airway management have been developed, along with a wide range of techniques [1,2]. The incidence of difficult intubation has been reported to range from 1% to 18% [3,4]. The incidence of 'cannot intubate' was found to be around 0.05–0.35% [2,5], whereas that of 'cannot intubate–cannot ventilate' situation was around 0.0001–0.02% [6]. We present a case of unrecognized difficult airway with a 'cannot intubate–cannot ventilate' scenario due to a rare malformation of the upper airway.

Case report

A 43-yr-old ASA I male suffering from chronic low-back pain was admitted for an elective lumbar discectomy. The preoperative anaesthetic assessment revealed a healthy male with no history of allergies or general anaesthesia in the past. Airway examination revealed a neck with free movements (extension and flexion), normal mouth opening (more than 6 cm), an inter-incisor width of 7 cm, class II pharyngeal landmarks in the Samson and Young classification and a thyromental distance greater than 6 cm.

General anaesthesia was induced with midazolam, remifentanil, propofol and rocuronium to facilitate endotracheal intubation. Ventilation by facemask encountered some difficulty but oxygen saturation was maintained within the normal range. Direct laryngoscopy revealed an oblique plane of the epiglottis corresponding to a laryngoscopic view grade III. The anaesthesiologist improved the position by placing another pillow under the shoulders and performed the optimal external laryngeal manipulation manoeuvre. The first and second attempts to insert an endotracheal tube failed and the anaesthesiologist called for assistance. Upon the arrival of a second senior anaesthesiologist, mask ventilation proved very difficult, despite the two-person mask ventilation. A laryngeal mask failed to provide effective ventilation. An intubating laryngeal mask airway was inserted at this point in an attempt to facilitate tracheal intubation but ventilation by this technique was poor and tracheal intubation failed. The laryngeal mask was removed. The mask ventilation was becoming more and more difficult, with oxygen saturation decreasing and the patient becoming bradycardic. At this stage, the anaesthesiology staff attempted to perform transtracheal jet ventilation, yet three repeated attempts failed. In the meantime, the ENT surgeons had been urgently called. Surgical cricothyroidotomy was started by the anaesthesiologists pending the arrival of the ENT team, but it failed as well. Maintaining oxygenation by mask ventilation was extremely difficult throughout these manipulations. The otolaryngologists encountered serious problems but succeeded eventually in obtaining a definitive airway by tracheotomy. The patient began to breathe spontaneously. Sedation, analgesia and muscle relaxation were next administered and the patient was transferred to the ICU for mechanical ventilation and observation without undergoing surgery.

A computerized tomography scan of the neck and upper airway performed on the second day revealed severe malformations, i.e. a low-lying valleculae at the level of C5–C6 (instead of C3 normally) – with the tracheotomy cannula penetrating through them, a low epiglottis, and an asymmetrical larynx with an obliterated left piriform sinus. We also noted a very low position of the hyoid bone at the C7 level (instead of C3–C4), which was obliquely positioned, with the hyoid cornua on the right lying higher than the one on the left, probably as a result of dislocation. Furthermore, a laterally rotated and low-lying thyroid cartilage was found at T1 (instead of C5), as well as a vertical oblique position of the vocal cords (instead of the normal horizontal orientation) that were lying at the level of the apex of the lungs. The trachea was short (8.5 cm instead of 10–12 cm in the normal adult male). A computerized tomography image of the malformed airway is presented in Figure 1.

The hypnotic medications and relaxants were stopped on the third day and the patient regained full consciousness. After a short course of weaning from mechanical ventilation, he was able to maintain normal oxygenation and ventilation by an oxygen mask. Neurological examination proved normal and the patient was transferred on day 4 to the ENT department for observation and further management. The tracheostomy tube was removed and the tracheotomy closed. The patient was discharged fully

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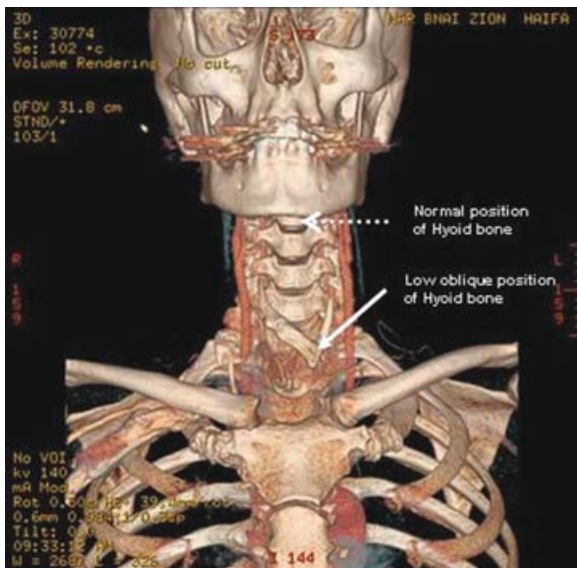
Figure 1.
Computerized tomography image of the malformed airway.

recovered on day 18, with a *Medical Alert* wallet card giving details of his difficult airway.

Discussion

Difficult tracheal intubation remains the most crucial predicament anaesthesiologists ever encounter in the operating room. The unanticipated difficult airway is a clinical problem encountered by most anaesthesiologists at some point, and is probably the most important cause of major anaesthesia-related morbidity [7]. Despite the development of various innovative devices for ventilation/intubation as well as the numerous alternative techniques for unanticipated difficult ventilation or tracheal intubation, studies designed to assess the efficacy of a predefined algorithm in the case of an unanticipated difficult airway are few [8,9]. Parmet and colleagues [9] reported the systematic use of the laryngeal mask in the case of combined unanticipated difficult intubation and ventilation and demonstrated that 94% of patients treated with the laryngeal mask as the first rescue alternative technique were successfully ventilated. Dimitriou and colleagues [8] reported a high success rate of tracheal intubation using the intubating laryngeal mask airway in 44 unpredicted failed laryngoscopy-assisted tracheal intubations. Despite following the management pathway according to the ASA guidelines in the present case, all of the orderly attempts to achieve endotracheal intubation failed because of severe malformation of the whole upper airway and the trachea. The lower position of the hyoid bone (mainly the right cornua) had caused

a misinterpretation of the thyromental distance during the preoperative airway evaluation.

The presented case describes an unsuspected abnormal anatomy of the airway that extended from the epiglottis to the short and low-lying trachea. This malformation defied the almost normal examination of the patient's airway (with the exception of the slightly short neck). This case of nearly fatal outcome is a rare case of severe airway malformation with an unknown congenital disorder or an acquired traumatic anomaly as possible aetiologies. With the peculiar laryngeal malformation and the hybrid position of the hyoid bone, this may be the first-described case of its kind. On a practical level, we conclude that one can never be too careful in preoperative anaesthetic assessment. Furthermore, since otolaryngologists are not always present in every instance (e.g. small hospitals, rural settings), we propose that anaesthesiologists become more familiar with surgical airway management by means of seminars and programmed workshops.

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