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Intractable blood loss during brain tumour surgery in a child: effect of recombinant activated factor VII

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Editor,

In neurosurgery, resection of richly vascularized brain tumours may be accompanied by excessive blood loss. In such cases, extensive transfusions of blood and blood products combined with application of local haemostatic agents and administration of antifibrinolytics may not halt blood loss sufficiently to end the procedure and may result in volume overload and brain swelling. Only two reports have been described in which the pro-haemostatic agent recombinant activated factor VII (rFVIIa) was administered for massive blood loss in children operated on for brain tumour resection [1,2].

Here, we report a case of a 10-year-old girl being operated on for a brain tumour, in which transfusion of routine pro-coagulation products was insufficient to stop the bleeding. rFVIIa was administered, and within minutes haemorrhage was controlled. The present case demonstrates the use of rFVIIa as a life-saving manoeuvre in a child who underwent a brain tumour resection accompanied by intractable bleeding.

A 10-year-old girl, weighing 27 kg, was admitted to hospital. She had a 1-year history of eating problems, recent vomiting, and minimal neurological deficits of the left arm and leg. Subsequent MRI showed a brain tumour (9.7 cm × 5.9 cm × 8 cm) in the right hemisphere, parieto-occipitally located, with a solid part and a large cyst on its anterior side. The ventricular system was compressed and the midline was shifted to the left. Her vital signs were normal. Haematological parameters were as follows haemoglobin 6.9 mmol l⁻¹ (normal values 7.1–9.0), platelet count 219 × 10⁹ cells l⁻¹ (150–450), activated partial thromboplastin time (APTT) 31 s (28–42), partial thromboplastin time (PTT) 13.9 s (<14.7), and fibrinogen 2.7 g l⁻¹ (2.0–4.0). The operation

was undertaken with the aim of performing a complete tumour resection.

After operating for 6 h, massive haemorrhage started to develop. During resection of the tumour, heavy bleeding episodes were difficult to control. Blood loss was calculated at 2500 ml. In total, 1400 ml packed red blood cells (RBCs), 640 ml fresh frozen plasma (FFP) and 180 ml platelets concentrate, and 1000 mg of tranexamic acid were administered. This resulted in the following laboratory parameters: haemoglobin 4.9 mmol l⁻¹, platelets 121 × 10⁹ cells l⁻¹, PTT 16.9 s, and APTT 36 s. Although the tumour was partly resected, due to continuous and uncontrollable bleeding, we decided to stop the procedure. rFVIIa (Novoseven; NovoNordisk A/S, Bagsvaerd, Denmark) at a dose of 90 µg kg⁻¹ body weight was administered. Within 10 min, the bleeding stopped and the operation was finished. Haemostatic parameters following the administration of rFVIIa were PTT 11.4 s, APTT 26 s, and platelet count 111 × 10⁹ cells l⁻¹.

One week after the operation, the child was discharged from hospital in good neurological condition. Pathological examination of the tumour tissue revealed a primitive neuro-ectodermal tumour.

The patient was treated with chemotherapy (etoposide and carboplatin) and, 3 months after the initial operation, she underwent a second operation and the tumour was completely resected. This procedure was performed without any bleeding complications.

rFVIIa was developed and registered for use in patients with haemophilia A and B who developed inhibitors against factor VIII and IX, respectively. Although the exact mechanism of action of rFVIIa has not yet been completely elucidated, the general opinion is that it binds tissue factor (TF), forms a complex with factor X, and subsequently causes a localized increase in the generation of thrombin [3]. However, in cell-based models, it was shown that FVIIa could increase FXa and thrombin generation on activated platelets in the absence of TF [4].

rFVII is increasingly used off-label in various (non)surgical procedures in adults as well as in paediatric patients during acute haemorrhage [5,6]. However, reports of the use of rFVIIa in neurosurgical patients, in adults [7,8] as well as in children, are extremely rare. Until now, there have been two reports that presented three cases in children (2, 9 and 14 years of age) with intractable haemorrhage during brain

tumour resection who received rFVIIa [1,2]. One child died on the third postoperative day from cerebral infarction, possibly related to a high dose of rFVIIa ($240 \mu\text{g kg}^{-1}$ within 30 min) [2]. Recommended doses in patients with haemophilia are $90\text{--}120 \mu\text{g kg}^{-1}$ [9]. However, for off-label use in haemorrhage, no dosage has yet been recommended. Also, reports suggest that, in patients without haemophilia, rFVIIa might be more thrombogenic in combination with other pro-coagulant factor concentrates [10], and the dosage should possibly be adjusted.

It is remarkable that, in our report, haemorrhage was massive, but coagulation parameters were only slightly disturbed. However, two of the above reported cases [2] described identical situations of massive haemorrhage with normal coagulation tests. Possible explanations of why diffuse bleeding can occur in spite of normal coagulation values have recently been discussed [2].

Large volumes of FFP and platelets concentrate, necessary to correct haemostasis, which are infused in addition to numerous quantities of crystalloids, colloids and RBCs, may, especially in children, result in pulmonary and brain oedema from overfilling. In such circumstances, early administration of rFVIIa should be recommended. However, the effect of the prophylactic use of rFVIIa has been questioned [11].

More data are needed to safely use rFVIIa in children during neurosurgery.

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Modified Folts models in the rabbit: variations on a well worn theme

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Editor,

We read with interest the paper by Dellamonica *et al.* [1] regarding an arterial cyclic thrombosis model in rabbit. As we work on the same model, we would like to share some comments regarding the procedure. In 1976, John Folts developed a canine model of coronary stenosis with intimal injury in order to reproduce experimentally the clinical situation of unstable angina [2]. In this dynamic model, a vascular wall injury associated with a stenosis of the artery (both induced experimentally) produces cyclic flow reductions (CFRs) characterized by a gradual decrease in blood flow followed by a sudden restoration of flow, either spontaneous or facilitated. The endothelial damage induces the formation of a platelet plug, which embolizes and forms again in a cyclic fashion. This model was extended by Folts [3] and others [4,5] to different species and vascular territories.

We, as others, have adapted the Folts model to the rabbit's carotid in our respective laboratories. We all monitored carotid thrombosis formation by measuring electromagnetic flow while controlling haemodynamic and ventilation variables. Although all three groups worked on the potential prothrombotic effect of recombinant activated factor VII, our observations were not similar [6,7]. Fortunately, we were able to discuss the differences in our results, particularly those concerning CFRs and their significance. This letter, as a link to the work by Dellamonica *et al.* [1], gives us an opportunity to share our conclusions.

First, there is concern about the ventilation parameters, as p_{O_2} affects the occurrence of CFR. The frequency and the tidal volume are established for rabbits as follows: frequency = $40\text{--}45 \text{ cycles min}^{-1}$ and tidal volume = 5 ml kg^{-1} . Therefore, the only variable parameter is FiO_2 . Dellamonica *et al.* [1] show that an abrupt decrease of p_{O_2} decreases the number of CFR. This result is very interesting and similar to the finding by Godier *et al.* [6] (same low number of CFR in 21% FiO_2) and

Charbonneau *et al.* [7] (CFR trend to vanish in room air ventilation). Therefore, FiO₂ should be adapted depending on the prothrombotic or antithrombotic trend of the experiment.

Second, anaesthetic procedures are achieved by three different products: isoflurane gas and intramuscular curare injection, intravenous mixture of ketamine and xylazine or intravenous penthotal infusion. These therapeutics lead to variations in blood pressure, heart rate and platelet aggregation. Isoflurane provides the best haemodynamic stability and no platelet interaction, but its use is much more expensive. Furthermore, it does not dispense with the use of analgesia, which will interact with platelets and the haemodynamics. The effective dose of pentobarbital is close to the lethal dose in rabbit and makes its use tricky and is not recommended by veterinary surgeons. Therefore, the combination of ketamine and xylazine could be the best solution, even if ketamine interacts with platelets, regarding its efficacy on anaesthesia–analgesia without vasoplegia.

Third, although we all define CFRs as a progressive reduction in blood flow followed by a sudden return to the initial level (in the absence of haemodynamic variations), the characterization of CFRs varies. The Nancy group shakes the clamp to induce CFRs, the Paris group considers only spontaneous emboli CFRs and does not mechanically dislodge the thrombus by shaking, and the Montreal group accepts both induced and spontaneous CFRs (and identifies them as such).

Thus, stenosis and carotid injury should be standardized. The stenosis can be achieved by a silicone occluder or a metal vascular clamp to obtain a consistent 10% decrease in mean carotid flow. Arterial deendothelialization is produced by external compression of the artery. However, even if nontraumatic forceps are always used, forceps differ from one laboratory to another and can lead to unavoidable differences in the degree of arterial trauma.

We investigated whether the use of a specific forceps induces more or less severe lesions. In the same rabbit, the injury was made with the Nancy group's forceps on one carotid artery and with the Paris group's forceps on the other. We then compared histological injuries. The Nancy group's forceps resulted in a higher degree of trauma; although the length of injury is similar, depth is obviously different. We postulate that more traumatic forceps will result in more thrombotic lesions. Logically, in the Nancy group's technique, as the injury is more traumatic, the model is more thrombotic, and the clamp must be shaken to obtain CFRs rather than irreversible thrombosis. In the Paris group's technique, the lesion is less pronounced, and spontaneous emboli may occur.

In conclusion, it is important to consider variations in experimental design. We suggest that the degree of trauma should be chosen with respect to the aim of the study and the drug under study; the more traumatic forceps and elevated FiO₂ should be used to study antithrombotic drugs, whereas the less traumatic forceps and room air ventilation should be used to test prothrombotic drugs.

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Comparison between manoeuvres facilitating tube advancement during orotracheal fiberoptic intubation, under general anaesthesia

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Editor,

Difficulty in advancing the tube over the fibrescope, during fiberoptic intubation, is a well recognized problem. Among the reasons for this, impingement of the tube's tip on the right arytenoid cartilage and tube migration into the oesophageal inlet have been reported as the most frequent causes of impeded tube advancement [1]. A ninety degree counterclockwise rotation of the bevelled tube (90CCWR) is recommended as the most effective manoeuvre to minimize the tube's

impingement on the right arytenoid [2]. In addition, the tube inadvertently entering the oesophagus may be avoided by applying external pressure over the cricoid cartilage [cricoid cartilage pressure application (CCPA)] [1].

However, when failure of tube advancement into the trachea occurs, the mechanism involved is not easily identifiable. Thus, in clinical practice, it is often necessary to try several manipulations until the correct one to solve the problem is applied. This scenario is quite inconvenient during fiberoptic intubation under general anaesthesia owing to the time limitation imposed by an apnoeic patient.

The goal of the present study was to compare the efficacy of the manoeuvre of 90CCWR with that of CCPA to overcome difficulty in advancing the tube into the trachea, under general anaesthesia.

After obtaining ethics committee approval and written informed consent, we prospectively evaluated, over a period of 1 year, all ASA I or II adult patients, undergoing routine orotracheal fiberoptic intubation under general anaesthesia. Exclusion criteria were a BMI of more than 35, risk of pulmonary aspiration and history of known or suspected difficult intubation (Mallampati score 3–4, thyromental distance <6.5 cm, interdental distance <3.5 cm) [3,4]. Our study included only those cases in which the first attempt to railroad the endotracheal tube over the fiberoptic unit, which had already been inserted into the trachea under general anaesthesia and muscle paralysis, failed. On the basis of the above criteria, a total number of 80 patients were studied.

Anaesthesia was induced with intravenous midazolam 2 mg, fentanyl $2 \mu\text{g kg}^{-1}$, propofol 2 mg kg^{-1} and *cis*-atracurium 0.15 mg kg^{-1} , followed by propofol infusion ($100\text{--}120 \mu\text{g kg}^{-1} \text{ min}^{-1}$) to loss of consciousness. The patient's lungs were hyperventilated by bag-mask with an FiO_2 value of 1, for at least 3 min, to a targeted end-tidal CO_2 (EtCO_2) of 25–35 mmHg. Any attempt at fiberoptic intubation was performed under complete neuromuscular blockade, confirmed by the disappearance of any visible reaction to train-of-four stimulation and continuous propofol infusion to maintain a bispectral index (BIS) value below 40.

The procedure was accomplished with the patient's head resting on a pillow, with the atlanto-occipital joint extended. A fibroscope (Olympus LF-GP, Olympus Optical Co., Ltd, Ishikawa-cho, Hachioji-Shi, Tokyo, Japan, 4.1 mm outer diameter), with the tracheal tube loaded onto it, was passed through the patient's mouth into the pharynx, while tongue traction was applied by an assistant to clear the pharyngeal airway. Reinforced bevelled tubes (Safety-Flex, Mallinckrodt Medical, Athlone,

Ireland) with inner diameters of 6.5 and 7.0 mm for women and men, respectively, were used. The orientation of the bevel was facing to the left.

Once the tip of the fibroscope was positioned in front of the carina, the tube was slowly advanced into the trachea. If resistance to the passage of the tube was encountered, patients were randomly assigned to undergo a second attempt at tube advancement, using tube withdrawal by 2–3 cm, 90° counterclockwise rotation and readvancement (90CCWR group, $n=40$) or tube withdrawal, cricoid pressure application and tube readvancement (CCPA group, $n=40$). Cricoid pressure was applied by an assistant, who had been trained to generate a force of approximately 30 N by practising on a weighing scale. During the second attempt to pass the tube into the trachea, no other manipulation was performed. If resistance to tube advancement was still encountered, after performing the manoeuvre under evaluation, it led to fiberoptic-guided intubation of the patient by means of the intubating laryngeal mask airway (ILMA) technique. If intubation was prolonged and the SpO_2 decreased below 95%, the procedure was interrupted and ventilation by mask was reinstituted immediately until the SpO_2 became at least 98% and the EtCO_2 was less than 35 mm. All manipulations were made under continuous infusion of propofol, titrated to a BIS value below 40.

Data collected included patient characteristics and success rates of tracheal tube advancement over the fibroscope between groups. Intubation times were also measured in all patients, when the performed manipulation (90CCWR or CCPA) resulted in successful tube advancement into the trachea. Intubation time was defined as the apnoeic interval from removal of the face mask until the reappearance of a normal EtCO_2 trace.

Statistical analysis was performed using the unpaired *t*-test and χ^2 test [degrees of freedom (DF), 1]. The level of statistical significance was set at a *P* value less than 0.05.

The two groups were comparable, regarding basis characteristics. Differences between groups were not observed with respect to either intubation success rates or the time needed for successful intubation (Table 1).

Table 1 Patient characteristics, rates of successful/failed intubation and intubation times between groups

	90CCWR ($n=40$)	CCPA ($n=40$)	<i>P</i> value
Age (years)	49 ± 15	52 ± 17	0.652
Weight (kg)	72 ± 15	75 ± 18	0.710
Height (cm)	169 ± 10	173 ± 9	0.078
Sex (M:F)	28:12	26:14	0.813
Success:failure	28:12	24:16	0.07
Intubation time (s)	79.8 ± 13.6	85.4 ± 13.1	0.19

Data are expressed as means $\pm$ SD, or numbers of patients. 90CCWR, 90° counterclockwise rotation of a bevelled tube; CCPA, cricoid cartilage pressure application; F, female; M, male.

None of the 52 patients in whom the two manipulations resulted in successful tube advancement developed desaturation ($\text{SpO}_2 < 95\%$), due to prolongation of the procedure, requiring interruption of the technique.

In all cases in which the examined manipulations failed to help tube advancement, orotracheal intubation through the fiberoptic-guided ILMA technique was successful at the first attempt.

Our study evaluated the efficacy between two manoeuvres, recommended as rescue methods to resolve difficulty in endotracheal tube advancement during fiberoptic intubation, under routine clinical conditions, when the exact site of obstruction was not known. The 90CCWR manoeuvre has been considered to be useful for bevelled tubes, when the bevel of the tube is conventionally oriented facing the patient's left [5]. When this manoeuvre is completed, the bevel faces posteriorly, and the tip of the tube lies anteriorly to the scope, minimizing the possibility of tube impingement into the right arytenoid cartilage [5,6]. On the contrary, CCPA has been proposed to facilitate fiberoptic intubation by compressing the hypopharynx, hence preventing inadvertent migration of the tube into the hypopharynx. In this scenario, resistance is felt when the tube is pushing the fibrescope over the interarytenoid notch into the hypopharynx. Pulling the tube back a few centimetres to remove the tube's tip from the hypopharynx, before cricoid pressure application and readvancing it, enhances the efficacy of the manoeuvre [1].

According to this study, the examined manoeuvres have comparable success rates and effective times needed for tracheal intubation. On the basis of these results, there is no obvious superiority of one technique over the other, in terms of which order they should be applied when tube advancement is impeded and the site of obstruction is not known.

Comparably high success rates recorded either for the 90CCWR or for the CCPA manoeuvre in our study may indicate that each of them is not specific for a unique mechanism of failure of endotracheal tube advancement during orotracheal fiberoptic intubation. Fiberscopic views have demonstrated that the endotracheal tube, due to its inherent curvature, is often advanced along the posterior pharyngeal wall into the hypopharynx, ignoring the course of the fibrescope [1]. The same applies to a lesser degree when a reinforced tube is used, which can change its direction more easily to follow the curve of the fibrescope. This mechanism may explain why 90CCWR, a manipulation that turns the tube's curvature to the side, might decrease the incidence of oesophageal intubation. Besides that, CCPA shifts the larynx towards the cervical vertebrae, keeps the tip of the tube away from the structures of the posterior glottis and

thus might decrease the incidence of impingement on the right arytenoid cartilage [1].

Our findings include comparable success rates of intubation with 90CCWR or CCPA, when tube advancement has initially failed. These intubations were performed through the oral route, under general anaesthesia, in patients with no anticipated difficult airway, using reinforced bevelled tubes of 6.5 and 7.0 mm inner diameters for women and men, respectively, railroaded over a fibrescope of 4.1 mm outer diameter. Provided that both the studied manoeuvres did not seem to be specific for only one type of tube impingement, randomly applying each of them leads to intubation rates greater than 60%. Performing more than one technique, in case of failure during the first attempt, may lead to even greater rates of success, without excessive prolongation of the procedure.

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Is the decreasing availability of vecuronium and pancuronium putting patients at risk?

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Editor,

An increasing incidence of drug allergies has been observed in the general patient population, and allergy services in the UK have been the subject of a House of Lords report [1]. The referral of patients who have suffered possible anaesthetic anaphylaxis to a bispecialty anaesthetic allergy clinic is now considered to be a desirable follow-up and the responsibility of the primary anaesthetist involved [2]. A comprehensive list of specialist allergy investigation centres in the UK, together with

Table 1 Neuromuscular blocking drugs involved in anaphylactic reactions during anaesthesia (n = 305)

NMBD	Number (%)
Rocuronium	132 (43.1)
Suxamethonium	69 (22.6)
Atracurium	58 (19.0)
Vecuronium	26 (8.5)
Pancuronium	10 (3.3)
Mivacurium	8 (2.6)
Cisatracurium	2 (0.6)

NMBD, neuromuscular blocking drug. Adapted from [5].

useful information regarding anaesthetic allergies, is available from the website of the Association of Anaesthetists of Great Britain and Ireland (www.aagbi.org).

We have recently established such a clinic and have identified a problem with the safe anaesthetic management of patients with allergies to neuromuscular blocking agents (NMBAs). It is generally accepted that NMBAs are the commonest cause of anaphylaxis during anaesthesia, although the comparative incidence may vary between different centres and countries [3]. An epidemiological study of suspected anaphylactic reactions during anaesthesia in France found NMBAs to be responsible for 62% of anaesthetic anaphylactic reactions [4]. The incidence of anaphylactic reactions to individual muscle relaxants from the French study in 1999–2000 is shown in Table 1 [5].

In addition, cross-reactivity to other NMBAs was found in 70% of patients allergic to an NMBA. As there is such wide cross-sensitivity between the NMBAs that are associated with anaphylaxis, it is imperative to skin test patients with suspected NMBA-associated anaphylactic reactions, to a range of NMBAs, to try and establish a well tolerated alternative for future general anaesthesia. Vecuronium and pancuronium are NMBAs that can be used for anaesthesia in the future if the probability of their safety has been determined at an anaesthetic anaphylaxis follow-up clinic. This entails reviewing the history and events surrounding the initial reaction, blood testing and skin testing patients with suspected anaphylaxis. A follow-up clinic may then advise that an NMBA is likely to be well tolerated or may advise avoidance of all NMBAs if there is any evidence of cross-sensitivity.

Hospitals appear to be limiting the range of drugs available for routine clinical use for a variety of reasons, often secondary to a decline in use by practitioners. Although vecuronium and pancuronium are available at our Trust, special arrangements have to be made to obtain these drugs in advance as neither drug is routinely stocked within the main operating theatres. Our initial enquiries suggest that the increasing scarcity of both these drugs for routine clinical use is a disturbing trend amongst hospitals in the UK. Treating patients with multiple neuromuscular blocking drug allergies may therefore become a

safety issue when the choice of drugs available is limited; particularly if faced with an emergency patient who requires neuromuscular paralysis, and who is known to be allergic to suxamethonium, atracurium and rocuronium, but in whom the likely safety of vecuronium or pancuronium or both has been shown by follow-up testing and these alternatives are not immediately available.

A further point to consider is that as specific drugs are decreasingly being used, it may not be profitable for the pharmaceutical companies to continue to manufacture them and to renew their product licence. Could this be the fate of vecuronium and pancuronium? Does this jeopardize patient safety?

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Outpatient videothoracoscopic sympathectomy: analgesia and complications

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Editor,

Excessive craniofacial, palmar and axillary hyperhidrosis is a functionally and socially disabling problem of unknown cause that affects young adults in particular. Ablation of the upper dorsal sympathetic chain has been accepted as the treatment of choice for refractory hyperhidrosis [1–3]. Simplification of the surgical technique with a minimally invasive procedure such as thoracic endoscopy [1,3–6] and a suitable analgesic protocol means that sympathectomy can be performed on an outpatient basis [3,5–7].

We present our experience with outpatient bilateral thoracic sympathectomy for hyperhidrosis. We analysed

patient characteristics, analgesia, the incidence of nausea, vomiting and complications (pneumothorax) as well as the number of admissions and readmissions for up to 72 h after the operation.

Twenty-seven patients underwent sympathectomy under general anaesthesia and were followed for a period of 14 months. A double-lumen tube was used to collapse the lung on the side being treated. Anaesthetic induction was carried out with remifentanyl $0.5 \mu\text{g kg}^{-1} \text{min}^{-1}$ over 3 min and 2 mg kg^{-1} propofol; maintenance was followed by an infusion of $0.1 \mu\text{g kg}^{-1} \text{min}^{-1}$ of remifentanyl, 1 minimum alveolar concentration (MAC) desflurane and 0.1 mg kg^{-1} vecuronium. The patient was placed in prone or semi-Fowler's position (15°) depending on the surgeon's preference.

Emetic risk was classified by taking into consideration these factors: female sex, nonsmoker, a history of motion sickness or postoperative vomiting and use of opioids for postoperative analgesia. Antiemetic prophylaxis (4 mg ondansetron 30 min before ending surgery and 4 mg dexamethasone at anaesthetic induction) was administered for patients with three or four risk factors. Antiemetic prophylaxis was not recommended for patients at low or moderate risk (two or fewer risk factors).

Thirty minutes before starting the surgery, 50 mg of dextropropofol was administered; 30 min before finishing the procedure, 1 g of paracetamol was administered. The operative site was infiltrated with bupivacaine 0.25%.

The sympathetic chain and the communicating nerves were ablated at levels in accordance with the site of hyperhidrosis. We monitored palmar skin temperature during sympathectomy. Lung re-expansion was observed by video at the end of each procedure. The thoracic drainage tubes were removed in the operating room and a routine radiograph of the thorax was checked before hospital discharge.

Patients were given a telephone number for contact in case of doubt or problems after they arrived home. All received a telephone call at 24, 48 and 72 h and were questioned on their postoperative course.

All patients also received a prescription for analgesics and a sheet with a list of recommendations. Home analgesia consisted of ibuprofen 600 mg alternating with a tablet combining tramadol (37.5 mg) and paracetamol (325 mg) every 6 h, and a 2-g rescue dose of metamizol.

Complete follow-up was achieved in 100% of patients. Patient characteristics, ASA physical status, duration of surgery and recovery time and number of admissions and readmissions are listed in Table 1. Data are presented as mean $\pm$ SD or numbers of patients.

Table 1 Patient characteristics, complications and admissions and readmissions

Sex, F/M	15/12
Age (years)	32.7 ± 10.2
ASA I/II	19/8
Time under anaesthesia (min)	93.51 ± 31.80
Operative theatre time (min)	53.0 ± 18.3
Recovery room time (min)	299.2 ± 80.4
Nausea	8
Vomiting	5
Pneumothorax	6
Hospital admission	4
Readmission	1

Data are expressed as mean $\pm$ SD or numbers of patients.

All procedures were scheduled on an outpatient basis, although four patients could not be discharged the same day of surgery because of pneumothorax. There were no deaths or major intraoperative complications requiring thoracotomy. All patients had satisfactory dryness of the head, palms, soles of the feet and armpits except for one who complained of incomplete dryness or residual over-sweating of one palm.

The most common complications included six cases of pneumothorax. Considerable pneumothorax ($>30\%$ of the pleural cavity) occurred in two female patients and required a chest drain. The remaining four patients having small pneumothoraces were treated conservatively; two were discharged as planned and two remained in hospital one night. One patient was readmitted from home. He complained of dyspnoea, but pneumothorax was not confirmed.

Seven patients received antiemetic prophylaxis. None of them experienced vomiting, and only one experienced nausea in hospital. Three patients experienced nausea and vomiting within the first 24 h after discharge and one patient between 24 and 48 h. No one required rescue treatment.

Outpatient thoracic sympathectomy was associated with only slight postoperative pain at rest with the prescribed analgesia. The mean visual analogue scale pain scores were 0.6 ± 1.4 on leaving the operating theatre, 2.0 ± 2.2 at 30 min, 1.1 ± 1.3 at discharge, 1.4 ± 1.4 at 24 h and 0.6 ± 0.9 at 72 h. Thus, no patient experienced postoperative pain greater than three, and no supplemental analgesic doses were required.

Bilateral thoracic sympathectomy with videoendoscopic visualization has been reported to be a viable treatment for essential hyperhidrosis. Although the procedure is usually performed in healthy young people, patients routinely stay one night because of pain, nausea or vomiting [1,4].

In our hospital, outpatient scheduling of this procedure was started in 2002. Our study confirms that videothoracoscopic sympathectomy can be performed

safely under these circumstances, consistent with reports in the literature [3,5,6]. Although complications are rare, patients should be clearly warned that it is not a minor procedure [1,4]. Nevertheless, effective analgesia, radiologic follow-up and strict antiemetic prophylaxis measures are recommended [6].

Because of the high incidence of nausea and vomiting in our study, we have reconsidered antiemetic prophylaxis in patients at moderate risk (two risk factors). We also recommend strategies for lowering underlying risk such as using total intravenous anaesthesia, keeping opioid use to a minimum and intravenously administering a large volume of preoperative balanced salt solution [6]. We found no reason to explain the high incidence of nausea and vomiting in these patients other than failure to implement these measures. There might have been an effect of starting to drink in the postoperative intensive care area; however, we could not establish a correlation between start of drinking and the onset of nausea and vomiting.

Thoracic sympathectomy by videothoracoscopy on an outpatient basis can be performed safely if strict control of pain is established and vomiting and surgical complications are avoided. Nevertheless, the anaesthesiologist should be alert to the possibility of serious complications associated with this type of surgery.

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Delayed reversal of a potentiated rocuronium neuromuscular block

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Editor,

Multiple drugs interfere with neuromuscular block (NMB), leading to clinically significant potentiation [1]. This favours postoperative residual curarization, which is a frequent complication in anaesthesia.

Good clinical practice includes the pharmacological reversal of all residual NMB to ensure complete recovery at the time of extubation. If care is taken in the correct dosage of the antagonist and in the degree of spontaneous recovery at the time of its administration, complete reversal is usually obtained within 10 min [2]. Here we report a case of a rocuronium NMB, which needed 85 min for reversal while using a routine reversal strategy.

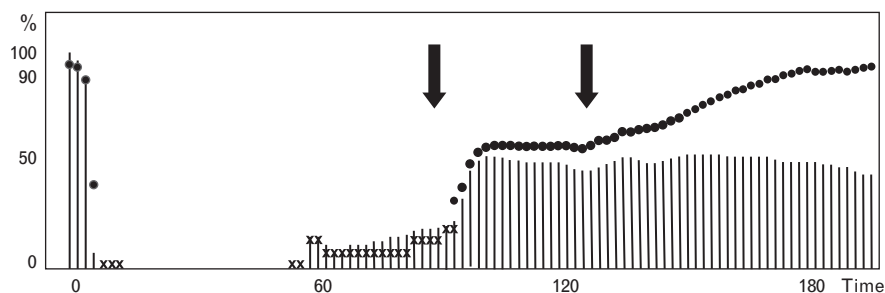
A 58-year-old man (height 168 cm, weight 71 kg, ASA II) was admitted to the operating theatre for an exploratory laparoscopy because of suspicion of a rectal perforation injury. He had a history of depression treated by lithium, venlafaxin, clonazepam and sodium valproate. During a previous anaesthetic for a retinal detachment, he complained of respiratory problems in the recovery room.

Preoperative laboratory investigations showed no abnormality, including normal hepatic and renal functions. The procedure was performed under general anaesthesia induced with sufentanil (10 µg), propofol (150 mg) and rocuronium (35 mg) and maintained with desflurane (end-tidal concentration 6.3–6.8%) in oxygen/air (FiO₂ 50%).

We continuously monitored the NMB with train-of-four (TOF) supramaximal (55 mA) stimulations of the ulnar nerve at the wrist and recording of electromyography responses of the hypothenar muscle with the self-calibrated Datex-Ohmeda NMT module (Datex-Ohmeda, Helsinki, Finland) (Fig. 1). After disappearance of the responses, the trachea was intubated. Surgery took place during uneventful maintenance of anaesthesia. The patient received multimodal analgesia [ketamine (50 mg), magnesium sulphate (MgSO₄, 2 g) and ketorolac (20 mg)] and antibiotics including amoxicillin (2 g) and clavulanic acid (200 mg) after induction and amikacin (1 g) 1 h later.

After close examination and abdominal washing, surgery ended 73 min after induction of anaesthesia. We waited another 15 min to recover the third TOF response before we administered 2.5 mg neostigmine (35 µg kg⁻¹) and 0.5 mg glycopyrrolate. The fourth response reappeared, and the TOF ratio rose rapidly to 58% before stopping at this level of incomplete reversal. To check for malfunction of the electromyographic neuromuscular transmission monitoring unit, we placed a TOF-Watch SX (Organon, Oss, The Netherlands) on the other hand, which confirmed the same results using acceleromyography. The hand temperature was kept above 32°C.

Fig. 1



Adapted from the original recording time (in minutes) of the neuromuscular block (88 min from onset to TOF count three) and its pharmacological reversal (85 min from TOF count three to TOF ratio 0.9 after two 35 $\mu\text{g/kg}$ doses of neostigmine, indicated by arrows); twitch height is represented in percentage of initial calibration by vertical lines; the first, second, third and fourth responses to TOF by crosses; the TOF ratio percentage by closed circles. TOF, train-of-four.

After 30 min at this stable but insufficient level of TOF ratio, we replaced desflurane by a continuous infusion of propofol (300 mg h^{-1}) to accelerate recovery. A second dose of 2.5 mg of neostigmine with glycopyrrolate was administered to reach the maximum dose of 5 mg ($70 \mu\text{g kg}^{-1}$). The TOF ratio rose again and very slowly reached the 0.9 value on both monitors 85 min after the beginning of the reversal process. Propofol infusion was stopped, and the patient was carefully awoken, showing no signs or symptoms of residual paralysis at that moment or later.

There were numerous reasons for the long duration of action of rocuronium in our patient. Similar to other neuromuscular blocking agents, the variability of its duration of action in clinical practice is well known; however, the probability of clinically significant action prolongation was increased in our patient, who was prescribed several drugs with effects on neuromuscular transmission [1].

Although sodium valproate is known to accelerate recovery caused by a possible increased hepatic binding of rocuronium, all other drugs used in this case may have contributed to a significant prolongation of the action of the neuromuscular agent.

Lithium, used as part of the patient's antidepressant therapy, decreases acetylcholine (ACh) release from the presynaptic neuron. MgSO_4 also inhibits the presynaptic release of ACh, and, thus, enhances the effect of neuromuscular blocking agents. Similar to other inhaled anaesthetics, desflurane extends the duration and increases the depth of NMB. Although most antibiotics (including penicillin and beta-lactams) do not have pronounced effects on neuromuscular transmission, some can potentiate the effects of neuromuscular blocking agents, such as amikacin, along with the inhibition of presynaptic ACh release.

Claudius *et al.* [3] advocated a genetically increased sensitivity to rocuronium to explain, in combination with other factors, a prolonged paralysis in an elderly woman. This latest explanation could also be applied to our patient who had already indicated postoperative residual curarization in the recovery room after prior anaesthesia.

In addition to the many reasons explaining the long NMB duration, the case presented here distinguishes itself by its long reversal duration. Other long NMB durations have been described, recovering rapidly after the administration of neostigmine, such as reported by Claudius *et al.* [3] (8 min from two responses to TOF ratio of 0.9 after $50 \mu\text{g/kg}$ neostigmine and atropine). Gilliard *et al.* [4] described a 4 h potentiation of a single dose of rocuronium with amikacin; recovery took place in 10 min with the same therapy.

Fuchs-Buder *et al.* [5] demonstrated the important effect of MgSO_4 on the speed of spontaneous recovery and neostigmine reversal; the delay was explained as a result of slower spontaneous recovery and not decreased response to neostigmine. We agree with their conclusion as we routinely administer MgSO_4 to our patients to improve the quality of postoperative analgesia. Consequently, we are used to managing prolonged NMB, but we have never before noticed such reversal difficulties. The explanation of the long reversal duration presented here probably lies not only in the prolongation induced by MgSO_4 but also in the association of the different drugs used, interacting in one way or another on the neuromuscular transmission.

As part of our routine practice, and conscious of the multifactorial potentiation of the curarization of our patient, we carefully monitored the NMB induced by an intermediate dose of rocuronium (0.5 mg/kg). The clinical duration of the block was effectively extended (88 min instead of the expected 30–40 min). According to

the recommendations of experts, we waited for the third TOF response before reversal. Then, we administered a standard $35 \mu\text{g kg}^{-1}$ dose of neostigmine with glycopyrrolate [2]. The initial improvement in neuromuscular transmission was followed by a levelling off of the TOF ratio at around 0.58. This plateau phase might be explained by the neostigmine 'ceiling effect', most often seen when reversing too deep NMB [6].

As shown for sevoflurane [7], we thought that desflurane might contribute to delaying the antagonism of rocuronium-induced NMB. Consequently, we stopped its administration and replaced it with propofol. At the same time, we administered an additional dose of neostigmine to reach the maximal recommended $70 \mu\text{g kg}^{-1}$ dose [6]. The NMB once more began to recover and slowly rose to a TOF ratio of 0.9, allowing for safe extubation. Our patient's NMB took, overall, 85 min to recover.

Would the administration of the maximum dose of neostigmine and the stopping of desflurane at the start of reversal have shortened the reversal time? Would the simultaneous administration of neostigmine with calcium chloride (1 g) or calcium gluconate (2 g) have improved reversal of the potentiated block induced by amikacin [4]? Would a dose of edrophonium have reversed the block resistant to neostigmine? Unfortunately, this drug is not available in our hospital. One should remember that all of these complementary therapies cannot, alas, guarantee a satisfactory result in all cases, as shown by Hasfurther and Bailey [8] in a patient who received oral neomycin, another antibiotic known to block the presynaptic release of ACh.

Sugammadex might be the future solution for these difficult standard reversals of NMB [9]. As it encapsulates rocuronium, it could completely reverse deep and potentiated blocks much faster than neostigmine. This would be a clear improvement in patient safety.

Until now, despite the use of neuromuscular blocking agents with an intermediate duration of action, post-operative residual curarization remains a frequent recovery room problem. Two complementary actions are recommended for the avoidance of this problem:

- (1) Pharmacological reversal with neostigmine at $40\text{--}70 \mu\text{g kg}^{-1}$. This is best done after recovery of the four TOF responses, without inhaled anaesthetics and following a delay of at least 15 min. That being said and irrelevant to all pharmacological potentiation, some patients fail to recover the TOF ratio 0.9 after 30 min [6].
- (2) Continuously monitoring all NMB by objective means allows the clinician to detect the extended NMB and prevent unexpected residual paralysis at the time of extubation [10]. Objective monitoring is

also an essential guide for the proper reversal of NMB; it determines the minimal threshold of antagonist administration, taking into account the time needed to complete its effect, and ensures full recovery.

Our case emphasizes the difficulty of reversing a rocuronium multifactorial potentiated NMB while using a routine reversal strategy. In fact, antagonist administration does not guarantee complete recovery within a predictable lapse of time; residual curarization is still possible for a long time afterwards. Therefore, when reversing profound or potentiated NMB, objective monitoring of neuromuscular function is required so as to guide the reversal process to complete NMB recovery.

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The value of plasma cholinesterase in children with severe liver disease

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Editor,

Plasma cholinesterase (PChE) is an enzyme (EC 3.1.1.8) that, albumin, is synthesized in the liver and distributed in the plasma. It hydrolyses choline esters, primarily butyrylcholine. The physiological function of PChE is not yet established but some reports indicate that PChE has a role in lipid, especially triglyceride, metabolism [1,2]. PChE activity is affected by many physiological and pathological conditions such as age, sex, pregnancy, puerperium, some drug therapies and diseases, as well as liver disease [3,4]. In adult patients with cirrhosis, the PChE value was less than 50% of the normal individual PChE level [5]. A study has also been carried out into PChE activity fluctuation and monitoring the course of liver function after Kasai portoenterostomy [6]. The aim of our study was to assess the liver function in terms of synthesis in children before liver transplantation or portosystemic shunting.

PChE activity, dibucaine number and albumin concentration were measured in 15 children aged from 9 months to 14 years (nine before liver transplantation and six before portosystemic shunting). Nine children were scored by Child Pugh classification with B degree and six children with C degree of liver damage.

The indications for transplantation (five cadaveric transplants and four liver donor transplants) were biliary atresia (three), choledochal cyst with cirrhosis (two), cryptogenic hepatal cirrhosis (one), α 1-antitrypsin deficiency (one), progressive familial intrahepatic cholestasis (PFIC) type 1 (one), and Crigler–Najjar syndrome type 1 (one).

The indications for portosystemic shunting were biliary atresia (one), portal vein thrombosis (one), portal vein thrombosis after living donor segmental transplantation (one), portal vein cavernoma (two), and congenital hepatic thrombosis (one).

Twenty healthy children undergoing inguinal hernia repair aged from 1 to 14 years were assessed by ASA/Confidential Enquiry into Perioperative Deaths (CEPOD) classifications as grade 1 for elective surgery. Preoperative examinations determined normal clinical status and laboratory values.

In all children, PChE activity, percentage inhibition by dibucaine and albumin concentration were measured prior to the anaesthesiological procedure.

For determination of PChE activity and dibucaine number, venous blood samples (2.0 ml) were collected from the standard inserted cannula for the anaesthesiological procedure. Plasma samples were stored at -20°C until analysed [7].

PChE activity was determined by the spectrophotometric method of Ellman *et al.* [8] using butyrylthiocholine as substrate (Sigma Chem Co., St Louis, Missouri, USA). Dibucaine number was determined at 25°C in phosphate buffer by determining the percentage inhibition of benzoylcholine hydrolysis in the presence of dibucaine (Sigma Chem. Co.). Serum albumin was determined by immunonephelometry as described by Naathelson, using the Behring Nephelometer Analyzer II, Dade Behring (Rueil-Malmaison, France).

The study was approved by the hospital ethics committee.

Statistical analysis included means and SDs of PChE and albumin and *t*-test for comparing the patients and control group. The correlation between PChE and albumin values was expressed by Pearson correlation coefficients. Statistical data processing was done by means of the SAS statistical package (SAS Institute Inc., Cary, North Carolina, USA).

Our results show that children with end-stage liver disease or severe liver disease have significantly lower PChE activity (over 50%) as well as albumin concentration (about 15%) compared with the control group values (Table 1).

Between the two groups, there was no significant difference in percentage inhibition by dibucaine.

The values of PChE activity and albumin concentration were not correlated in patients with liver disease ($r = 0.31$, $P = 0.266$).

Discussion

Many drugs are bound to albumin in the plasma and, in this regard, it is the most important protein, responsible mainly for the binding of acidic and neutral drugs. If a drug is highly protein bound, any change in plasma protein concentration may have clinical effect.

Table 1 Plasma cholinesterase activity, dibucaine number and albumin concentration in patients with liver disease and in patients in the control group

	<i>n</i>	PChE $\mu\text{mol min}^{-1} \text{ml}^{-1}$	Inhibition by dibucaine (%)	Albumin (g l^{-1})
Patients	15	1.96 ± 0.28^a	78.39 ± 3.67	36.54 ± 1.57^b
Control group	20	3.97 ± 0.20	79.20 ± 2.44	42.86 ± 3.94

DF, degree of freedom; PChE, plasma cholinesterase. ^a Significantly different value of PChE in relation to the control value ($t = 25.01$, $\text{DF} = 33$, $P < 0.0001$). ^b Significantly different value of albumin in relation to the control value ($t = 6.51$; $\text{DF} = 26.3$; $P < 0.0001$). ^c *t*-test for unequal variances was applied. Data are means $\pm$ SD.

The preoperatively lower albumin concentration in children with end-stage liver disease or severe liver disease (15% in relation to the control group) could play a part in the degree of protein binding of some anaesthetic drugs, resulting in their prolonged action (increase of free, unbound drug fraction) and delayed onset of action (increase in the volume of drug distribution).

In all children, dibucaine number (percentage inhibition of PChE by dibucaine) was normal and ranged from 78.39 in patients to 79.20 in the control group of patients. We would like to point out that a method such as dibucaine inhibition may easily help in identifying the phenotype in PChE deficiency [9].

Measuring PChE activity by the spectrophotometric method of Ellman is available and provides the opportunity to predict an altered response at least with certain drugs that are metabolized by PChE or drugs that have an inhibitory effect on PChE activity [3].

Measured decreased activity of PChE in children with end-stage liver disease or severe liver disease (over 50% in relation to the control group) can compromise the well known pharmacological role of PChE (ester hydrolysis of local analgesics, mivacurium, succinylcholine, etomidate; anticancer drugs such as methotrexate; the short-acting β -blocker esmolol, etc.).

A patient who is found to have reduced PChE activity and/or structurally abnormal cholinesterase should be given a warning card.

PChE and albumin are synthesized in the liver only by functioning hepatocytes [10]. There appears to be a parallel between both proteins in chronic liver disease [11].

In our study, in children with liver disease, the values of PChE and albumin were not correlated and confirm the data of the independence of PChE and albumin synthesis by the liver [1,6,12].

Our study also indicates that PChE activity reflects more sensitively the degree of synthetic liver function than albumin concentration.

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Intubation in patients with acromegaly: experience in more than 800 patients

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Editor,

We would like to share our experience in intubating more than 800 patients with acromegaly who underwent transphenoidal surgery for pituitary tumours under general anaesthesia during 1995–2008.

In the study conducted by Schmitt *et al.* [1], difficult intubation was found in 33 out of 128 patients with acromegaly (26%). However, in only three (2%) of them, manoeuvres were not effective and intubation was done blindly. The authors finally concluded that ‘the incidence of difficult laryngoscopy and intubation in acromegalic patients is higher than in the normal population and preoperative Mallampati scores of three and four were of value in predicting difficult laryngoscopy’.

Difficult intubation in patients with acromegaly also has been reported in another study by Seidman *et al.* [2]. It is completely rational and conceivable to expect difficult intubation in patients with acromegaly due to macroglossia, vocal cord hypertrophy, and longer thyromental distance (TMD). We do agree with the authors regarding the

inefficacy of TMD in predicting difficult intubation, but we are not sure whether the Mallampati classification [3] would serve as the best predictor of difficult intubation in these patients. Over a 13-year period, most of the time, when assessing preoperative airway configuration, we could score a Mallampati class 3 or 4 and seldom get class 1 or 2 views. Anticipating difficult laryngoscopies, we would prepare a difficult intubation cart in the event of encountering difficulty in visualizing the vocal cords and subsequent intubation. However, to our surprise and delight, we never encountered any impediment in glottis visualization or intubation. The glaring discrepancy of Mallampati class and intubating conditions preoccupied us until we introduced our preoperative airway classification, the upper lip bite test (ULBT) [4]. Henceforth, we started evaluating both the Mallampati classification and the ULBT in our preoperative assessment of patients with acromegaly. Without fail, we would always get an ULBT class 1 or 2 and a Mallampati class 3 or 4, and, despite conflicting results from both tests, the intubation would be easier except in a small number of cases in whom external laryngeal pressure would solve the problem. Owing to the prognathism that patients with acromegaly have, mandibular protrusion is easy and a ULBT class 1 or 2 is achieved without any difficulty. On the contrary, Mallampati class depicts difficult intubation probably due to massive macroglossia, vocal cord hypertrophy, and longer TMD. Mandibular length was infrequently found to be longer in patients with acromegaly (unpublished data), and this factor could serve as the dominating factor in predicting difficult intubation. In our opinion, the longer mandibular length could serve to provide enough space for the huge tongue to be displaced anteriorly in these patients, facilitating good glottis visualization and ease of intubation. The space anterior to the larynx (the mandibular space) determines how readily the laryngeal axis will fall in line with the pharyngeal axis. When the atlanto-occipital joint is extended, this space can be easily measured by the horizontal length of the mandible. In acromegalic patients, the mandibular length is long, pointing towards a large mandibular space, thus affording easy compression of the large tongue into this compartment rather than pulling it forward in order to reveal the larynx.

Another important finding was difficult mask ventilation in a significant number of these patients. In most instances, an oral airway and a jaw thrust could solve the problem. However, in order to avoid disappointments, after preinduction doses of narcotics and benzodiazepines, and later induction doses of thiopental sodium, we would initiate mask ventilation in the apnoeic patients and confirm the feasibility of mask ventilation. If feasible, we would administer a neuromuscular blocking drug and attempt laryngoscopy. In contrast, if mask ventilation was difficult following induction dose of thiopental, we would straight away attempt laryngoscopy and

conduct intubation under lidocaine spray and without a neuromuscular blocking drug. This routine works well and we have adhered to it. As a word of caution, neuromuscular blocking drugs should be totally withheld if mask ventilation following induction doses of thiopental sodium is found to be difficult or else impossible.

Lastly, as the nose is packed, we would extubate the patients while fully awake and obeying commands. In some cases, an adequate oxygen saturation by pulse oximeter (*SpO₂*) could not be attained. In these cases, the large tongue impeded respiration in the supine position. In such cases, a tonsil position or, at best, a prone position helped the patients in performing unimpeded respiration, thus maintaining adequate arterial oxygen saturation.

We cannot give good reasons for the differences between our findings and those of other studies [1,2]. Perhaps Iranian patients with acromegaly undergo early surgery that prevents development of profound structural changes. A randomized controlled trial to compare sensitivity, specificity, and positive and negative values of the ULBT with the Mallampati score in patients with acromegaly is recommended.

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Tracheobronchial thrombus: management of a life-threatening complication of central venous catheterization

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Editor,
Central venous catheterization (CVC) is a routine procedure in the hospital setting but approximately 15%

of patients undergoing CVC experience some sort of complication [1,2]. Infectious, mechanical and thrombotic complications have been described.

We report a case of a 60-year-old man, with diabetes mellitus, ischaemic heart disease, peripheral vascular disease and hypertension, who was admitted for amputation below the knee due to critical limb ischaemia. The patient was put on low-molecular-weight heparin (LMWH). Three days after surgery, the patient complained of chest pain and an acute coronary syndrome was diagnosed.

Double antiaggregation (clopidogrel and aspirin) was added and the patient was transferred to the coronary unit.

In the coronary unit, a right internal jugular vein catheterization was attempted due to difficult vascular access. An accidental puncture of the carotid artery was noticed, promptly followed by haemoptysis, respiratory distress and desaturation.

A catheter was placed in the femoral vein. An endotracheal tube was placed and artificial ventilation was started. A flexible bronchoscopy was performed revealing a partially obstructing clot in the trachea, which was impossible to remove. A rigid bronchoscopy was then started. It disclosed a clot that completely obstructed the trachea. Several attempts were made at removing the clot but only small pieces were initially removed with a forceps. Finally, a clot that was a perfect cast of the tracheobronchial tree was effectively removed (Fig. 1). During the procedure, it became increasingly difficult to ventilate the patient and he developed cardiorespiratory arrest (asystole). Advanced life support was started and return of spontaneous circulation was achieved after two

cycles. No neurological damage resulted from this episode and the patient recovered uneventfully.

The case we report reveals a rare and unexpected complication of a right internal jugular vein catheterization attempt: tracheobronchial haemorrhage and thrombus formation.

A PubMed search did not disclose any similar previously reported case.

The cause of the accident must have been an overlooked tracheal puncture associated with incorrect technique, leading to haemorrhage and clot formation within this organ. Double antiaggregation and postsurgical prophylactic doses of LMWH compounded the severity of the accident by impairing both primary and secondary haemostasis.

Treatment of the life-threatening airway obstruction was achieved by removal of the tracheobronchial clot through rigid bronchoscopy, coupled with standard life-support measures, thus reversing the cause for cardiorespiratory arrest: hypoxia.

Internal jugular vein catheterization is known to be associated with higher probability of arterial puncture than subclavian vein catheterization [3]. Carotid artery puncture is the most frequent complication of internal jugular vein cannulation; however, it seldom is a serious complication as it is amenable to direct compression. The use of a finer needle (22 G) is an additional step to increase the margin of safety should arterial puncture occur, resulting in significantly less bleeding and haematoma formation. Respect for CVC technique and landmarks is essential for an uneventful procedure. Moreover, CVC performed by inexperienced physicians is associated with a higher incidence of mechanical complications [4]. Ultrasonography is increasingly recommended for further reduction of mechanical complications and improved success rates [5,6]. Nevertheless, its routine use is not generalized, which is probably related to cost and training issues.

Airway obstruction caused by the presence of blood clot has been noted as a complication of several different clinical entities. In unstable patients whose airway patency and gas exchange are impaired or seriously threatened, initial efforts at removal of the endobronchial clot should involve flexible bronchoscopic evaluation with physiological saline lavage, suctioning and forceps extraction [7]. Should this approach fail, rigid bronchoscopy allows greater access for suctioning and forceps extraction [7].

In conclusion, CVC complications may be life-threatening. It is important that every effort is made to minimize iatrogeny, especially through adequate training and routine use of ultrasonography. Unlike infectious and

Fig. 1



Thrombus removed from the tracheobronchial tree using rigid bronchoscopy forceps. It is a perfect cast of the tracheobronchial tree.

thrombotic complications, mechanical complications may have a sudden onset and require emergency multidisciplinary medical care.

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