Correspondence

Thoracic epidural analgesia

EDITOR:

We read with great interest the editorial by Kamming and Davies [1] regarding the choice of thoracic epidural anaesthesia in cardiac surgery. While the authors provided an interesting analysis, we believe their conclusion regarding the 50% chance of this technique’s failure warrants further comment.

Kamming and Davies reported that in two large studies [2,3] ‘epidurals have failed to achieve adequate analgesia in between 33% and 50% of patients’. On the basis of these figures and on the apparently high percentage of failure they appear to demonstrate for thoracic epidural anaesthesia, the authors questioned whether patients should in fact be submitted to this kind of anaesthesia. Both of the studies cited by them [2,3] included patients who underwent abdominal surgery. Although not specified in either study, it is likely that the thoracic epidural catheters used during surgery were placed in the middle or lower thoracic region and it is known that the approach to the epidural space is more difficult at these levels than at a higher level in the high thoracic area, for example C7–T3. As a result, we would argue that it is not possible to extrapolate the failure rate of middle thoracic epidurals to high thoracic epidurals.

Additional studies recently conducted on larger and smaller scales confirm a lower percentage of failure in the use of thoracic epidurals for cardiac surgery. Focusing on high thoracic epidurals, Chakravarthy and colleagues [4] found that of 2113 patients submitted to thoracic epidural anaesthesia (C7–T3) for cardiac surgery, there was inability to locate the epidural space or to insert the catheter in 0.9% of the patients and that there was a blood tap in 0.09%; in all the other patients the level of the block was tested preoperatively. In studies involving more than 500 patients, both Pastor [5] and Sanchez [6] experienced a global failure rate around 2.5%. The first author reported ‘nine failed puncture and four failed blocks’, that is the thoracic epidural was correctly functioning in the remaining 508 cases. Sanchez abandoned the procedure in 12 patients because ‘blockade was uncertain’; he found one dural puncture and one unsuccessful catheter placement. Therefore, in the other 557 patients, the epidural block was properly functioning. We reported a successful catheter insertion in 104 out of 106 patients submitted to coronary surgery. The degree of sensory blockade was tested before surgical incision and found to be C7–T1 to T6–T7 in all patients. Moreover, for the first postoperative 24 h, visual analogue pain scores were recorded to be 0.9 at rest and 1.7 during coughing, showing a properly functioning epidural [7].

In addition, in our own centre, we monitored data concerning 677 patients consecutively submitted to high (T1–T3) thoracic block for coronary surgery and we found a failure rate of 6.9%. The reasons for failure include: the inability to find the epidural space (3.8% of patients); the catheter not positioned (1%); and the block not properly functioning (2.1%). In 26% of the patients scheduled for thoracic epidural anaesthesia, the technique was aborted for dural puncture (1%) or blood tap (1%) or for vasovagal reaction (0.6%) during attempts at insertion. Two possible causes could be cited to explain the rate of failure, which is higher than reported by other authors. Firstly, our protocols, which are strictly followed, allow only three attempts to find the epidural space before abandoning the technique. Secondly, and no less importantly, all of the 11 anaesthetists amongst our staff, including the youngest, are experienced. Subsequently, our study reflects the experience of a whole group and not just of a single operator.

We would contend therefore that the risk of failure of a thoracic epidural block and therefore of inadequate analgesia, sympathetic blockade and attenuation of the stress response is much less, around 10% and not 1 : 2 as reported by Kamming and Davies. While we agree that the use of thoracic epidural anaesthesia for cardiac surgery remains subject to debate, we would suggest that the problem lies not in the high failure rate of this technique but in the lack of a multi-centre prospective randomized trial demonstrating a reduction of mortality and morbidity.
Is use of epidural fibrin glue patch in patients with metastatic cancer appropriate?

Epidural blood patch is frequently used to treat symptoms due to accidental dural puncture. However, in patients with cancer, epidural blood patch carries a potential risk of dissemination of neoplastic cells. Alternative treatments using saline and colloid injection into the epidural space have therefore been proposed. Epidural fibrin glue injection may be efficient in case of severe postdural puncture headache resistant to epidural blood patch. Its use in patients with cancer has not been much reported.

We report a case of a postdural puncture headache in a patient with a metastatic lung cancer successfully treated with an epidural fibrin glue injection.

Case report

A 50-yr-old, ASA II woman was scheduled for a left lobectomy for a metastatic lesion of the lung secondary to breast cancer. Before induction of general anaesthesia a thoracic epidural with an 18-G Tuohy needle was performed at T10 for postoperative analgesia. The dura mater was punctured. A new epidural approach at T11 permitted the insertion of a catheter without problem and 5 mg of morphine were injected epidurally. Anaesthesia was induced and maintained with propofol, sufentanil and muscular relaxation obtained with cisatracurium. Left lung resection was carried out without any complications. Postoperative analgesia was maintained for 48 h with two injections of 3 mg of morphine daily. During this period the patient did not complain of headache. The epidural catheter was removed after the fifth morphine injection. A few hours later, the patient complained of a severe fronto-occipital headache. Symptomatic treatment including hydration and analgesics (paracetamol) was ineffective. After discussion of the risks and benefits of epidural blood patch in this case, we proposed an injection of fibrin glue in the epidural space in order to close the leakage. After the patient’s agreement, a new epidural puncture was performed at T10. Fibrin glue (Tisseel™; Tissucol; Baxter Bioscience, Wien, Austria) was injected from a kit containing fibrinogen and thrombin extracted from human being pooled plasma. A double-barrelled syringe with a common piston (Duploject™; Baxter Bioscience, Wien, Austria) was used to enable simultaneous mixture. A special catheter (Duplocath™; Baxter Bioscience, Wien, Austria) shortened and connected to the Tuohy needle, was used (Fig. 1). A volume of 5 mL of fibrin glue was injected without the occurrence of lumbar pain. For 2 h after the injection, the patient remained supine. Afterwards the headache had completely resolved and never recurred.

Discussion

Headaches most likely result from cerebrospinal fluid leak leading intracranial content shift and traction on pain sensitive structures. Epidural blood patch is
Further studies are recommended regarding its safety.

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References

Anaesthetic management of upper oesophageal coins in children

Swallowed foreign objects in children are difficult to manage as there is potential for serious complications. Anaesthesia is required for their removal which can be challenging because of the shared airway. We describe the anesthetic management of three children who presented with a history of swallowing coins.

Case reports

Case 1
A 3-yr-old boy (15 kg) presented having swallowed a coin 6 h prior to admission. He complained of throat

Figure 1.
Fibrin glue epidural injection.

the usually recommended procedure for severe or persistent postdural puncture headaches, which do not resolve after conventional symptomatic treatment [1]. In cancer patients, when performing an epidural blood patch, malignant cells may be directly injected to the epidural space together with the patient's blood. However, the risk of metastatic dissemination which may result from this procedure is unknown and it is not recommended [2,3]. Several alternative solutions using colloid or crystalloid injection have been reported [4,5] but epidural injection of blood or fibrin glue remains the most effective method of treatment [6]. We proposed fibrin glue as an alternative in this case [7,8]. Fibrin glue is widely used in neurosurgery as a method to achieve watertight dural closure. Experimental studies show that cerebrospinal fluid leakage may be treated with epidural fibrin glue [9,10]. When the two solutions one of fibrinogen and the other of thrombin are mixed, fibrinogen is converted to fibrin monomers which produces a plasma clot around the puncture hole [11]. The mixed solution becomes active within 1 min so injection is not recommended through an epidural catheter. No case has so far been documented of viral transmission with fibrin glue.

In conclusion, epidural blood patch remains standard management of persistent postdural puncture headache. However, in patients with cancer, epidural fibrin glue may be an effective alternative although
pain and had developed a cough. X-rays of the neck and chest showed the coin in the neck. He was breathing comfortably and was taken to the operating room for extraction. Using a modified Ayre’s T-piece breathing circuit, anaesthesia was induced with halothane, nitrous oxide and oxygen. Intravenous access was secured and monitoring connected (electrocardiogram and pulse-oximeter). On direct laryngoscopy using a Macintosh Blade size 1, the coin was visualized in the upper oesophagus and was easily removed using Magill’s forceps. The procedure lasted approximately 18 s. Anaesthesia was discontinued and the patient woke up breathing comfortably.

Case 2
A 3-yr and 6-month-old girl (14 kg) had swallowed a coin 8 h prior to admission and presented with cough and hoarse voice. She was breathing noisily with mild chest retraction. The plain radiograph showed the coin in the neck. She was scheduled for urgent removal. Anaesthesia was induced in a similar manner to Case 1 and direct laryngoscopy revealed the tip of the coin only. There was minimal oedema of the glottis. Anaesthesia was deepened and the trachea intubated with a 4.5 mm uncuffed RAE oral tube (Mallinckrodt Anesthesia Division, Mallinckrodt Medical Inc, Athlone, Ireland). Ventilation was assisted and a repeat laryngoscopy permitted the coin to be grasped and removed with Magill’s forceps. Anaesthesia was discontinued and the trachea was extubated once the patient had awakened.

Case 3
A 6-yr-old boy (20 kg) was admitted 6 h after accidental ingestion of a coin. His radiograph taken 5 h prior to admission at a different hospital showed the coin in the upper third of the oesophagus. Anaesthesia was conducted in the same way but the coin could not be visualized on laryngoscopy. The trachea was intubated with a 5 mm cuffed RAE tube and atracurium administered for muscular relaxation. Ventilation was assisted and flexible fiberoptic oesophagoscopy performed with an adult bronchoscope (7 mm diameter). The coin was located at 20 cm and removed by grasping it with biopsy forceps. The procedure lasted 15 min and after another 10 min of ventilation, neuromuscular blockade was reversed with neostigmine and atropine. His trachea was extubated once awake and he made satisfactory recovery.

Discussion
Coins are amongst the most common ingested foreign objects in children [1, 2]. Most of the children are less than 5-yr old [3] though older children do occasionally present with this emergency [4]. The most common sites are the upper third of the oesophagus (64% are in the proximal oesophagus [5]) and in the hypopharynx [2]. The diagnosis is usually made by the history and confirmed by plain radiographs [4]. Coins obscured by the clavicles may be visualized in the Swimmer’s view [6]. One study found radiographic assessment of coin denomination to be reliable, but the denomination that would pass could not be predicted [7]. All of our patients presented with the same sized one-rupee coin. Radiographs should be taken immediately prior to extraction so as to locate the coin and determine the feasibility of its retrieval. In an anteroposterior radiograph coins that are seen ‘face-on’ are more likely to be in the oesophagus, as they cannot pass through the vocal cords in this orientation. This may be confirmed by a lateral film where the tracheal gas shadow is seen anterior to the coin. Radiographs older than 2 h may result in misdiagnoses as the coin may migrate further down.

Considerable debate exists as to the role of conservative management because natural elimination has been reported in up to 46% of patients [5, 7–9] although spontaneous passage occurs least frequently in the proximally located coins [5]. Oesophageal foreign bodies should be removed within 24 h [10] because of the risks of perforation and other complications [2–4]. All patients with suspected or definite coin ingestion should undergo radiological evaluation to determine the location of the coin. Asymptomatic patients may be managed conservatively but should be observed in the hospital and undergo repeat radiographs in 2–5 h [11]. Symptomatic patients should be treated aggressively and immediate endoscopic treatment is the best approach. In children, we advocate removal for all coins in the proximal oesophagus.

Numerous techniques have been described for the removal of oesophageal foreign objects. These include laryngoscopy and removal with Magill’s forceps [1], bougie [12], Foley’s catheter [13], laparoscopic cautery hook [14], magnet [15] or rigid oesophagoscopy [2]. It is important to test the available grasping accessories on a duplicate of the foreign object, as a ‘dry run’ to determine which accessories will grasp them securely [10]. Some of these retrievals may be attempted in the Emergency Department with sedation [16] although we prefer the environment of the operating rooms. In a study of 36 children who had upper oesophageal coins extracted using a Magill’s forceps, all coins were removed without complication in approximately 45 s (33 on the first attempt, three on the second attempt) [17].

The role of the anaesthetist in the removal of oesophageal foreign objects has been previously described [18]. The anaesthetist’s familiarity with the upper airway, skill at laryngoscopy and use of the Magill’s forceps makes their expertise useful in
removing foreign bodies from the upper oesophagus. While surface anesthesia is suitable for adolescents and adults, general anaesthesia with tracheal intubation is desirable for children [19]. Ketamine has also been used [16]. We prefer inhalational induction and maintenance with the patient breathing spontaneously.

Our technique is simple and logical. After inhalational induction, at an adequate depth of anaesthesia we perform a preliminary laryngoscopy. If the coin is seen, its removal is attempted using Magill’s forces. If it is not seen or this fails the trachea is intubated. A further attempt using Magill’s forces may then be considered or we proceed to flexible fibreoptic oesophagoscopy. Occasionally, rigid oesophagoscopy may be required.

The management of children with oesophageal foreign bodies is a challenge to the anaesthetist. Airway protection allows for different strategies and may prevent morbidity associated with inadvertent delays or equipment failures. Avoiding neuromuscular blockade may decrease the further migration of the coin. Patient safety is the cornerstone of successful retrieval.

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Oral piercing: risk of aspiration

Oral piercing is becoming increasingly popular in western culture [1]. Complications may arise during general anaesthesia particularly in the case of oral piercing, there being a risk of trauma, foreign body aspiration and hypoxia, e.g. when airway management proves to be difficult [2–5]. We present the case of an orthopaedic patient who had to undergo elective knee surgery. She was pierced with several peri-oral items of jewellery, which were replaced preoperatively by place holders or so called ‘keepers’.

Case report

A 19-year-old female (59 kg, 164 cm) was scheduled for elective knee arthroscopy and posterior cruciate ligament reconstruction. Her airway was of medium difficulty and the decision was made to perform a general anaesthetic with intubation. A transnasal oro-tracheal catheter was inserted and the patient was given anaesthesia with propofol and remifentanil infusion. At the end of the procedure, she was given 2 mg of glycopyrrolate. After surgery, the patient complained about severe dysphagia, hoarseness, and some difficulty with the swallowing of saliva. A plain chest X-ray was performed immediately and was normal. A flexible fibreoptic laryngoscopy was carried out and normal findings were reported. The patient continued to feel unwell and was transferred to the ward where she was observed overnight. The following day, she was experiencing some hoarseness and a feeling of something in her throat. A second flexible fibreoptic laryngoscopy was carried out and normal findings were reported. The patient was discharged home the same day with no further problems. A check Flexible Laryngoscopy was performed 2 weeks later and no residual foreign bodies or any pathology was found.

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ligament repair. She had no history of clinically relevant diseases and no allergies. Preoperative airway assessment revealed Mallampati class I, normal thyromental distance, good mouth opening and free range of head and neck motion. There were several piercings with material consisting of metal and jewellery (tongue stud, lower lip piercing). After explaining to her the potential risk of the piercings, the patient was asked to remove them for the period of the operation. As the young female was afraid that she would not be able to replace the oral jewellery due to closure of the tissue perforations, she requested that they be replaced with ‘keepers’. In her case these keepers consisted of flexible plastic rods with a plastic bead 6 mm in diameter and a piece of cork at the other end as a retainer. It was agreed that the replacement should be done immediately prior to anaesthesia.

The patient consented for spinal anaesthesia and was premedicated with temazepam 20 mg orally to be administered the evening before and midazolam 7.5 mg orally 1 h prior to anaesthesia. In the induction room, blood pressure monitoring, Electrocardiogram, pulse oximetry and intravenous (i.v.) access were established and a crystalloid infusion started. All piercing jewellery was replaced with the keepers and spinal anaesthesia using 3 mL bupivacaine 0.5% was provided uneventfully. The L3–L4 space was used in the midline and spread of anaesthesia tested by loss of temperature sensation. A block to L1 was established. During the operation, the patient started to complain of discomfort and pain at the operation site, and 0.1 mg fentanyl was given i.v. As analgesia was still not satisfactory, it was decided to induce general anaesthesia and maintain the airway using a laryngeal mask (LM). The patient was oxygenated by a face mask, and another 0.1 mg fentanyl was given. The tongue rod was removed and a ‘loop’, a ribbon of rubber, was inserted, while the rod and cork retainer below the lower lip was kept in place. Anaesthesia was induced with propofol 150 mg i.v. and the patient was ventilated via a face mask uneventfully. An LM size 3 was successfully inserted on the first attempt without any problems. While fixing the LM by tape, however, it was noted that the cork retainer below the lower lip was missing.

The operation continued while we performed a fiberoptic bronchoscopy in order to exclude endotracheal aspiration of the missing foreign body. To our surprise, the cork retainer was found within the LM ‘cage’ and could not be removed with the bronchoscope (Fig. 1). Twenty minutes later, surgery was completed and the mask was carefully withdrawn with the patient awake and the missing cork retainer was still within the LM. The keepers were replaced by the original jewellery a few hours later, and the postoperative course was uneventful.

Discussion

Previous reports on the potential danger of oral piercing during anaesthetic procedures describe complications such as upper airway bleeding or tissue oedema [2–7]. They usually occurred because the jewellery was left in situ during airway instrumentation. In the present case, we therefore took precautions to avoid such risk but considered the patient’s concern on unwanted tissue closure. We used plastic keepers and a spinal anaesthetic. It was due to an unexpected change in anaesthetic management that the patient then became prone to the risk of endotracheal aspiration of a cork retainer of the keeper.

It is likely that the cork piece that retains the plastic rod was itself displaced and separated from the plastic rod during insertion of the LM. It was then caught by the soft bars across the LM orifice and fortunately was trapped within the lumen. It is also possible that the cork retainer was displaced during ventilation with the face mask, which was retained in the airway filter above the mask and caught by the LM once the filter was connected to the LM.

The risk of upper airway jewellery causing trauma or aspiration during airway management is obvious. Endotracheal aspiration or oesophageal ingestion of small items may cause tissue perforation, bleeding, obstruction and further complications. Although the danger of trauma may be reduced by place holders made of plastic or cork, there still remains the risk of pulmonary aspiration and related complications. An additional risk is the low radio-density of such keepers, which would make them difficult to localize by chest radiography [6]. In our case, we had to balance these risks inherent with the place holders within the upper airway with the wishes of our patient. We
therefore decided to tolerate the place holders and perform spinal anaesthesia. The insertion of an LM in patients with peri-oral piercing jewellery may be current practice [7].

We conclude that piercing jewellery along or near the upper airway as well as place holders have to be seen as a potential danger to the patient independent of the anaesthetic procedure. Anaesthetists may be confronted with an increasing number of patients with oral piercings who request not to have the material removed for the operation. This individual wish has to be weighed against the risks of tissue trauma and pulmonary aspiration. We strongly suggest that for safety reasons all patients undergoing anaesthesia have to remove any peri-oral piercing material and may replace it temporarily by loop strings, but not keepers.

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Allergic reaction to hyaluronidase in cataract surgery

EDITOR:
Thiomucase® injectable is a pharmaceutical product containing hyaluronidase, a mucopolysaccharidase obtained from bovine testicles. Hyaluronidase breaks down hyaluronic acid, a key component of connective tissue, reducing viscosity and facilitating drug absorption [1]. Hyaluronidase has many clinically proven indications [2]: plastic surgery, ophthalmology and in dental anaesthesia as a spreading agent to facilitate local anaesthetic block. In paediatric oncology it facilitates drug penetration in chemotherapy [3]. Only a few cases of allergic reactions associated with hyaluronidase have been reported. In our hospital we have had only one case in 3285 ophthalmological surgical operations in 2 yr. We report a case of allergic reaction to hyaluronidase in a patient scheduled for cataract surgery.

A 71-yr-old male was admitted for cataract surgery. His surgical history included an uneventful transurethral removal of the prostate under spinal anaesthesia 5 yr before. He had no history of atopy or drug allergy. After intravenous (i.v.) administration of alfentanil 150 µg and propofol 25 mg a peribulbar block was performed using bupivacaine 0.5% 5 mL and mepivacaine 2% 5 mL with the addition of hyaluronidase 1 mL (100 IU). The patient developed a generalized rash, pruritus and periorbital oedema immediately after the injection. The operation was cancelled and hydrocortisone 100 mg and deschlorpheniramine 5 mg were administered i.v. All the symptoms disappeared within 6 h. Two hours after the reaction only the urinary methylhistamine level was positive: 215 µg mL$^{-1}$ (normal range up to 115 µg mL$^{-1}$). All other tests for allergy (complement factors C3, C4, C3a, latex specific IgE and serum tryptase level) were negative. Six weeks after the reaction allergic skin tests (prick test) to hyaluronidase were positive. Hyaluronidase SDS-PAGE immunoblotting revealed two IgE-binding bands of 35 and 36.4 kDa, respectively. Skin tests to bupivacaine, mepivacaine, alfentanil and propofol were negative.

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Peribulbar block with the association of hyaluronidase and local anaesthetics is a common practice in ophthalmic surgery. In ophthalmic surgery, allergic reactions to hyaluronidase are uncommon. In spite of this, four cases of early and local reactions in which symptoms disappeared rapidly after i.v. administration of antihistamines and corticosteroids [4–7] and one of the delayed reactions 28 h after hyaluronidase administration have been also reported [8]. Szepfalusi and colleagues [3] described five cases of serious systemic reactions after i.v. administration of hyaluronidase for treating central nervous system tumours. Apart from ours, this is the only other study which has described the molecular mass of the protein fraction involved: two IgE-binding bands of 73 and 41–43 kDa. Allergic sensitization by previous exposure is an essential event to suffer from an IgE-mediated reaction after drug administration, but unlike other published cases [5,7] our patient had not been previously treated with hyaluronidase.

We conclude that allergic reactions to hyaluronidase in ophthalmic surgery are rare and difficult to diagnose. Anaesthetists and ophthalmologists should be aware of the potential complications of this drug. Anaphylaxis to hyaluronidase in ophthalmic anaesthesia is usually IgE-mediated; nevertheless, it could produce a dangerous increase in intraocular pressure. Serious anaphylactic reactions have only been reported when hyaluronidase was administered i.v.

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References

Intermittent manual positive airway pressure for the treatment and prevention of atelectasis

There is growing interest in noninvasive positive pressure ventilation as the primary approach for ventilatory support in numerous clinical settings [1] including the management of spinal cord injury [2]. Continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BIPAP) are the mainstays of those interventions and several types of masks (full face masks, nasal masks and helmets) are successfully used [3]. This case report demonstrates the feasibility and successful use of intermittent manual positive airway pressure (IMPAP) for the treatment and prevention of atelectasis in spontaneously breathing critically ill patients.

Case report

A 48-yr-old female was admitted to the intensive care unit (ICU) after drainage of a spontaneous C5 to C7 epidural and paravertebral abscess. There was pronounced weakness in her right leg (0–1/5) and in her left leg (3/5). She also exhibited bilateral arm weakness

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(4/5). As more than half of the key muscles below the neurological level had a muscle power grade of 3 or more she was classified as Grade D on the ASIA impairment scale [4]. Previously, she was healthy and had only received acupuncture treatment for spastic neck pain in the past.

At the end of surgery she was extubated in the operating room after reversal of neuromuscular blockade (train of four, TOF ratio > 95%). She was following commands and able to sustain tidal volumes of 450 mL with a respiratory rate of 15 min \(^{-1}\) meeting extubation criteria as described by Meade and colleagues [5].

After about 1 h in the recovery room, she showed signs of respiratory distress and increased work of breathing with a respiratory rate of 40 min \(^{-1}\). Her \(\text{SpO}_2\) was 93\% on a high-flow face mask and she was transferred to the ICU for further monitoring and treatment.

A chest X-ray on arrival in the ICU demonstrated reduced right lung volume and significant air space disease. She did not have signs of stridor, but there were concerns of upper airway swelling expressed by the neurosurgeon. She also had problems clearing secretions. Transthoracic echocardiography was performed to rule out bacterial endocarditis as part of a focus search and revealed good left ventricular function, no signs of valvular dysfunction or vegetations, no pulmonary hypertension and no diastolic dysfunction. Diaphragmatic function appeared normal by ultrasound examination.

The patient was treated with morphine, 1–2 mg intravenously as required for pain and agitation, oxygen by face mask, oral and tracheal suction of secretions, 0.2 mg of glycopyrrolate to reduce secretions and 8 mg of dexamethasone to reduce soft tissue swelling. Empiric antibiotic treatment for her epidural abscess had already been started with vancomycin and gentamicin and was later changed to nafcillin according to the wound and blood culture results showing methicillin sensitive \textit{Staphylococcus aureus}.

Chest physiotherapy and incentive spirometry (5000 Voldyne Volumetric Exerciser\textsuperscript{\textregistered}; Hudson RCI, Temecula, CA, USA) were initiated but the patient had problems utilizing the spirometry device and no improvement was seen. A slight worsening of the right lung air space disease was diagnosed on a consecutive chest X-ray. The patient suffered another episode of desaturation into the low 70s, which was successfully treated with short-term manual positive airway pressure via an inflatable bag and mask system (Hyperinflation Bag System\textsuperscript{\textregistered}; Vital Signs Inc, Totowa, NJ, USA). At this time, IMPAP with the inflatable bag and mask system for 5 min every hour by an experienced respiratory therapist was initiated. The mask was held tight to let the bag inflate and pressure was applied gently by hand assisting the spontaneous breaths of the patient. The application of the standard full CPAP face mask would have been difficult because of the presence of a cervical collar. A nasal CPAP mask was considered but the patient already showed anxiety with the elastic strap of a conventional oxygen face mask and displayed signs of claustrophobia. She also stated that she would not want a ‘machine breathing for me’, so the decision was made to use IMPAP instead of continuous CPAP or BIPAP.

Her oxygen saturation rapidly improved over the following hours and remained above 95\% on 2 L min \(^{-1}\) oxygen via nasal cannula for the first 2 days and room air on the 3rd day. Her respiratory rate normalized to 12–18 breaths min \(^{-1}\). The chest X-ray after 12 h showed complete resolution of the right lung air space disease and normal aeration of both lungs.

The patient tolerated the IMPAP well and the interval was prolonged to 2 h, then later to 4 h. There was no recurrence of atelectasis during her 3-day stay in the ICU.

**Discussion**

The development of atelectasis can be a major problem in post-surgical patients admitted to the surgical ICU secondary to underlying pulmonary or neuromuscular disease or sedation. Especially with spinal cord injuries, neuromuscular weakness of the ‘breathing pump’ is quite frequently seen [6,7]. IMPAP can be an alternative to continuous CPAP or BIPAP in selected patients especially if patients do not tolerate the masks needed for continuous therapy as was the case in our patient. IMPAP can be established at the bedside, without any further technical device than an inflatable bag and mask system. The application of the mask and positive pressure by the bag, although not measurable as with the mechanical CPAP/BIPAP devices, seems to be more comfortable for patients who have a history of anxiety disorder, phobias or agitation. The personal attention of the caregiver during IMPAP also plays an important psychological role. IMPAP may also be considered post-extubation in patients after prolonged weaning in an effort to prevent the formation of atelectasis [8,9]. Controlled studies might be warranted to compare this modality to continuous or intermittent CPAP/BIPAP after weaning from mechanical ventilation and successful extubation.

Although the applied pressure during IMPAP cannot be measured using most commonly available commercial inflatable bag/mask systems for adults, the risk of barotraumas to the lung or inflation of the stomach seems to be relatively low, especially when used in awake patients who will signal uncomfortable high airway pressures. The use of an inline manometer would be helpful in providing consistent measured
insufflation manoeuvres. Compared to some rather tight mechanical systems with full face masks or hoods, the close attendance of the caregiver and observation of the patient comfort level during IMPAP might actually decrease the complication risk because pressure can be immediately released by simply lifting the mask. Those factors, however, restrict its use to experienced doctors, nurses or respiratory therapists but not necessarily to an ICU setting. Based on theoretical concerns of increased absorption atelectasis from high inspiratory oxygen concentrations \[10\], the optimal inspired oxygen concentration for IMPAP might be around 50% if no higher concentration is needed to maintain adequate oxygenation.

Our case report illustrates that a low-tech solution such as IMPAP can be helpful in the treatment and prevention of atelectasis in selected patients and that the human factor of administration should not be forgotten, especially in patients with underlying psychological problems or acute traumatic stress reactions.

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