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CASE REPORTS / CASE SERIES

Airway management options in a prone achondroplastic dwarf with a difficult airway after unintentional tracheal extubation during a wake-up test for spinal fusion: To flip or not to flip?

Options de gestion des voies aériennes chez un patient en procubitus atteint de nanisme achondroplastique avec intubation difficile après extubation trachéale accidentelle au cours d'un test de réveil pour fusion vertébrale: tourner ou ne pas tourner?

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Abstract

Purpose *To present a case of unintentional tracheal extubation in a prone positioned patient with a known difficult airway.*

Clinical features *This case report describes the unintended tracheal extubation of an achondroplastic dwarf with kyphosis undergoing spinal fusion and instrumentation. The patient had a history of obstructive sleep apnea and a difficult airway requiring fibreoptic-guided tracheal intubation through an air-Q™ supraglottic airway device. Abrupt head movement during a wake-up test to evaluate lost motor-evoked potential signals resulted in dislodgement of the tracheal tube. Airway obstruction was evidenced by rapid oxygen desaturation and the absence of end-tidal capnography waveforms despite apparent chest excursions. An air-Q was used for successfully rescuing the airway and quickly re-establishing oxygenation and ventilation, which eliminated the need for emergent supine positioning for airway management. The air-Q was then used as a conduit for fibreoptic-guided tracheal intubation while the patient remained in the prone position.*

Conclusion *This case highlights some of the safety advantages of supraglottic airway devices for airway rescue and subsequent tracheal intubation even with the patient in the prone position. The use of an air-Q may have the advantages of not requiring an intubation introducer technique and allowing for direct tracheal intubation with an appropriately sized cuffed tracheal tube.*

Résumé

Objectif *Présenter un cas d'extubation trachéale accidentelle chez un patient en procubitus présentant des difficultés d'intubation connues.*

Caractéristiques cliniques *Ce rapport de cas décrit l'extubation trachéale accidentelle d'un patient atteint de nanisme achondroplastique avec cyphose au cours d'une fusion vertébrale avec pose d'appareillage. Le patient avait des antécédents de syndrome d'apnée du sommeil et des voies aériennes complexes nécessitant une intubation trachéale guidée par bronchoscope à fibre optique via un dispositif supraglottique air-Q™ pour les voies aériennes. Un mouvement brusque de la tête au cours d'un test d'éveil destiné à évaluer les signaux des potentiels moteurs évoqués a entraîné le déplacement du tube trachéal. L'obstruction des voies aériennes a été mise en évidence par la désaturation rapide en oxygène et l'absence d'ondes de capnographie, en dépit de mouvements respiratoire apparents du thorax. Un air-Q a été utilisé pour rouvrir avec succès les voies aériennes et restaurer rapidement l'oxygénation et la ventilation, ce qui a éliminé le besoin*

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urgent d'un changement de position en décubitus dorsal pour reprendre le contrôle des voies aériennes. L'air-Q a alors été utilisé comme guide pour réaliser l'intubation trachéale avec bronchoscope à fibre optique pendant que le patient est demeuré en procubitus.

Conclusion *Ce cas souligne certains des avantages en termes de sécurité des dispositifs des voies aériennes supraglottiques pour le sauvetage des voies aériennes suivi de l'intubation trachéale,même chez des patients en procubitus. L'utilisation d'un air-Q pourrait avoir comme avantage de ne pas nécessiter une technique avec introducteur pour l'intubation, et de permettre une intubation trachéale directe avec un tube trachéal avec ballonnet de taille appropriée.*

Supraglottic airway (SGA) devices have become indispensable to the practice of anesthesia. Practical applications for SGAs range from routine airway maintenance to airway rescue, in addition to facilitating tracheal intubation.[1] Their utility in challenging scenarios involving mask ventilation and tracheal intubation has been well described.[2,3] Conventionally, airway management is performed with the patient in the supine position, but some of the same principles of the difficult airway algorithm can be applied for prone patients requiring immediate airway rescue.

Emergency management of an unintended tracheal extubation with the patient in the prone position and a difficult airway can be a potentially disastrous scenario. We present a case where the air-Q^{TM} (Mercury Medical; Clearwater, FL, USA) SGA was used to rescue a known difficult airway in a patient in the prone position after inadvertent tracheal extubation during a wake-up test for lost motor-evoked potentials (MEPs).

Case report

An obese 11-yr-old female (weight, 39 kg; height, 105 cm) with a history of achondroplasia with kyphosis was scheduled to undergo a T7-12 posterior spinal fusion with posterior vertebral resection, spinal osteotomy, and instrumentation. Her disease process was associated with restrictive lung disease, progressive bowel and bladder incontinence, and baseline lower extremity parasthesias and weakness. Additional medical history included hypertension and obstructive sleep apnea (OSA) requiring nocturnal continuous positive airway pressure (CPAP) support. Her airway examination revealed course facial features, limited mouth opening, short neck, and macroglossia.

After induction of anesthesia with propofol and neuromuscular blockade with rocuronium, mask ventilation was easy with an oropharyngeal airway. Direct laryngoscopy with a Miller blade revealed no clear view of the larynx. Furthermore, an adequate view of the larynx with a GlideScope® (Verathon Medical; Bothell, WA, USA) was not possible due to the patient's macroglossia and limited mouth opening. The air-Q supraglottic airway was then easily placed, allowing for adequate ventilation and a conduit for fibreoptic-guided tracheal intubation with a cuffed tracheal tube. Successful tracheal intubation was confirmed, and the air-Q was removed using a removal stylet. The ProneView® Helmet and Mirror System (Mizuho OSI, Union City, CA, USA) was used to support the patient's face during the prone procedure on a Jackson table. Sevoflurane (0.5 MAC) together with fentanyl and propofol infusions were used with satisfactory monitoring of motor and somatosensory-evoked potentials.

The case proceeded uneventfully until spinal instrumentation. Motor-evoked potential signals were lost with the placement of the rods and set screws. Blood loss had been minimal, and the patient's hemodynamic status was stable and unchanged throughout the procedure. Loosening the instrumentation and decreasing the anesthetic depth did not improve the MEP signals, and the surgeon requested a wake-up test. About ten minutes after all anesthetics were discontinued, and despite no return of spontaneous respiratory effort, the patient abruptly raised her head. The breathing circuit became trapped under the ProneView helmet and led to dislodgement of the tracheal tube. The patient did not make any other head movements and was not yet awake enough to follow commands. The loss of end-tidal carbon dioxide and rapid oxygen desaturation ($SPO_2 < 70\%$) despite chest excursions noticeable to the surgeon was concerning for tracheal extubation with significant airway obstruction. An assistant kept the patient's head elevated and rotated to the side for airway management. Physical causes of obstruction, such as a kinked tracheal tube, were quickly ruled out, and the tracheal tube was removed from the oropharynx. Mask ventilation was attempted but unsuccessful. A bolus of propofol was then given to facilitate placement of an air-Q, and ventilation and oxygenation were quickly re-established. After fibreoptic confirmation of adequate alignment of the air-Q for tracheal intubation, a dose of succinylcholine was administered to avoid laryngospasm and to minimize the delay for motor function recovery for MEP monitoring and wake-up testing. The patient's trachea was successfully reintubated with fibreoptic assistance while she remained in the prone position. The case was continued with both the air-Q and tracheal tube secured in place and with the

Table Practical advantages and limitations of airway management strategies after unintentional tracheal extubation in a prone patient with a difficult airway

Position	Airway Management strategy	Advantage(s)	Limitation(s)
Supine	*Attempt placement of a SGA in the prone position prior to repositioning Reposition supine • Pack surgical field with *x-ray* detectable sponges or towels • Cover patient with sterile drape • Cover bed to be transferred onto with sterile drape	• Familiar setting for airway management • No special alteration of airway management techniques needed	• If unable to first place an SGA, potential for prolonged hypoxemia and delayed oxygenation • Potential injury to spinal cord (spine surgery) • Risk for contamination of surgical field
Prone	SGA	• Easy to insert and allows for immediate oxygenation/ventilation of the lungs • Can be placed in prone position • Spontaneous and mechanical ventilation are possible • Option to facilitate tracheal intubation	• Pulmonary aspiration risk if SGA is used alone without intubating the trachea • Narrower diameter SGAs may require use of an intubation introducer technique
	Wake up patient	• Maintenance of spontaneous respiratory effort	• May not be feasible if significant airway obstruction is present • Limited by oxygen saturation of patient • A cooperative patient is needed • May need to re-induce anesthesia for definitive airway management
	Video laryngoscopy	• Gravity effect may help with tongue displacement for video laryngoscopy	• May be difficult/impossible to perform in the prone position • Access to the head and neck would depend on the positioning of the patient and the table used for the procedure
	Surgical airway	• A definitive airway intervention	• May be difficult/impossible to perform in the prone position

SGA = supraglottic airway

patient's head turned to the side and cradled on the ProneView cushion without the helmet. On subsequent wake-up tests, her head was elevated and supported by an assistant while the anesthesiologist manually stabilized the tracheal tube without further incident. The patient was consistently able to follow commands and demonstrate upper extremity coordination with only partial lower extremity movement during wake-up testing but without recovery of her MEP signals. Given the patient's potential for airway swelling related to a lengthy procedure in the prone position, her history of OSA, restrictive lung disease, difficult tracheal intubation, and concerns for adequate pain control, the decision was made to maintain tracheal intubation for the immediate postoperative period. A removal stylet was again used to remove the air-Q without difficulty once the patient was supine.

Tracheal extubation was performed successfully in the intensive care unit on postoperative day one, and her baseline CPAP regimen was restarted without any problems. Some improvement in the patient's lower extremity motor and sensory function was seen during her hospitalization, and she was transferred to an inpatient rehabilitation facility for further care.

Discussion

Challenges for this case included a known difficult airway; oxygenation and ventilation of a prone patient with an unsecured, obstructive, and edematous airway; loss of MEPs during instrumentation; and the need for wake-up testing. The first question to consider might be the feasibility or practicality of positioning the patient supine for the purposes of airway management. This process, however, can be precarious and less than ideal, with delayed oxygenation, prolonged hypoxemia, and an

increased risk for mechanical injury to an already compromised spinal cord. If emergent repositioning (i.e. flip) to the supine position is needed, expeditious precautions to minimize surgical wound contamination should be employed (Table). This would include packing the surgical wound with *x-ray* detectable sponges or towels and covering the patient and bed with sterile drapes. Another option may be to awaken the patient completely in the prone position if oxygen saturation permits. This may be possible only if the patient is breathing spontaneously without evidence of airway obstruction. A third option is to use an SGA for airway rescue, which can be effective even in a prone patient.[4,5] Once oxygenation is restored, emergent repositioning to supine may not be necessary, and the procedure may be completed with the SGA in place and the patient's head turned to the side.[6] Considerations for this option include the potential for aspiration in a patient with risk factors and the possibility of reflex airway activation if light anesthesia is needed for monitoring purposes. We chose to reintubate the trachea through the air-Q for airway protection during ongoing MEP monitoring and wake-up tests and for postoperative ventilation. The Table summarizes the airway management strategies for inadvertent tracheal extubation in the prone position.

The SGAs with a larger diameter shaft (air-Q, Ambu® Aura-i™) to accommodate larger cuffed tracheal tubes may have specific advantages for tracheal intubation over other traditionally utilized SGAs[7,8] (LMA-Classic™ and LMA-ProSeal™), which may require an intubation introducer technique[9] to utilize appropriately sized cuffed tracheal tubes. This technique may also be more challenging with the patient in the prone position, particularly when edema may hinder passage of the tracheal tube in an already obstructive airway. Therefore, it is conceivable that the use of an SGA for direct tracheal intubation may bypass edema and obstruction by providing a patent path to the laryngeal inlet. The LMA-Fastrach™ may be utilized for rescue ventilation and tracheal intubation, but it may be more difficult to place with the patient in the prone position due to its rigid and bulky design. Additionally, this device is available only in adult sizes and is less compressible than an air-Q of similar size, which further limits its use in patients with a smaller mouth opening.

During wake-up testing, it may also be advisable to consider elevating the patient's head pre-emptively and reconnecting the circuit above the ProneView cushion to reduce the risk of tracheal tube dislodgement. This may necessitate a second assistant to support the patient's head while the anesthesiologist maintains control of the tracheal tube.

In conclusion, there are several advantages for keeping SGAs readily available during a prone case. Analogous to airway management in the supine position, they offer a practical solution for airway rescue and immediate oxygenation when mask ventilation may not be straightforward or possible in the prone position. By providing a conduit for fibreoptic-guided tracheal intubation, the need for emergent supine repositioning, which can be risky, may be avoided entirely. Additionally, it may be beneficial to use an SGA that can accommodate an appropriately sized cuffed tracheal tube to manage a difficult airway with the patient in the prone position as it provides a means for direct tracheal access without the need for an intubation introducer.

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