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When the end is really the end? 
The extubation in the difficult airway patient

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ABSTRACT
Difficult airway management remains one of the most important sources of anesthesia related accidents; recent reviews and dedicated guidelines suggest that not only intubation, but extubation too is a critical phase in terms of potential accidents and serious complications. This paper will highlight some fundamental concepts regarding extubation related problems, focusing particularly on epidemiology, risk factors and time course of difficult extubation, suggesting some conceptual points to plan and manage patients in which a difficult extubation might be expected, including parameters and test to be performed to assess and predict such a situation. (Minerva Anestesiol 2013;79:194-9)

Key words: Airway extubation - Catheter - Airway obstruction.

Difficult airway management (DAM) is known to be one of the most fascinating and challenging tasks for anesthetists, remaining one of the most dangerous sources of anesthesia related critical accidents.1, 2

Data from other countries, particularly the USA,2 highlight a very interesting concept: incidence of fatal airway accidents during anesthesia induction, including death or brain damage, is twice the incidence than of intraoperative, extubation and postanesthesia phases. After ASA Guidelines the incidence of accidents was reduced by half for anesthesia induction, while it remained unchanged for all other phases, indicating that extubation still remains a critical moment and that a lot of work is yet to be done to increase the safety of postanesthesia course.

Starting from these points of view, the present experts’ opinion will elucidate some crucial points regarding the extubation of the difficult airway: epidemiology of difficult extubation; patients and risk factors for difficult extubation; time course of difficult extubation; the protected extubation concept (techniques, devices and strategies).

Epidemiology of difficult extubation

According to ASA Closed Claims data, extubation related problems occur up to 12% of postoperative cases.1 A recent review3 suggests that a Medline search up to June 2009 produced more than 6000 calls in PubMed, with only 46 studies selected as suitable to draw out some kind of recommendations. A similar search, performed in the context of the very recent Difficult Airway Society (DAS) Guidelines for the management of difficult extubation 4 and updated to June 2011, produced 327 useful abstracts above more than 6200. The conclusion that might be drawn is that we have many different type of papers including case reports and experts’ point of view, few systematic reviews, very few evidence based medicine studies and just a couple of Recommendations documents.4, 5 including a dedicated paragraph in SIAARTI Difficult Airway Guidelines.6
Which is the real incidence of extubation related accidents in Italy? We do not have an answer, actually, for at least two reasons: the first one is represented by the lack of national registries, audits — such as the National Audit Projects 7 or insurance databases access, and the second is the “near miss phenomenon”,8 accounting for a certain number of accidents to remain undisclosed or undetected due to individual reluctance to share them.

What we know is that difficult extubation is probably a main concern in the postanesthesia care unit (PACU) or the intensive general care unit (ICU),9 with a lower occurrence in the operating room, as generally difficult-to-intubate patients after surgery are cautiously extubated in protected settings starting from the concept that after a difficult intubation, a difficult extubation should be expected and planned.10

Only rarely extubation difficulties might result in serious damage, or even death, while in the large majority of cases these extubation accidents result in acute and low complication rate (though very stressful) situations. This is probably why it results so difficult to establish correct epidemiologic data regarding this quite common but extremely variable problem.

Patients and risk factors for difficult extubation

Experience and Difficult Airway Guidelines taught us how to identify a difficult to intubate patient, and a large amount of literature identifies anatomical and functional factors to preview a difficult intubation/ventilation, suggesting specific predictive tests. Is there anything similar for difficult extubation prediction? Citing Cooper affirmation that: “Each tracheal extubation is a potential re-intubation; each reintubation is a potential challenge, even if the same intubation was previously managed easily and uneventfully”,11 we might admit that every patient receiving tracheal intubation is at risk. This would result in an unaffordable patients management, while we rather need to define at least “increased risk” patients for extubation difficulties.

One more thing we must keep account of is that, despite being aware of a certain though not measured risk of complication occurrence (desaturation, laryngospasm, airway obstruction and vomiting)12 during tracheal extubation, we forget that the challenge of an airway, might it be difficult or not, starts with difficult intubation, and only apparently ends there. Extubation and the immediate postoperative period are certainly high-risk situations in all cases of difficult intubation, but they can occur also in “easy” patients, becoming even more dangerous as the unexpected occurs when tension has vanished, when danger awareness has faded, attention is low and the airway cart may be far from where it is urgently needed.

Recent papers3-4 identify some risk factors for potential difficult extubation, with the common limitations of this kind of approach, which accounts for a certain rate of false positives.

Within the critical factors we should consider:

— known difficult airway;
— severe airways anatomical abnormalities, including scars, burns or previous radiotherapy;13
— severe underlying cardiopulmonary disease (low apnoea/hypoxemia tolerance);
— severe obesity, including Obstructive Sleep Apnoea Syndrome (OSAS);14
— specific comorbidities: severe gastro-oesophageal reflux disease, high risk for inhalation;
— scheduled surgery and airway manoeuvres: all patients undergoing head and neck surgery should be considered at different level of risk for problematic extubation accordingly type of surgery they are submitted to. Posterior fossa neurosurgery,15-17 total thyroidectomy (which might account for 10.6% of recurrent nerve lesions and for postoperative hematoma),18-20 laryngeal surgery (postoperative nerve lesions and haematoma occurrence: 0.1-1.1%),11 neck surgery, including neck great vessels surgery (with particular reference for carotid ideal surgery), temporomandibular joint and maxillo-facial surgery,21,22 tracheal resections,23 head and neck abscesses evacuation, shoulder arthroscopic prolonged procedures, cardio-thoracic24 prolonged procedures, can all be considered situation at high risk for severe, acute and sometimes delayed extubation problems.

The common point for most of the postopera-
tive situations mentioned above is represented by haematoma and postoperative oedema occurrence. As an example, if we consider carotid surgery, literature describes an occurrence of tracheal re-intubation of around 1-3% due to neck swelling,\textsuperscript{11, 25} with 1-4% if considering thrombo-endarterectomy and re-intubation due to soft tissues swelling and edema.\textsuperscript{26, 27}

The latter might develop both rapidly or slowly within hours, with a direct compressive effect or in a progressive soft tissues imbibition resulting in limited venous and lymphatic return and blood-derived local osmotic effect.\textsuperscript{28} Such a situation might represent a critical periestubation problem made more dangerous because of restricted pharmacologic opportunities: as an example, steroids, which are known to reduce airway oedema from direct airway injury, do result fully effective only if administered with convenient time interval, and in any case they do not show significant effect on mechanical oedema resulting from obstructed venous return.\textsuperscript{4, 29}

Early use of extraglottic devices for airway rescue, because of their intrinsic limitations on a narrowed airway,\textsuperscript{30, 31} might result challenging and time consuming.\textsuperscript{32, 33}

Summarizing, we should remind that routine intubation per se is not atraumatic, especially whenever it is not performed correctly.\textsuperscript{34} The more difficult the intubation is, the higher the possibility of developing oropharyngeal (19%), temporo-mandibular joint (10%), esophageal (18%), tracheal (15%) and laryngeal (87.3%) trauma\textsuperscript{35} and vocal cord palsy. As a result, a difficult intubation always provides traumatic consequences in proportion to the number and quality of attempts.

Time course of difficult extubation

Definition of a safe time window after extubation is particularly difficult. Not taking account of single variables such as patient status and operator’s experience, some situations provide such wide intervals of (presumed) safety to make quite impossible to draw out precise rules.

We could consider extubation after thyroid surgery as paradigmatic: a recent survey\textsuperscript{19} reports all airway accidents to occur within 12 hours after surgery, with three time splits (0-2 h, 2-6 h and 6-12 h, postoperative bleeding being the first cause of complications), whereas rescue strategies comprised wound opening, emergency reintubation and surgical airway.

Accordingly to type of surgery, a safe window could be established in 12 hours postoperatively close patient monitoring, taking account that the larger number of accidents remains predictable within the first 4-8 hours of observation.

The protected extubation concept (techniques, devices and strategies)

As suggested in many case reports and recommendations, the safest way to proceed while suspecting a difficult extubation is the “protected” extubation over an Airway Exchange Catheter (AEC).\textsuperscript{36} any attempt at tube removal should be preceded by preoxygenation and by the preparation of dedicated devices in the suspicion of airway loss, and followed by careful tube position assessment in case of reintubation.

The AEC can be left in situ for a more or less long period after extubation, the decision depending on close clinical and instrumental evaluation of patient’s status and vital parameters, counting on careful preparation before the procedure (size choice, generous lubrication and local anesthetic topicalization).

In need for reintubation after AEC removal, and generally if laryngeal obstruction and stridor occur during patient observation, a recent survey indicates that 90% of Anesthetists do prefer awake fiberoptic intubation, with full maintenance of spontaneous breathing, muscular tone and protective reflexes, as gold standard if airway control is needed in these situations.\textsuperscript{37}

Detailed strategies are provided in different papers and recommendations, as in the recently published DAS document.\textsuperscript{4}

In any case, it seems clear that the best approach for protected extubation should be proper maneuver planning, similarly to what we have learnt for induction phase and intubation. Such an approach should be someway “multileveled” and take account of:

— muscular readiness (tests for evaluation of muscular force, neuromuscular monitoring);
— lung/alveolar readiness (oxygen saturation, minute volume, blood gases);
— airway protection readiness (integrity and effectiveness of airway reflexes);
— airway patency readiness.

The last point is probably the most crucial and controversial; where the first three factors might account for “functional” extubation failure, without adding per se any factor increasing the difficulty of reintubation, the last point represents an important cause of extubation failure and at same time one of the most important factors increasing re-intubation difficulty and conditioning a rapid progression towards hypoxemia and cannot ventilate – cannot intubate scenario.

To make things less easy, while we have different possibilities to evaluate the first three “extubation readiness” parameters, evaluation of airway patency after tube removal remains difficult to perform. A clear example could be represented by postoperative course of carotid surgery: neck appearance might seem normal, with no evidence of bleeding or swelling, whereas the airway might be strictly narrowed, resulting in severe respiratory failure after extubation. Such a situation, which is often rapidly evolving, is evident in the study by Carmichael et al.38 using CT scans in a sample of 19 patients before and after carotid endarterectomy, clearly showing variable degrees of tissue swelling in all patients and not necessarily related to relevant clinical signs (such as voice change or stridor).

This kind of approach cannot be performed routinely in all patients suspected for difficult extubation, and more practical techniques such as ultrasonography are still object of studies and validation;39 unfortunately, at present, there is currently no good method for identifying the risk of obstruction in still intubated patients with supraglottic oedema. We might suggest, if in doubt, use of direct visual control techniques. Two more tests have been suggested: the cuff leak test consists of simple measurement of difference between inspired and expired volume over 6 breaths performed with endotracheal tube cuff first inflated and then deflated (and not simply measuring air flow around a closed endotracheal tube with deflated cuff), to detect the amount of airway passage between the tube and suspected swelling laryngeal structures.5,40 Results are actually controversial, so if a positive test should encourage direct visualization of airway structures because of high obstruction suspicion, a negative test does not exclude extubation failure.41

Another test is to search for PES (post extubation stridor) which occurs in about 2-16% of extubations in ICU and which represents an easy to detect sign for diagnosis of airway obstruction and need for reintubation.42, 43 Simple repeated neck auscultation is a frequently underestimated tool to assess airway patency and PES especially over time, as it is known to detect early wheezing and stridor even before they become audible.

No perfect tool actually exists to predict or to early detect an airway obstruction or rapid evolution towards a difficult ventilation/intubation setting; the only valuable option remain close observation of the patient within the first 12 hours, relying on close and careful clinical and instrumental tests but first of all being aware of potential life-threatening complications which might occur at any time.

Such an awareness, independently on available instruments, will alert us and suggest early interventions in a setting in which everything might become extremely rapidly evolving towards drama.

Conclusions

The conceptual issue with difficult extubation is quite complex: on one hand it represents a problem, even wider than expected, but with very few informations on both real incidence and consequential morbidity.

However, it seems that the problem is frequently occurring, but it does not seem to be so dangerous and challenging as it might seem, if not for less experienced physicians.

The question which might arise is: but really, is it worth the effort? Should we spend time, resources, skills acquiring and maintenance for something which is not so dangerous if not in specific and particular settings? The answer might be represented by the growing attention which can be observed either between anesthetists and industries choices with cricothyrotomy: incidence of cannot ventilate-cannot intubate is
definitely lower than problems at extubation, nevertheless so many different devices are available, and so much energy is spent in research and teaching. This because both events, though rare, are seriously life threatening and strictly related.

More and more people are today interested in skills and knowledge of cricothyrotomy, while we have evidence that competencies for tracheal extubation do not exist and trainees are not formally assessed on this.\(^{44}\)

As an experts’ point of view, we might conclude that opportune compromises should be found, taking account that if one experiences a critically difficult extubation, at least he knows what he is facing, in a good probability he will be able of thinking what to do, and in a rich environment he will take advantage of dedicated devices and strategies to manage it.

Starting to do it, maybe in selected patients, will mean thinking of it. And thinking means doing, doing means increasing opportunity to do it well.

And a well done protected extubation represents a further step in increasing clinical safety, as it might save two lives: the patient’s and the Anesthetist’s.

### Key messages

— Any anesthetist managing with a suspected difficult airway, should plan and organize airway management strategies with equal attention for both intubation and extubation.

— A potentially difficult extubation should be anticipated accordingly to patients’ characteristics, scheduled surgery, airway manoeuvres and surgery specific complications.

— Time course of extubation related accidents should be focused on the first 12 hours with particular reference on the first 4-8 hours.

— As few resources and drugs are effective and available for a complicated extubation, the best strategy remains prevention through protected extubation options, close clinical monitoring and difficult extubation awareness.

### References

1. Cheney FW. The ASA Closed Claims Project: what have we learned, how has it affected practice, and how will it affect practice in the future? Anesthesiology 1999;91:552-6.
7. The Royal College of Anaesthetists – 4th National Audit Project (NAP4): Major Complications of Airway Management in the UK [Internet]. [cited December 17, 2012]. Available at: http://www.rocka.ac.uk/nap4
23. Marques P, Leal I, Spratley J, Cardoso E, Santos M. Trache-