Content available at: iponlinejournal.com

Indian Journal of Clinical Anaesthesia

Journal homepage: www.innovativepublication.com

Original Research Article

Challenges in airway management of trauma patients: An update

Abhijit Kumar[1],*, Amit Kohli[2]

[1]*Dept. of Anesthesiology, Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi, India*
[2]*Dept. of Anesthesiology, Maulana Azad Medical College(MAMC), New Delhi, India*

ARTICLE INFO

Article history:
Received 02-12-2019
Accepted 21-12-2019
Available online 28-02-2020

Keywords:
Airway
Trauma
Cervical spine
Endo Tracheal Tube
Tracheostomy

ABSTRACT

Trauma has been a widely studied subject in western world in past decade. Many international organizations have formulated guidelines regarding the management of victims who have threatened airway due to any kind of trauma. Indian subcontinent is following the western world in such situations but incidence and nature of trauma is different, moreover the availability of resources varies. This review article will highlight the topics like need for pre-hospital intubations, status of rapid sequence intubation, cricoid pressure, adjuncts for intubation and airway management of victims with trauma of special nature.

"My heart and soul were wrecked; I was not sure whether my windpipe is going to make it or not"- Joshua Graham

1. Introduction

Trauma is becoming an epidemic in India. As per the national data of this decade, 10% of the global deaths are due to road traffic accidents that occur in India itself and hypoxia due to airway mismanagement leads to 34% of pre hospital deaths in such cases.[1] Securing a definitive airway may pose significant challenge in severely injured trauma patients. Loss of anatomical landmarks, hemodynamic compromise, blood, vomitus further complicate the scenario. Simple steps like head tilt, chin lift and use of oropharyngeal or nasopharyngeal airways often enable sufficient oxygenation as well as ventilation until tracheal intubation is performed. High velocity blunt trauma victims should be treated as a patient with unstable spinal injuries until formal assessments have been completed. Rapid sequence induction and endotracheal intubation in these patients is a critical step in the management algorithm and it should be performed only by personnel with appropriate training and competency. In last two decades advancement in pre-hospital care and the development of trauma response system have been remarkable but the early mortality from trauma has essentially remained unchanged. The founder of Bal timore's Shock Trauma Institute, Dr Adams Cowley R has defined the "golden hour" in trauma as a window to arrest the physiologic consequences of severe injury by rapidly transporting trauma patients to definitive care.[2] The popular "stay and play" versus the alternate "scoop and run" approach to pre-hospital trauma care has been a topic of debate since the early 1980s.[3,4] There were evidences that the advanced airway management can be performed by skilled emergency medical services (EMS) providers in the pre-hospital setting without compromising the quality of care and not delaying the transfer of the patient to a trauma centre but results were pretty equivocal as it did not decrease the overall mortality of those victims. On the other hand, delayed intubation is associated with increased mortality in trauma patients who are already hospitalised. Although endotracheal intubation remains gold standard, there are growing of evidences that advanced airway management in pre-hospital scenario may increase overall mortality of trauma patients in many circumstances.[5]

* *Corresponding author*.
E-mail address: abhijit.kumar999@gmail.com (A. Kumar).

https://doi.org/10.18231/j.ijca.2020.008

Thus there is a need to highlight the challenges in the assessment and management of airway in trauma settings. Along with the above mentioned, some latest developments in management of a traumatized airway have been emphasized with special focus on securing airway in certain special scenarios.

1.1. Challenges in airway management in trauma settings

1.1.1. Accident site

1. Unfavorable conditions (e.g. darkness, inadequate space, limited access to the patient)
2. Poor patient positioning who may be lying on the road, stuck inside cramped cars
3. Contaminated airway
4. Unknown assisting personnel with different levels of training.
5. Non availability of trauma team responders
6. Lack of equipment, expertise & education

1.1.2. In hospital

1. Hemorrhage
2. Trauma to face and neck
3. Patients either Agitated or Comatose
4. Improper confirmation of correct airway device placement
5. Displacement of airway device which was successfully placed beforehand
6. Inadequate ventilation even with definitive airway device in situ
7. Cervical spine involvement
8. Immobilized cervical spine (mostly with a rigid cervical collar)
9. Possible full stomach and the assistant applying faulty Sellick's maneuver
10. Unknown volume status putting a dilemma on the use of pharmacological adjuncts.
11. Rapid desaturation adding on to the stress to the operator.
12. Uncooperative, comatose or combative patient and attendants.

1.2. Difficult airway in trauma

ASA defines "difficult airway" when a conventionally trained an aesthesiologist finds difficulty with bag & mask ventilation (BMV), laryngoscopy & intubation, Supraglottic airway device (SAD) placement and/or front of neck (FONA) access.[6] The "physiologically difficult airway" is used to describe the hemodynamic or ventilator factors which can influence the outcome of airway management. Uncorrected hypotension, hypoxemia, and hypo or hypercapnia can lead to catastrophies in the peri-intubation period.[7] Patients in whom endotracheal intubation (ETI) and oxygenation both are anticipated to be difficult, the most popular airway algorithms recommend is an "awake" intubation approach where the patient remains on spontaneous respiration all through the procedure. The success of awake intubation to some extent depends on the experience of the airway manager as well as on available recourses

1.3. Evaluation of the traumatized difficult airway

Before managing any patient a protective gear for trauma care providers is an absolute necessity.[8] A threatened airway due to trauma is not always obvious. Any trauma evaluation should incorporate a high indexed suspicion for airway disruption or compression. Thus airway examination should be as detail as possible but some of the hindrances may be the lack of time, patient cooperation and neck immobilization. A thorough airway assessment can even determine the mode of injury, extent & severity of shock, and previous interventions if done. Bleeding within or outside the air way like a fast growing hematoma (*e.g.* over neck which can compress the airway) may be due to anticoagulant medication following a trivial trauma. Thus like any branch, history and examination plays a crucial role in successful airway management also. Airway compromise due to laryngo-tracheal disruption, epiglottis or tongue oedema as well as hematoma may worsen over minutes to hours. These emphasises the need for frequent re-evaluation of airway after trauma, at least for six to twelve hours after the event. Important clinical findings related to maxillofacial and laryngo-tracheal trauma may be bleeding, bruises, disruption of bony landmarks or soft tissues, localised swelling and subcutaneous emphysema. One of the ominous sign for impending airway obstruction is inspiratory stridor which should never be looked upon in any circumstances. Ability to vocalise and answer full name are indicators of a patent airway, adequate respiratory reserve to produce voice and perfusion of the brain. The Advanced Trauma Life Support (ATLS) Manual mentions three underlying concepts:[9]

1. Treat the cause which is greatest threat to life at first
2. Even without definitive diagnosis appropriate airway management should never be deferred
3. A detailed history is not always essential in emergency situation

An injury to airway and surrounding structures can be visualised by direct laryngoscopy (DL), Videolaryngoscopy (VL), Fiberoptic bronchoscopy (FOB) and even by ultrasound imaging. Other high quality imaging modalities like CT and Magnetic resonance imaging (MRI) may be performed early if ETI is not an emergency else these should be performed once the airway has been secured. Advanced imaging modalities provide comprehensive information

Table 1: Factors which can predict a difficult airway in trauma victims and their remedies

Difficult airway in trauma	**Practical tips**
Difficult Bag Mask Ventilation	
Mandibular fracture, facial trauma (poor seal)	Consider early supraglottic device use
Full stomach, Risk of aspiration (blood/vomitus)	Two suctions, SALAD Approach, consider surgical airways
Penetrating neck trauma (disrupted airway)	Passive oxygenation, minimum positive pressure ventlation
Difficult Endotracheal Intubation	
MILS	Use External laryngeal manipulation, Bougie
Collar	Always remove collar and apply MILS
Full stomach, Risk of aspiration (blood/vomitus)	Two suctions, SALAD Approach, consider surgical airways
Penetrating neck trauma (disrupted airway)	Consider Fiberoptic guided intubation, can consider Video laryngoscopes
Difficult Supraglottic Insertion	
Full stomach, Risk of aspiration (blood/vomitus)	Two suctions, SALAD Approach, consider surgical airways
Penetrating neck trauma (disrupted airway)	Consider Fiberoptic guided intubation, low tracheostomy
Difficult Surgical airway	
Penetrating neck trauma (disrupted airway)	Consider low tracheostomy

about the wholesome airway anatomy, injury & hematoma which put the patient on risk of airway compression.

In a traumatized airway, surgical airways like emergency cricothyroidotomy should be considered earliest and any failed intubation attempt should not been taken as Anaesthesiologist failure.

1.4. Securing airway in trauma

Worldwide ASA difficult airway algorithm for trauma patients has been followed when it comes to airway management. Though it is recommended Anaesthesiologist working in trauma centres should formulate and follow their own algorithms based on available resources and equipments. It is further emphasized that whenever intubation is attempted in trauma victims, expert in doing cricothyroidotomy should be readily available.[10]

1.5. Need for intubation

All patients of trauma don't need intubation. Emphasis should be on maintaining adequate oxygenation first. All trauma caregivers support the concept of preoxygenation and paraoxygenation in all such victims.

1.6. Indications

1.6.1. Need for airway protection

GCS$<$8, Risk of obstruction, massive bleeding, vomitus, severe maxillofacial injury, stridor, neck hematoma.

GCS was always been a key in neurotrauma cases since years. Lately emphasis has been given to fact that patients with higher GCS may also require intubation in light of altered neurological assessment.[11]

1.6.2. Need for ventilation

Apnea, severe hypoxemia, refractory hypercarbia, massive haemorrhage in airway.

1.6.3. Pre oxygenation

1. There should be two oxygen sources for all trauma patients: high flow nasal prongs $\geq$ 15L/min and Non rebreathing mask or bag mask ventilation $\geq$ 15L/min.
2. Always ensure that you have two attachments to bag mask ventilation: A PEEP valve and a manometer
3. During bag mask ventilation always prefer two hand technique and two provider technique if manpower is not the concern
4. For patients with poor mentation who don't tolerate preoxygenation, concept of "Delayed Sequence Intubation" has been widely studied which advocates use ketamine or other sedation to calm the patient during preoxygenation without affecting the patient's respiratory drive.[12] Sedation may allow placement of a non- rebreather mask, noninvasive positive pressure ventilation, and/or a nasogastric tube for gastric decompression. These techniques may prevent repeated desaturation episodes during intubation and improve outcome. Its role in trauma settings is still controversial.

1.6.4. Para-oxygenation

Emphasis is given on oxygenation through use of high flow nasal prongs continuously throughout all intubation attempts so as to increase the apnea time.

1.7. Rapid sequence intubation (RSI) and drug assisted intubation (DAI)

1.7.1. Endotracheal intubation in pre-hospital settings

Attempting intubation out of the hospital setting by primary caregivers always remain a matter of concern. Worldwide many trauma protocol researchers are advocating attempting intubation at first place itself. A large study on 7523 patients also concluded that a well-trained paramedic has equal success rate of intubation when compared to emergency physicians.[13] However in Indian scenario there is a paucity of evidence supporting the same. It's always debatable to use drugs for RSI in prehospital settings. Those advocating its use say it provide better intubating conditions while others raise concerns of ablation of spontaneous respiratory efforts with it and what if intubation fails? Studies have demonstrated higher mortality rates with no favourable neurological out comes in patients with GCS <8 and poor outcomes of prehospital intubations in hypotensive patients as positive pressure ventilations has further made patients unstable.[14] Many researchers advocate use of supraglottic devices in pre hospital settings with better outcomes but some have found no change in neurological outcomes. Improved protocols and rigorous training of EMS providers will surely change the pre hospital management of trauma victims in future.

1.7.2. Cricoid in trauma cases

It is widely accepted dogma since years as it was supposed to protect against passive aspiration during intubation attempts. It has been challenged by many researchers. There is a sufficient published data by numerous trauma and emergency medicine organizations which analysed risk vs benefit of the same and eliminates or judicious application of cricoid in RSI.[15,16]

1.7.3. RSI in hemodynamically unstable patients

Usually trauma victims are hypotensive due to volume loss. In such cases trauma physicians should start vasopressors like phenylephrine or ephedrine before attempting intubation simultaneously. All induction agents are myocardial depressants, so RSI in such cases need some modification. Mostly caregivers prefer etomidate because of its cardiovascular stability over other drugs. Though there occurs a risk of transient adrenocortical suppression even with single dose of etomidate used for intubation but it is not clinically significant and doesn't cause haemodynamic perturbations in trauma victims.[17,18] Ketamine is another agent used in such circumstances, it carried a theoretical risk of effect on increase in cerebral activity and intracranial pressure since ages but very recently evidence suggests that beneficial effects overweighs clinically insignificant risks.[19,20] Golden rule in such patients is whatever agent you select dose to be reduced by 50% and may increase dose of paralytic agent like succinylcholine (unless contraindicated).

1.8. DAI

1. Approved by American College of Emergency physicians in 2012
2. To be used with caution in pre-hospital settings
3. 85% success rate compared to 91% in RSI
4. Better hemodynamic stability than RSI

1.8.1. Video laryngoscope (VL) guided Intubation in trauma

In the past decade various VL have been used in trauma intubations. It has been shown to improve intubation success rate but with higher intubation times.[21] However the contamination of lens with blood, secretions and vomitus makes the procedure more difficult in certain cases.

1.9. Rewarming to the core

Significant hypothermia is observed in trauma patients specifically in winter season and drowning cases. The principles of core rewarming place significant value on the delivery of heated, humidified oxygen to the lungs.[22] Humidified oxygen is heated to 45° C (113°F) and delivered continuously. The best way to achieve this is with the help of endotracheal tube.

1.10. Airway management in patients with suspected cervical spine injuries

Resuscitation in trauma victims typically proceed with the assumption that the patient has an injured cervical spine (c-spine) until proven otherwise. In pre-hospital settings, these patients are often put on a cervical spine collar along with a rigid backboard placed with blocks. There is a traditional belief in emergency trauma care that the rigid cervical collars prevent secondary spinal cord injury by immobilizing the spinal cord. Recently this dictum has been challenged with high quality literary evidence. The incidence of c-spine injuries is relatively low (2% in overall trauma victims and 6%-8% in patients with head and facial trauma) still airway managers express deep concerns regarding intubation related secondary spinal cord injury. It is one of the most frequently encountered problem that comes in the way of prompt trauma airway management. These patients are typically placed in fully supine position, inhibiting the operator's ability to position the patient optimally for direct laryngoscopy (DL). Manual inline stabilization (MILS) worsens the view created with DL in almost 50% of intubation attempts. C-spine collars along with improper MILS restrict mouth opening and further it hampers tongue displacement required for optimal ETI. Even if MILS is properly applied, the airway manager should still expect a poor Cormack Lehane (CL) grade with DL, prolonged intubation time ultimately leading

to failure of intubation attempts. These problems can easily managed by application outer external laryngeal manipulation (OELM) or with the use of a bougie. Application of MILS results in the increased need of force application during laryngoscopy that paradoxically leads to increased movement during ETI. Many investigators have found the McCoy laryngoscope blade to be better than the same sized McIntosh blade to produce better CL grade even with MILS application.[23] The fundamental geometric challenge of DL is that the optical point is away from operator. This problem again can be avoided with the use of a "look-around-the-corner" approach by using video laryngoscopes, specifically those with a hyper-angulated blade.

Fiberoptic guided intubation has proven to be the best method in unstable cervical spine cases as it is associated with least movement when compared to other techniques.[24] However in most of the trauma cases blood, vomitus or edema limits its use. ILMA is another popular method with some trauma caregivers in such cases but standard literature also mentions a greater degree of movement at cervical spine level, thus it should be used with caution.[24,25]

1.11. Facial trauma

In patients with maxilla-facial trauma, both BMV and ETI may be challenging and difficult. In these scenarios, awake and spontaneous respiration is preferred during airway manipulations. If the airway manager is planning for RSI, simultaneous approaches to control the bleeding is must as airway manipulation may further aggravate the bleeding. In cases of profuse bleeding in and around airway, front of neck access should be considered as early as possible to prevent airway contamination. Injuries involving m andibular and zygomatic arch can produce trismus which usually resolves with neuromuscular blockade. On the contrary, fractures involving mandibular condyles actually limit jaw opening as the bony fragments mechanically block its conjugate movements. Sometimes surgical intervention are required to dislodge the se bony fragment to obtain proper mouth opening. Bilateral mandibular fractures many a times ease laryngoscopic retraction of jaw leading to easy ETI but at instances it may become a mirage. Surgical airway becomes the only option available in mid-face fractures and crush injuries. As an alternative to surgical airway, submental intubations can be tried in these scenarios. In submental intubation, the ETT exits from in the floor of mouth by an iatrogenic incision and it is usually fixed with sutures. Avulsion of permanent teeth is common during a difficult laryngoscopy. If the tooth is not totally displaced, it should be replanted in its native location as soon as possible after the completion of the procedure. Its needless to mention that a Ma gill's forceps is ineluctable in such situations to prevent foreign body aspiration. Nasal intubation is rarely performed due the risk of basilar skull injury and spread of infection. In case of a fractured base of skull, oxygen through nasal cannula and application of high-flow nasal oxygen increases the risk of pneumoencaphalus as well as intracranial infection. Nowadays, nasal intubation is mostly used for elective oral and maxillofacial surgeries. Nasal intubation with the use of FOB is suitable if the fracture line does not cross midline and more importantly the cribriform plate is intact on CT imaging. In fronto-basal fractures with CSF rhinorrhoea, although nasal intubation has not been found to increase the incidence of meningitis, it is not indicated because of similar reasons above mentioned.

1.12. Extrinsic airway compression following neck trauma

Sometimes manipulation of airway dislodges a formed clot, leading to increase bleeding as well as tissue oedema. In these circumstances, surgical incision on the overlying tissue relieves compression in lieu of increase bleeding. To minimize the risk of hematoma expansion due to coughing and bucking, RSI is favoured but paradoxically it may worsen airway obstruction also. If such scenario happens, a surgical airway should be immediately created if RSI fails.

1.13. Disruption of laryngo-tracheal complex

In case of large neck trauma or subglottic injury, a surgical airway should be the best initial approach. Sometimes, it is even possible to insert an ETT through the wound into the airway but securing the ETT into proper place may become difficult. FOB remains a wonderful option to pass the ETT distal to the site of disruption without causing any further injury. In partial separation or avulsions of larynx and trachea, conventional DL may be clueless and spontaneous ventilation should be maintained at any cost in such conditions.

1.14. Airway contamination with blood, vomitus, secretions

Blood or vomitus always decrease the first-attempt success rate of ETI whenever they are present in the airway of trauma victims despite use of multiple sophisticated airway devices[26] Airway contamination not only produces a difficult airway scenario, it often produces grave complications like aspiration pneumonitis or acute respiratory distress syndrome. The conglomeration of altered sensorium, lost/minimal protective airway reflexes, delayed gastric emptying due to head trauma and full stomach situations put post traumatic patients at an higher risk of vomiting and ultimately aspiration during attempts of ETI. The operator must remember the "tip of iceberg" theory while managing such patients as the amount of blood or vomitus seen externally can just be a fraction of the accumulated fluids inside body cavity and those can pose a life threatening situation on initiation of an

RSI. Trauma physicians must keep at least 2 rigid large bore suction cannulas while dealing with contaminated airway. Placement of the patient in reverse Trendelenburg, sitting or even leaning forward position to allow drainage of blood and vomitus may turn out to be most fruitful manoeuvres in the entire airway management procedure. P re-oxygenating and positive-pressure ventilation should be attempted only when absolutely necessary as pressures of more than 20 cm-H2O increases the risk of passive regurgitation and aspiration of stomach contents. Many a times, it becomes challenging to effectively suck out the contaminants and intubate trachea particularly if contaminants are thick. Some trauma physicians mention about placement of one rigid suction or endotracheal tube in the upper oesophagus and the n use another suction during laryngoscopy to look for the epiglottis. Once the epiglottis is seen in such scenarios, it is used as reference point to place a bougie underneath the epiglottis. The ducanto suction-assisted laryngoscopy and airway decontamination (SALAD) approach has been popularised as a method to manage the so called contaminated airway.[27] Although previously contraindicated, videolaryngoscopes with McIntosh blades have been studied successfully in such situations but researchers concluded that the success rates of intubation remains same for VL and DL scopes.[26]

In spite of these techniques when the intubation fails and the patient is critically desaturates, rescue oxygenation using a Bag-mask or Supraglottic devices may be further devastating. Thus, the Front of Neck Access should be instituted immediately in such scenarios.

*1.15. **Trauma victim can be** uncooperative or violent*

The first and foremost challenge in such patients is that caregivers may not be able to do complete assessment which may lead to missed injuries and ineffective resuscitation. Patients may be agitated directly because of his injuries or it may be the result of hypo-perfusion, hypoxemia, or alcohol in toxication. The Eastern as sociation for Surgery of Trauma guidelines recommend that endotracheal intubation must be instituted if patient is showing aggressive behaviour refractory to initial pharmaco logic intervention and specifically patient's level of agitation prevents assessment and resuscitation.[28] Many a times if trauma victim is badly agitated one has to attempt intubation without fluid resuscitation and adequate pre-oxygenation. Weingart and colleagues introduced a new terminology "delayed-sequence intubation" in which ketamine is used to facilitate cooperation.[12] If given slowly in a dose of 1 to 1.5 mg/kg poses little threat of respiratory depression. However, there is always an apprehension of using any sedatives particularly in cases of intoxications. As mentioned earlier, the concerns that ketamine may raise intracranial pressure and worsen neurological outcomes is not evidence based.[29,30]

1.16. Extubation in trauma patients is another challenge:

Mostly trauma physicians plan intubation in such cases and extubation plans are underestimated. Decision for extubation should be based on mental stat us, airway anatomy and reflexes, respiratory mechanics and systemic stability. Elective ventilation should be continued till the physiological parameters return to normal. Premature extubations are always associated with worse outcomes. So it's advisable that when in doubt always ventilate and preparations for reintubation should be in place.

2. To summarize

Trauma care is always a team approach in which management of airway is primarily the responsibility of the anaesthesiologist. Both anatomical and physiological alterations should be kept in mind while managing such airways. Adequate oxygenation should be the priority and intubation should be attempted in selected cases. Pre-hospital intubations are being advocated worldwide but continuous training and expertise is must. Appropriate cervical immobilization techniques should be implemented at the earliest. RSI using drugs and role of pre as well as para-oxygenation should is being emphasized. Fibre-optic and videoscopes should be reserved for selected cases. Front of neck access and surgical airways should be considered at the earliest. There remains paucity of Indian data and evidences. The approaches and the optimal airway rescue techniques should be chosen on the basis of the clinical decision of trauma caregiver considering patient's condition, clinical setting, nature of injuries to airway and the available expertise as well as equipment.

3. Conflict of interest

None.

4. Source of funding

None.

References

1. Khan RM, Sharma PK, Kaul N. Airway management in trauma. *Indian J Anaesth*. 2011;55(5):463–469.
2. Rogers FB, Rittenhouse KJ, Gross BW. The golden hour in trauma: Dogma or medical folklore? *Injury*. 2015;46(4):525–527.
3. Border JR, Lewis FR, Aprahamian C. Panel: prehospital trauma care-stabilize or scoop and run. *J Trauma*. 1983;23(8):708–711.
4. Gold CR. Prehospital advanced life support vs "scoop and run" in trauma management. *Ann Emerg Med*. 1987;16(7):797–801.
5. Lecky F, Bryden D, Little R. Emergency intubation for acutely ill and injured patients. *Cochrane Database Syst Rev*. 2008;(2):1429.
6. Law JA, Broemling N, Cooper RM. The difficult airway with recommendations for management-part 2-the anticipated difficult airway. *Can J Anaesth*. 2013;60(11):1119–1138.

7. Mosier JM, Joshi R, Hypes C. The physiologically difficult airway. *West J Emerg Med*. 2015;16(7):1109–1117.
8. Jain U, Mccunn M, Smith CE. Management of traumatized airway. *Anesthesiol*. 2016;124:199–206.
9. American College of Surgeons: Advanced Trauma Life Support Manual, Ninth edition. Chicago, American College of Surgeons ; 2012,.
10. Ortega GM. Anaesthesia for trauma patients. *S Afr Fam Pract*. 2012;54(3):2–6.
11. Advanced trauma life support: the ninth edition. *J Trauma Acute Care Surg*. 2013;74(5):1363–1366.
12. Weingart SD, Trueger NS, Wong N. Delayed sequence intubation: A prospective observational study. *Ann Emerg Med*. 2015;65:349–355.
13. Prekker ME, Kwok H, Shin J. The process of prehospital airway management: Challenges and Solutions during paramedic endotracheal intubation. *Crit Care Med*. 2014;42(6):1372–1378.
14. Jacobs PE, Grabinsky A. Advances in prehospital airway management. *Int J Crit Illn Inj Sci*. 2014;4(1):57–64.
15. Gwinnull M, Gwinnull J, Robinson D. The use of cricoid pressure during rapid sequence induction in trauma patients. UK and European practices compared. *Trauma*. 2015;18:21–27.
16. Tumbull J, Patel A. Cricoid pressure: The argument against. *Trends Anaesth Crit Care*. 2015;5:52–56.
17. Hinkewich C, Green R. The impact of etomidate on mortality in trauma patients. *Can J Anaesth*. 2014;61(7):650–655.
18. Jabre P, Combex S, Lapostolle F. Etomidate vs ketamine for rapid sequence induction in acutely ill patients: a multicenter randomized controlled trial. *Lancet*. 2009;374(9686):293–300.
19. Wang X, Ding X, Tong Y. Ketamine doesn't increase intracranial pressure as compared to opioids: meta-analysis of randomized controlled trials. *J Anesth*. 2014;28(6):821–827.
20. Himmelseher S, Durieux ME. Revising a dogma: Ketamine for patients with neurological injury? *Anesth Analg*. 2005;101(2):524–534.
21. Yeatts DJ, Dutton RP, Hu PF. Effect of Video laryngoscopy on trauma patients survival: a randomized controlled trial. *J Trauma Acute Care Surg*. 2013;75(2):212–219.
22. Danzel DF, Pozos RS, Hamlet MP. Accidental hypothermia. In: Auerbach PS, editor. Wilderness Medicine, 3rd ed. St. Louis: Mosby ; 1995,. .
23. Cranshaw J, Nolan J. Airway management after major trauma. Continuing education in Anaesthesia. *Crit Care Pain*. 2006;6(3):125–127.
24. Brimacombe J, Keller C, Kunzel KH, Gaber O. Cervical spine motion during airway management: A cinefluoroscopic study of the posteriorly destabilized third cervical vertebra in human cadavers. *Anesth Analg*. 2000;91:1274–1278.
25. Keller C. Pressure exerted against the cervical vertebrae by the standard and intubating laryngeal mask airways: A randomized, controlled, cross-over study in fresh cadavers. *Anesth Analg*. 1999;89:1296–1300.
26. Sakles JC, Corn GJ, Hollinger P. The impact of a soiled airway on intubation success in the Emergency Department when using the GlideScope or the direct laryngoscope. *Acad Emerg Med*. 2017;38(1):42–49.
27. Ducanto J, Serrano K, Thompson R. Novel airway training tool that simulates vomiting: suction-assisted laryngoscopy assisted decontamination (SALAD) system. *West J Emerg Med*. 2017;18(1):117–120.
28. Mayglothling J, Duane TM, Gibbs M. Emergency tracheal intubation immediately following traumatic injury: an Eastern Association for the Surgery of Trauma practice management guideline. *J Trauma Acute Care Surg*. 2012;73(5):333–340.
29. Cohen L, Athaide V, Wickham ME. The effect of ketamine on intracranial and cerebral perfusion pressure and health outcomes: a systematic review. *Ann Emerg Med*. 2015;65(1):43–51.
30. Zeiler FA, Teitelbaum J, West M. The ketamine effect on ICP in traumatic brain injury. *Neurocrit Care*. 2014;21(1):163–173.

Author biography

Abhijit Kumar Senior Resident

Amit Kohli Associate Professor

Cite this article: Kumar A, Kohli A. Challenges in airway management of trauma patients: An update. *Indian J Clin Anaesth* 2020;7(1):39-45.