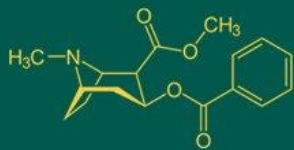


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Concise review on anaesthetic considerations & emergency management techniques in brachycephalic patients for successful anaesthesia

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Abstract

Anaesthesia is a complicated subject in brachycephalic breed of dogs like pug, english bulldog etc. as they are highly prone to develop anaesthetic complications due to the airway obstruction caused by anatomical faults like elongated soft palate, hypoplastic trachea & stenotic nares. Multiple factors like pre-anaesthetic evaluation (ASA physical status, lab evaluation etc), selection of drugs & techniques, conscious monitoring of vitals throughout the anaesthetic protocol, stabilization of airway, ETT intubation, oxygenation & ventilation all plays crucial role to complete a successful anaesthetic protocol in a brachycephalic patient. Before conducting anaesthesia in any patient it essential to perform a thorough medical analysis of that patient. Selection of drugs for an anaesthetic protocol should be based on individual case assessment. Preoxygenation before induction of anaesthesia is a good option in brachycephalic patient to avoid anaesthetic emergencies. Generally brachycephalic patients shows more frequently symptoms of anaesthetic emergencies during recovery. Anaesthetic emergency medications are play crucial rule to overcome from anaesthetic emergencies.

Keywords: Brachycephalic, boas, anaesthetic protocol, intubation, anaesthetic emergencies, recovery assessment

Introduction

Brachycephalic dogs with BOAS (Brachycephalic Obstructive Airway Syndrome) are twice as likely to have anesthetic complications as non-brachycephalic dogs primarily dyspnoea, regurgitation & aspiration pneumonia, occurring in the postoperative period (Grubb, 2022) [8]. Anaesthesia is a pre-requisite for most of the surgical procedures, so that surgeons can perform surgical intervention with maximum precision and sagacity (Muhammad *et al.*, 2009) [17]. Surgical general anaesthesia is the state of anaesthesia that provides unconsciousness, amnesia, muscular relaxation and hypoalgesia sufficient for painless surgery (Grimm *et al.*, 2015, Novakovski *et al.*, 2017) [7, 18]. There is no single drug available that can fulfil all the quality of anaesthesia as a result concept of balanced anaesthesia is developed that includes use of a combination of anaesthetic agents with different mechanisms of action. Balanced anaesthesia included four different phases: 1. Pre-anaesthesia, 2. Induction, 3. Maintenance 4. Recovery. Preanaesthetic & sedative drugs (anticholinergics, alpha-2 agonists, narcotics, benzodiazepines) calms the patient, induce sedation, decreases salivation, airway secretions, provide muscle relaxation, analgesia promote smooth induction and recovery from anaesthesia (Tranquilli *et al.*, 1999, Novakovski *et al.*, 2017) [26, 18].

Preanaesthetic considerations (patient assessment & preparation): A full medical assessment starts with proper collection of history of patient which includes deworming, vaccination status, ongoing medications, any history of pre-existing disease, any history of surgery at past, history of food or medicinal allergy, epilepsy, anxiety medication. Any history of hospitalization within last one month. History of feeding schedule and common foods are given. Patient risk assessment should be done by assessing vitals like-rectal temp., heart rate, respiration rate, NIBP monitoring, SpO₂ etc., observing patient behavioral responses with cardiopulmonary (ECG, ECHO, chest X-ray, abdominal USG, endoscopy) & haemato-biochemical (CBC, LFT, KFT, blood glucose profile, thyroid profile) analysis.

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After clinical, diagnostic, & laboratory assessment, patient is categorized based on ASA physical status classification to assess the anaesthetic and surgical risk. Feed and water withdrawal is highly important for a successful anesthesia. Off-fed at least 8-10 hours for solids and at least 4 hours for liquids are highly advised. Fasting helps to avoid unwanted anaesthetic complications like regurgitation and aspiration pneumonia. Stress is a very deleterious factor specially in brachycephalic patients prior anaesthesia, as stress increases respiratory distress and developed BOAS condition which may further leads to laryngeal & tracheal collapse, so every caution needs to be taken to avoid such condition. Allow some time to the patient to adjust with it's environmental surroundings it will help to reduce anxiety issues. For handling and restraining of brachycephalic patients slip leads are not at all recommended as they can increase respiratory distress and obstruction for giving direct pressure on the neck. Harness is a better option for handling and restraining of brachycephalic patient as it does not causes any respiratory obstruction. Commonly used anxiolysis drugs like (benzodiazepines, gabapentin) or herbal anti-anxiety medications can be given. IV catheterization (cephalic or cephalic vein) is highly important in all anesthetic patient including brachycephalic patients for pre-operative, intraoperative, anaesthetic maintenance, emergency care medication. If patient is stable and calm on such case IV catheterization can be done with

out any sedation. If any symptoms of stress & anxiety is showing by patient then sedation followed by catheterization is advised. To reduce pain on catheterization site application of topical anaesthetic gel like Lox 2% (15-20 min before catheterization) is a good option. Prior to start of an anaesthetic protocol anti-emetic & gastroprotectants medication can reduce the chance of anaesthesia induced vomiting & aspiration etc. Maropitant is most commonly used anti-emetic before induction but also ondansetron can be a substitute if maropitant is not available. Inj. Pantoprazole can be given as a gastroprotectants 3-4 hours before anaesthesia. 10-15 minutes of oxygenation can profoundly reduce induction related apnoea or respiratory distress.

Selection process of drugs for an anaesthetic protocol:

Selection of drugs, doses and techniques are depend on patient-related factors, procedural factors, drug availability, professional experience and cost (Bednarski *et al.*, 2011) [2]. Using known drugs by the anaesthesiologist is highly advised as it increase safety window for patients. In the discussion section an example of a balanced anaesthetic protocol will be prepared based on the different research parameters for a hypothetical brachycephalic patients undergoing for a surgical protocol. Commonly available drugs in veterinary anaesthesia field in Indian markets are includes-

Table 1: Common anaesthetic drugs available in Veterinary Practice in India

Drug group	Commonly available drugs
Anticholinergics	Atropine, Glycopyrrolate
Opioid derivatives	Butorphanol, Buprenorphine, Fentanyl
Alpha-2 agonist	Xylazine, Dexmedetomidine
Benzodiazepines	Diazepam, Midazolam
Induction agent (injectable)	Thiopentone, Propofol, Ketamine, Etomidate, Telazol
Induction agent (Inhalant)	Isoflurane, sevoflurane, halothane

Discussion: Selection of drugs for an will be done from the above listed drugs to make a balanced anaesthetic protocol so it can cover all the aspects of anaesthetic triad (analgesia, unconsciousness & muscle relaxation). Selection of these drugs are purely based on clinical experience and it's not an universal protocol. Any anaesthesiologist can select and create any anaesthetic protocol by considering pre-anaesthetic assessment and surgical procedure of respected patient. Here in this hypothetical anaesthetic protocol-glycopyrrolate is taken as a preanaesthetic, butorphanol as premedicant analgesics, midazolam as sedative & muscle relaxant, combination of ketamine & propofol commonly known as ketofol @ (1:1) ratio for induction and finally isoflurane with 100% oxygen as inhalant anaesthetic for maintenance of anaesthesia. Here in this protocol selection of drugs are done purely based on clinical experience of using drugs, their availability also considering their combined pharmacological effects in different body systems as well as different clinical & physiological parameters.

Reason to choose glycopyrrolate as premedicant:

Anticholinergic agents are used as preanaesthetics in veterinary practice to reduce salivation and bronchial secretions and to block the effects produced by agents who stimulate the parasympathetic system. Premedication with glycopyrrolate provides better CV stability and decreases cardiac arrhythmias which is caused by atropine and also

decreases excessive salivation and bradycardia. It has more rapid onset of action than atropine and has a powerful and prolonged anti-sialagogue activity and is about five times as potent as atropine (Hall *et al.*, 2001; Lemke, 2001) [9, 15]. Glycopyrrolate administration as preanaesthetic leads to dryness of muzzle and nostrils and it also blocked vagal mediated bradycardia caused by alpha-2 agonist like xylazine (Potliya *et al.*, 2015) [20]. Glycopyrrolate is long acting drug and provides better cardiovascular stability than atropine.

Reason to choose butorphanol as premedicant

analgesics: Butorphanol is a agonist/antagonist opioid group of drug can be used to produce dose dependent analgesia (2-6 hours) to control moderate pain with mild sedation effect in combination with other drugs. (Grimm *et al.*, 2015) [7]. Butorphanol Produces light to moderate level of sedation with short-duration analgesia and minimal to no respiratory effects (Grubb, 2022) [8]. Combination of butorphanol, midazolam and alfaxalone in Beagles and concluded that this drug combination resulted in excellent recoveries (Seo *et al.*, 2015) [24].

Reason to choose midazolam as sedation & muscle relaxation agent:

Midazolam is a water soluble agent shows rapid onset of action with minimal negative cardiovascular & respiratory effects unlike alpha-2 agonists

and also shows anticonvulsant properties. It is less irritant and short acting in nature compared to diazepam. The co-administration of midazolam with propofol decreased the total dose of propofol needed for induction of anaesthesia in sedated healthy dogs (Hopkins *et al.*, 2014) ^[11]. Midazolam causes dose-dependent significant decrease in the MAC value of isoflurane which may be due to the centrally mediated sedative effect or its spinally mediated antinociception or both together (Seddighi *et al.*, 2011) ^[22]. Midazolam is a short acting benzodiazepines with higher potency (3times) than diazepam and produce profound sedation when combined with opioids.

Reason to choose ketofol as induction agent: Combination of ketamine and propofol known as Ketofol; administered either individually or by mixing in a single-syringe offering the benefits of both the agents, and for reducing the adverse effects of either agent alone (Lee and Lee, 2016) ^[14]. The anaesthetic duration of propofol could be enhanced when used in combination with ketamine hydrochloride (Van Natta and Rex, 2006) ^[27]. The cardiovascular effects of ketamine and propofol are opposite in action from each other, thus balancing each other out when they combined together for anaesthesia (Arora, 2007) ^[1]. Combo of ketamine and propofol can reduce unwanted adverse effects of both drugs, since these drugs act on different extremes-excitation and depression, respectively (Mair *et al.*, 2009) ^[16]. IV shots of ketofol @ 2mg/kg each drug produces effective anaesthesia which can be maintain by introducing ketofol @ 1 mg/kg each drug alternative to inhalation anaesthesia (Saikia *et al.*, 2016) ^[21]. Admixture of ketamine and propofol helps to mask the side effects of the individual drugs which increase the safety and efficacy without changing the haemodynamic stability of the patient when used as general anaesthetic in dog (Shinde *et al.*, 2018) ^[25]. Etomidate provides better cardiovascular stability with minimal CV depression but have disadvantages like pain

and myoclonous effect with adrenal suppression in prolong use. It is also very costly and not so commonly available in India. Alphaxolone (alfaxolone) is also not available in India currently. Propofol provides rapid and smooth induction and recovery however induction propofol associated with apnoea, reduction in arterial blood pressure (BP), cardiac output and substantial respiratory depression. (Hofmeister *et al.*, 2008, Onkarappa *et al.*, 2016) ^[10, 19]. A greater degree of respiratory depression of a longer duration is seen with propofol than with thiopental (Larisa *et al.*, 2008) ^[13]. None of these agents individually provides all the components of anaesthesia like adequate muscle relaxation, analgesia & unconsciousness. By considering all these factors ketofol is preferred over propofol, ketamine, etomidate and alphaxolone.

Reason to choose isoflurane as maintenance agent: Maintenance of anaesthesia can either be done by TIVA technique by inhalant anaesthesia (isoflurane and sevoflurane) technique in dogs. After induction intubation is done by inserting proper sized cuffed endotracheal tube and connecting it with anaesthetic machine for supply of anaesthetic agent and for fresh gas flow (Grimm *et al.*, 2015) ^[7]. The MAC value of isoflurane in dogs was between 1.28% and 1.30%. Isoflurane is one of the common inhalant anaesthetic for maintenance of anaesthesia. It is not considered as nephrotoxic as methoxyflurane. Maintenance of anaesthesia with isoflurane in acepromazine-propofol induced dogs had no adverse effects on haemato-biochemical and physiological parameters and has smooth and fast recovery from anaesthesia (Kulkarni, 2012) ^[12]. Recovery from anaesthesia from isoflurane maintenance is very smooth and rapid and very less recovery complications are observed. Maintenance with isoflurane is easy and safe although it did not provide any analgesia in painful procedures, so administration of analgesics in pre or intraoperative period is necessary (Sen and Kilic, 2018) ^[23].

Table 2: Selection of drugs & doses with route for anaesthetic protocol

Anaesthetic Protocol (Example)		
Drug name	Dose rate (mg/kg)	Indications
Glycopyrrolate	0.01-0.02 mg/kg IM	Premedication
Butorphanol	0.1-0.2 mg/kg IM	Premedication analgesic
Midazolam	0.1-0.2 mg/kg IM	Sedation & Muscle relaxation
Ketofol (Ketamine + propofol)	Ketofol @ 4mg/kg (each drug 2 mg/kg) body wt. IV.	Induction of anaesthesia
Isoflurane	2-4% Isoflurane with 100% oxygen	Maintenance of anaesthesia

Importance of preparation of intubation tray & intubation technique: Preparation of an intubation tray is highly essential for brachycephalic patient for easy stress free intubation and anaesthetic management. Intubation tray is need to be prepare even before the induction of anaesthesia. Intubation tray usually contains items like-different sized ET, laryngoscope with different size blades (curved & straight), 2ml, 5ml syringe to inflate cuff, lox 2% gel, roll gauze threads to place knots & security of intubated ET. In brachycephalic patient due to their specific anatomical changes like narrowed nostrils, elongated soft palate & hypoplastic trachea intubation is always a little bit challenging than other dogs. Due to hypoplastic trachea or narrowed tracheal lumen brachycephalic dogs required smaller size ET than required in other breed dogs of almost same age, body size and body weight. Laryngoscope with long blades are generally better for proper visualization of glottis and ease of intubation with less attempts & less

trauma in these patients. Topical anaesthetic gel like lox 2% is applied to the surface of ET tube before intubation, it acts as a lubricant as well as reduce laryngospasm leads to an easy intubation. Crash cart contains all essential drugs, anaesthetic drugs and their antagonists. Positioning of patient during anaesthesia (lateral, ventro-dorsal or dorso-ventral position) is mostly depends on which surgical procedure is to be performed, easy access of anatomical area involved with surgery. But some measures are taken related to positioning to avoid respiratory distress like keeping the head & neck in extended position which improves airflow and reduce the chances of respiratory distress. During anaesthetic procedure eye drops or NS drops are applied to the eyes at a regular intervals (15-20 mins). To control hypothermia inside the OT room heater, hot water bag, warm IV fluid therapy these techniques can be implemented.

Anaesthetic monitoring & emergency management

approach: Most of the anaesthetic deaths occur during recovery period and postoperative mortality rate is 47% in canines (Brodelt *et al.* 2008) ^[4]. Death in canines occurs within first 24 hours after the operation are called as anaesthetic death, makes the post-operative period a high risk time (Gil and Redondo 2013) ^[6]. Hypoventilation, hypotension, hypercapnia, hypoxemia and ventricular arrhythmias are common complications during anaesthesia which leads to other complications and death during recovery (Gaynor *et al.* 1999; Bednarski *et al.* 2011) ^[5, 2]. Anaesthetic death has correlation with ASA status of animal, species, age, type of operation, anaesthetic drugs used, where it was observed that low ASA score was low death rate while the death rate of animals with higher ASA score was higher (Bille *et al.* 2012) ^[3]. Before induction of anaesthesia functioning of suction machine, anaesthetic

machine, vitals parameter monitor, CO₂ canister, central oxygen line, inhalant anaesthetic level in vaporizer all are must be checked by a OT staff/anaesthetic staff. Once induction is done and tongue, jaw, larynx are relaxed immediately intubation & cuff inflation followed by fixing of ET with anaesthetic machine is performed. Inhalation anesthetic and oxygen supply is started & capnograph probe is fixed to monitor EtCO₂, along with that heart rate, pulse rate, respiration rate, SpO₂, ECG, NIBP, rectal temperature. One or two dedicated anaesthesiologist or anaesthetic trained nurse are always should be with patient for constant monitoring of parameters to assess patient condition throughout the anaesthesia to avoid emergency situations or to take prompt actions against any emergency if happen. Common anaesthetic emergency drugs should be in emergency medicine cart to avoid anaesthetic emergencies with above proposed anaesthetic protocol are listed below.

Table 3: Emergency drug cart for anaesthetic emergency management

Drugs	Use
Naloxone	Antagonizing the side effects of Butorphanol in case of emergency
Flumazenil	Antagonizing the side effects of midazolam in case of emergency
Doxapram	Respiratory stimulant drug used to revive from respiratory arrest
Deriphylline	To treat bronchial spasm related respiratory distress
Trenexamic acid	Control haemorrhage
Adrenaline	Used to treat Bradycardia & Cardiac arrest conditions
Dopamine	Cardiac arrest conditions
Atropine	Bradycardia treatment
Dexamethasone	Airway inflammation or swelling control

Importance of recovery stage monitoring: A smooth, rapid and pain less recovery in a calm environment and proper extubation is also a critical factor as most of anesthetic complications arises at the time of recovery. Vitals monitoring till complete anaesthetic recovery is highly advised. Post operative antibiotic & NSAID's courses are important for control of pain and inflammation and early complete recovery of brachycephalic patients. Post recovery conditions like hypothermia, hypovolemia, hypoglycemia, pain should be addressed & managed properly. After surgery patients should be immediately positioned to sternal recumbency & if not then at least on lateral recumbency with extended head & neck for effective ventilation. To counter hypothermia earlier mentioned techniques are commonly used & actinotherapy can also be given to increase body temperature. Eye drops or ointments can be applied as well as advised to the owner for to continued for few days at home for eye care. In brachycephalic animal extubation should be done only after complete recovery from anaesthesia happened. Symptoms like swallowing, chewing, coughing are the symptoms to determine the time of extubation. Before extubation oxygen

supply can be given via anaesthetic machine whereas after extubation also oxygenation in these patient are important to avoid sudden respiratory distress. Mask oxygenation technique most commonly used at our place after extubation. Sometime early extubation may lead to respiratory issues to counter such conditions re intubation, suctioning and oxygenation with proper head & neck position is essential. To control recovery anxiety, stress or emergence delirium anxiolytics like benzodiazepines or opioids can be given but dose selection is very crucial and low dose rate is highly advised. IV catheter can be removed only after complete recovery from anaesthesia and completion of scheduled post-operative medication like antibiotic and analgesics if IV route is indicated. Discharge of brachycephalic patient from hospital or clinics should be done only after complete post operative analysis & effective client communication for proper management. Multimodal recovery action plans (maintaining temp, position, oxygenation, vitals monitoring, proper extubation) needs to be followed for a successful recovery of a brachycephalic patients (Novakovski *et al.*, 2017) ^[18].



Glycopyrrolate



Butorphanol



Midazolam



Ketofol



Isoflurane



Anaesthetic machine



Isoflurane Vaporizer



Vitals monitor



Laryngoscope



Endotracheal tube



Capnography probe



Pulse oximeter probe

Images of drugs and instruments required for a successful anaesthetic protocol

Conclusion

Brachycephalic breeds are highly susceptible for anaesthetic complications & emergencies due to the specific anatomy of upper respiratory tract and precision of anaesthesiologist plays important role to overcome these critical challenges. All anaesthetic drugs are comes with some advantages & disadvantages so it's always better to use a balanced anaesthetic protocol. Selection of drugs, doses & techniques all are critically important for patient survival. I have selected all these drugs based on my clinical/anaesthetic knowledge, experience, availability and cost of drugs. Finally, I want to close my conclusion with a statement that-

“There are no safe anaesthetic agents; there are no safe anaesthetic procedures; there are only safe anaesthetists”- Robert Smith...

Declaration

Author hereby declare that use of google scholar, pub-med, research gate etc. platforms to study & analyse different research, review, short communication articles, for collection of conclusive data's & statements related to the article topic. All the sources are properly acknowledged by the authors wherever necessary.

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