UPPER AIRWAY OBSTRUCTION DURING SEDATION

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Abstract

Healthy or diseased, slim or obese, male or female, sedation can cause upper airway obstruction, which should be clearly differentiated from hypoventilation. Upper airway obstruction is far more common & more dangerous. It is reassuring that significant unpleasant events can be prevented by careful preoperative assessment, along with attentive intraoperative monitoring and postoperative care. Nevertheless, we must be prepared to manage unpleasant events should they arise. The aim of this review is to focus on upper airway collapse during sedation in relation to different drugs used in sedation in different clinical & experimental conditions with a close reference to patient related factors augmenting the problem, preoperative detection of susceptible patients, and intraoperative management of such a problem.

KEY WORDS:

-Upper airway- obstruction-collapse

-Sedation

-Obstructive sleep apnea

List of Abbreviations

ABCs	Airway, Breathing, Circulation
AHI	Apnea-hypopnea index
AI	Apnea index
BMIs	Body mass index
Bi-PAP	Bi-level continuous positive airway pressure
CNS	Central Nervous System
COPD	Chronic obstructive pulmonary disease
CT	Computed tomography
EEG	Electroencephalogram
EMG	Electromyelogram
EOG	Electrooculogram
ESWL	extracorporeal shock-wave lithotripsy
F	flow
FIO2	Fractional inspired oxygen
FOT	Forced oscillation technique
FRC	Functional residual capacity
GABA	Gamma amino butyric acid
Hb-O_2	Oxy-hemoglobin
HI	hypopnea Index
LMA	Laryngeal mask airway.
LSAT	lowest oxyhemoglobin saturation
MAC	Monitored anesthesia care
MRI	Magnetic resonance imaging.
N-CPAP	Nasal continuous positive airway pressure
NREM	non-rapid eye movement sleep
OSA	obstructive sleep apnea
Pa CO_2	Partial pressure of carbon dioxide
PEEP	positive end expiratory pressure
$P_{upstream}$	upstream pressure
$P_{downstream}$	downstream pressure
P_{tr}	trachea pressure

$P_{crit:}$	critical closing pressure
P_{n}	nasal pressure
PTT	pulse transit time
P_{tp}	transpulmonary pressure
P_{oes}	oesophageal pressure
psi	Pound per square inch
PO_2	Partial pressure of oxygen
REM	Rapid eye movement sleep.
$R_{upstream}$	upstream resistance
$R_{downstream}$	downstream resistance
SAHS	sleep apnea hypopnea syndrome
SLI	sublingual injection
$Sp\ O_2$	Oxygen saturation
TTJV	Transtracheal jet ventilation
UAR	Upper airway resistance
UAO	Upper airway obstruction
$V'_{I,max}$	maximal inspiratory flow

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INTRODUCTION

Invasive diagnostic and minor surgical procedures outside the traditional operating room setting have increased in the last decade. As a consequence of this change and the increased awareness of the importance of providing analgesia and anxiolysis, the need for sedation for procedures in physician offices, dental offices, subspecialty procedure suites, imaging facilities, emergency departments, and ambulatory surgery centers has also markedly increased.(1)

Upper airway obstruction is common during sedation. Obstruction is caused by loss of muscle tone present in the awake state. Patients with a tendency to upper airway obstruction during sleep are vulnerable during sedation and anesthesia. Loss of wakefulness is compounded by depression of airway muscle activity by the agents, and depression of the ability to arouse, so they cannot respond adequately to asphyxia. (2)

Identifying the patient at risk is vital. Previous anesthetic history and investigations of the upper airway are helpful, and a history of upper airway compromise during sleep (snoring, obstructive apneas) should be sought. Beyond these, risk identification is essentially a search for factors that narrow the airway. These include obesity, maxillary hypoplasia, mandibular retrusion, bulbar muscle weakness and specific obstructive lesions such as nasal obstruction or adenotonsillar hypertrophy. Such abnormalities not only increase vulnerability to upper airway obstruction during sleep or anesthesia, but also make intubation difficult. (2)

Appropriate drug selection for the intended procedure as well as the presence of an individual with the skills needed to rescue a patient from

an adverse response is essential. Appropriate physiologic monitoring and continuous observation by personnel not directly involved with the procedure allow for accurate and rapid diagnosis of complications and initiation of appropriate rescue interventions. [3]

Only recently quantitative methods were identified as being reliable in the evaluation of sedation induced upper airway obstruction. Methods used to evaluated sleep apnea & related breathing disorders are now being employed for the study the effects of sedation and general anesthesia. [4]

Identification of risk and caution are keys to management, and the airway should be secured before sedation where doubt exists. If tracheal intubation is needed, spontaneous breathing until intubation is an important principle. Every anesthetist should have in mind a plan for failed intubation or, worse, failed ventilation. [2]

Familiarity with emergency airway management procedure algorithms is essential. These guidelines are intended for all venues in which sedation for a procedure might be performed (hospital, surgical center, freestanding imaging facility, dental facility, or private office). [5, 6]

ANATOMY OF THE UPPER AIRWAY

Upper airway is a compartment that has two openings: the nose, which leads to the nasopharynx, and the mouth, which leads to the oropharynx.These passages are separated anteriorly by the palate, but joined posteriorly in the pharynx. The upper airway extends from the anterior nares down to and including the larynx. (Figure 1-1) [7]

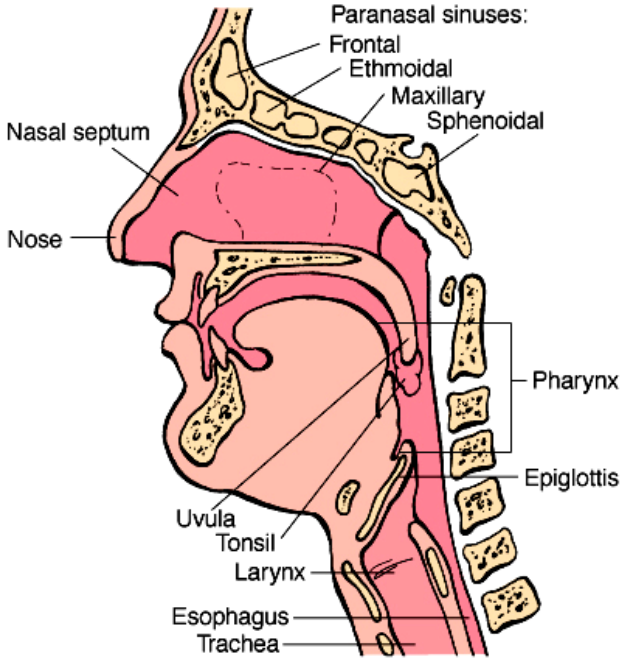

Figure 1-1. Major structure of upper airway. [7]

The Mouth

The mouth is made up of the vestibule and the mouth cavity, the former communicating with the latter through the aperture of the mouth.

The vestibule is formed by the lips, cheeks and by the gums and teeth within. An important feature is the opening of the parotid duct on a small papilla opposite the 2nd upper molar tooth. Normally the walls of the vestibule are kept together by the tone of the facial muscles. The mouth cavity is bounded by the alveolar arch of the maxilla and the mandible, and teeth in front, the hard and soft palate above, the anterior two-thirds of the

tongue and the reflection of its mucosa forward onto the mandible below, and the oropharyngeal isthmus behind. [8]

Nerve supply: The palatine nerves provide sensory fibers from the trigeminal nerve to the hard and soft palate. The lingual nerve (a branch of the mandibular division of the trigeminal nerve) and glossopharyngeal nerve provide general sensation to the anterior two-third and posterior third of the tongue, respectively. [8]

The Nose

The nose is divided anatomically into the external nose and the nasal cavity.[8]

The External Nose is formed by an upper framework of bone (made up of the nasal bones, the nasal part of the frontal bones and the frontal processes of the maxillae), a series of cartilages in the lower part, and a small zone of fibro-fatty tissue that forms the lateral margin of the nostril (the ala). The cartilage of the nasal septum comprises the central support of this framework.[8]

The Cavity of the Nose is subdivided by the nasal septum into two separate compartments that open to the exterior by the nares and into the nasopharynx by the posterior nasal apertures or choanae. Immediately within the nares is a small dilatation, the vestibule, which is lined in its lower part by stiff, straight hairs. Each side of the nose presents a roof, a floor and a medial and lateral wall. .[8]

The roof first slopes upwards and backwards to form the bridge of the nose (The nasal and frontal bones), then has a horizontal part (the cribriform plate of the ethmoid), and finally a downward-sloping segment (the body of the sphenoid). The floor is concave from side to side and slightly so from before backwards. It is formed by the palatine process of the maxilla and the horizontal plate of the palatine bone.

The medial wall is the nasal septum, formed by the septal cartilage, the perpendicular plate of the ethmoid and the vomer. The lateral wall has a bony framework made up principally of the nasal aspect of the ethmoidal labyrinth above, the nasal surface of the maxilla below and in front, and the perpendicular plate of the palatine bone behind.[8]

Upper part of the nasal cavity receives its arterial supply from the anterior and posterior ethmoidal branches of the ophthalmic artery, a branch of the internal carotid artery. The sphenopalatine branch of the maxillary artery is distributed to the lower part of the cavity and links up with the septal branch of the superior labial branch of the facial artery on the antero-inferior part of the septum. [9]

A rich submucous venous plexus drains into the sphenopalatine, facial and ophthalmic veins, and through the latter links up with the cavernous sinus. Small tributaries also pass through the cribriform plate to veins on the undersurface of the orbital lobe of the brain. [9]

Nerve supply: The olfactory nerve supplies the specialized olfactory zone of the nose, which occupies an area of some 2 cm in the uppermost parts of the septum and lateral walls of the nasal cavity. The ordinary sensory nerves are derived from the nasociliary branch of the 1st division of trigeminal nerve and also from the 2nd or maxillary division. [8]

The pharynx

The pharynx is a wide muscular tube that forms the common upper pathway of the respiratory and alimentary tracts. Anteriorly, it is in free communication with the nasal cavity, the mouth and the larynx, which conveniently divide it into three parts, termed the nasopharynx, oropharynx and laryngopharynx, respectively .In extent, it reaches from the skull (the basilar part of the occipital bone) to the origin of the oesophagus at the

level of the 6th cervical vertebra (C6). Posteriorly, it rests against the cervical vertebrae and the prevertebral fascia. **(8)**

- ***The Nasopharynx***

The nasopharynx lies behind the nasal cavity and above the soft palate. It communicates with the oropharynx through the pharyngeal isthmus, which becomes closed off during the act of swallowing. On the lateral wall of the nasopharynx, 1 cm behind and just below the inferior nasal concha, lies the pharyngeal opening of the pharyngotympanic (Eustachian) tube. The underlying cartilage of the tube produces a bulge immediately behind its opening, termed the tubal elevation, and behind this, in turn, is a small depression, the pharyngeal recessa-fossa of Rosenmüller. **(8)**

The nasopharyngeal tonsil (‘adenoids’) lies on the roof and posterior wall of the nasopharynx. It consists of a collection of lymphoid tissue covered by ciliated epithelium and lies directly against the superior constrictor muscle; it has no well-defined fibrous capsule. The lymphoid tissue begins to atrophy at puberty and has all but disappeared by early adult life. **(8)**

- ***The oropharynx***

The mouth cavity leads into the oropharynx through the oropharyngeal isthmus, which is bounded by the palatoglossal arches, the soft palate and the dorsum of the tongue. The oropharynx itself extends in height from the soft palate to the tip of the epiglottis. Its most important features are the tonsils. **(8)**

The palatine tonsils are the collections of lymphoid tissue that lie on each side in the triangle formed by the palatoglossal and palatopharyngeal arches (the pillars of the fauces), connected across the base by the dorsum of the tongue The free surface of each palatine tonsil presents about 12–20