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Role of Ultrasound in Airway Management

An Essay
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First thanks to **ALLAH** *to whom I relate any success in achieving any work in my life.*

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بسم الله الرحمن الرحيم

﴿وَعَلَّمَكَ مَا لَمْ تَكُنْ تَعْلَمُ وَكَانَ فَضْلُ اللهِ عَلَيْكَ عَظِيمًا﴾

صدق الله العظيم

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List of Abbreviations

Abb.	Full term
4S	*Four-step*
ARDS	*Acute respiratory distress syndrome*
ASA	*American Society of Anesthesiologists*
CEUS	*Contrast-enhanced ultrasonography*
COPD	*Chronic obstructive pulmonary disease*
CT	*Computed tomography*
DLT	*Double-lumen bronchial tube*
EFAST	*Extended focused assessment with sonography for trauma*
ETCO2	*End-tidal carbon dioxide*
ETT	*Endotracheal tube*
FC	*False cord*
IS	*Interstitial syndrome*
LMA	*Laryngeal mask airway*
NAP4	*National Audit Project 4*
PDT	*Percutaneous dilational tracheostomy*
POCUS	*Portable point of care ultrasound*
PZT	*Probe uses piezoelectric*
SARI	*Airway Risk Index'*
SM	*Strap muscles*
T.R.U.E.	*Tracheal rapid ultrasound exam*
TARGET	*Traditional landmark versus ultrasound Guided Evaluation Trial*
TC	*Thyroid cartilage*
TRUST	*Tracheal rapid ultrasound saline test*
UK	*United Kingdom*
US	*Ultrasound*
V	*Vocalis muscle*
VL	*Vocal ligaments*

INTRODUCTION

Ultrasound, as a non-invasive radiological assessment, was first used in 1953 when two Swedish cardiologists performed the first successful ultrasonographic examination of the heart ***(Meyer, 2004).***

Recent years have witnessed an increased use of ultrasound in evaluation of the airway and the lower parts of the respiratory system. Apart from use in diagnostics it may also provide safe guidance for invasive and semi-invasive procedures ***(Votrubaet al., 2015).***

With the development of technology, ultrasound has been established as a rapid bedside method in preoperative assessment and perioperative practice and also in the intensive care setting ***(Kristensen, 2011).***

Upper airway ultrasound is a valuable, non-invasive, simple, and portable point of care ultrasound (POCUS) for evaluation of airway management even in anatomy distorted by pathology or trauma. Ultrasound enables us to identify important sonoanatomy of the upper airway such as thyroid cartilage, epiglottis, cricoid cartilage, cricothyroid membrane, tracheal cartilages, and esophagus ***(Osman and Sum, 2016).***

Understanding this applied sonoanatomy facilitates clinician to use ultrasound in assessment of airway anatomy for difficult intubation, endotracheal tube (ETT) and laryngeal

musk airway (LMA) placement and depth, assessment of airway size, ultrasound-guided invasive procedures such as percutaneous needle cricothyroidotomy and tracheostomy, prediction of postextubation stridor and left double-lumen bronchial tube size, and detecting upper airway pathologies ***(Osman and Sum, 2016).***

Widespread POCUS awareness, better technological advancements, portability, and availability of ultrasound in most critical areas facilitate upper airway ultrasound to become the potential first-line non-invasive airway assessment tool in the future ***(Osman and Sum, 2016).***

Two modalities of respiratory system ultrasound are currently used for preoperative assessment, for postoperative examination, and for real-time guidance in some interventional airway procedures. Transcutaneous ultrasound includes translaryngeal and transtracheal ultrasound examinations which have been used for conventional scans of the oral cavity, vocal cords or trachea, and transcutaneous ultrasound assessment of the lungs ***(Kristensen, 2011).***

Endobronchial ultrasound is a novel tool combining bronchoscopic evaluation with tissue ultrasonography and has been used mainly for preoperative diagnostic purposes ***(Beaudoin et al., 2014).***

Aim of the Essay

This essay will highlight briefly the role of upper airway ultrasound in airway assessment and management. The essay will focus also on the detailed applications of both conventional and endobronchial ultrasound in perioperative practice.

APPLIED SONOANATOMY OF THE AIRWAY

Upper airway anatomy

There are two openings to human airway, nose and mouth the former leads to nasopharynx and the latter leads to oropharynx. They are separated anteriorly by palate, but joined posteriorly. At the base of the tongue, epiglottis prevents aspiration by covering the glottis during swallowing ***(Schwartz et al., 2010).***

The mouth:

The mouth is made up of the vestibule and the mouth cavity. The vestibule is formed by the lips and cheeks without and by the gums and teeth within. The mouth cavity (Figure 1) 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 ***(Ellis et al., 2004).***

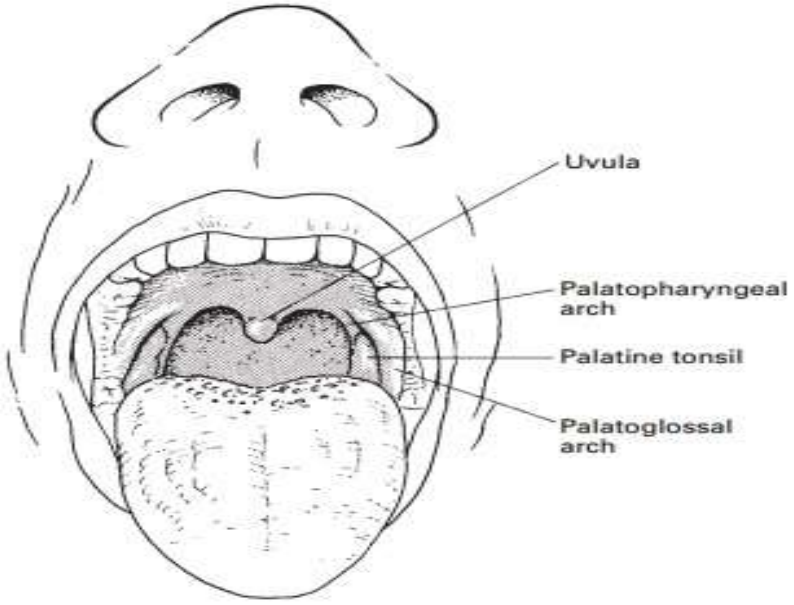

Figure (1): Mouth cavity ***(Ellis et al., 2004).***

Pharynx:

Pharynx is a musculofascial tube, acts as common entrance to respiratory and alimentary tract (figure 2). It is divided into three parts:

1. Nasopharynx:

It lies above soft palate which cuts it from rest of pharynx during deglutition of food through mouth.

Two important structures lie in this compartment:

- Orifice of pharyngotympanic or auditory tube (Eustachian canal).
- Nasopharyngeal tonsil (adenoids) ***(Ellis et al., 2004).***

2. 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. There is a threefold sensory nerve supply:

1. The glossopharyngeal nerve via the pharyngeal plexus;
2. The posterior palatine branch of the maxillary nerve;
3. Twigs from the lingual branch of the mandibular nerve.

For this reason, infiltration anesthesia of the tonsil is more practicable than attempts at nerve blockade ***(Ellis et al., 2004).***

3. Laryngopharynx:

Extends from tip of epiglottis to termination of C6 vertebra. The inlet of larynx defined by epiglottis, aryepiglottic folds and arytenoids lay anteriorly. Larynx itself bulges into this part of pharynx ***(Ellis et al., 2004).***