CASE REPORT

# Ludwig's angina: need for including airways and larynx in ultrasound evaluation

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## SUMMARY

Ludwig's angina is a deep neck space infection. Unlike other abscesses elsewhere in the body, rapid progression of the disease results in serious complications such as airway oedema, distortion, total obstruction with loss of airway and death. Thus, early diagnosis and skilful airway management is necessary. For safe airway management, fibreoptic intubation or tracheostomy under local anaesthesia is recommended.[1] We describe a case report where an initial attempt at fibreoptic intubation failed and subsequently bleeding ensued causing difficulty in viewing the larynx by fibreoptic bronchoscopy. Radiological investigations such as ultrasound and computer tomography (CT) are commonly ordered by surgeons and emergency physicians to know the extension of disease, but airways and larynx are seldom included. We discuss the role of ultrasound in airway assessment in such critical cases to ensure safe and uncomplicated airway access.

## BACKGROUND

Safe and early airway management is life saving in Ludwig's angina. Radiological investigations such as ultrasound and CT are commonly ordered by surgeons and emergency physicians to know the extension of disease, but airways and larynx are seldom included.

In our report, initial attempt at fibreoptic intubation failed due to a narrowed glottis. Even though preoperative ultrasound was undertaken in our case, airways were not studied. This led to failure to select the appropriately size endotracheal tube and subsequently bleeding ensued causing difficulty in viewing the larynx by fibreoptic bronchoscopy. In another case report of Ludwig's angina, initially bedside ultrasound of submandibular area was performed but airways were not studied. Subsequently, CT scan in this case showed lumen of the airway narrowed and significantly displaced to the right.

Thus, including airways in ultrasound evaluation of Ludwig's angina is useful for clinical decision-making and intervention in airway management and there is a rapidly growing body of evidence showing its benefits. Ultrasound is non-invasive, painless, inexpensive, safe and portable, and examination can be completed in any part of the hospital. Assessing extension of disease, involvement of airways and estimation of glottic diameter may provide valuable clues for early decision-making towards safe and uncomplicated airway management and surgical drainage.

## CASE PRESENTATION

This case is reported with the written consent of the patient. A 40-year-old woman presented with pain and swelling in the left lower jaw over 8 days. Systemic examination was unremarkable. Locally, a solitary spherical swelling 5×7 cm in the left lower jaw with oedema in the surrounding area was noted. However, visible swelling did not extend to the side of the neck or perilayryngeal area. The inter-incisor distance was reduced to less than one finger.

Emergency incision and drainage under awake fibreoptic intubation was planned. Airway anaesthesia was achieved with 2 ml of 4% lignocaine spray via the nostrils. After premedication with midazolam 1 mg intravenously and pentazocine 15 mg intravenously, a Pentax 4.1 mm fibreoptic bronchoscope with 6.5 endotracheal tube railroaded was passed through the right nostril. The 6.5 mm endotracheal tube was selected after consideration of a possibly narrowed airway. The epiglottis visualised was red, soft, swollen and oedematous. The false cords were red and swollen, and the glottic aperture was narrowed. A spray-as-you-go technique with lignocaine 4% 3 mL was adopted. Although the fibreoptic bronchoscope was in the trachea, the 6.5 mm tube could not be passed through the clearly visible but narrowed glottic aperture. The fibreoptic scope was removed and a 6 mm endotracheal tube was railroaded. However, during the next attempt airway bleeding made subsequent bronchoscopic visualisation of the glottis difficult. Attempts at intubation had to be stopped for a few minutes to allow for continuous suction and physiological stabilisation. After cessation of bleeding, the fibreoptic bronchoscope was successfully passed through the glottis and the trachea intubated with a 6.0 mm endotracheal tube. General anaesthesia was induced with propofol 100 mg and maintained with oxygen, nitrous oxide, isoflurane and vecuronium.

## OUTCOME AND FOLLOW-UP

The patient (figure 1) was safely extubated at the end of the procedure.

## DISCUSSION

Airway management in Ludwig's angina is challenging due to patient's inability to open the mouth, swollen oedematous airways, periglottic spread and extension of abscesses to deep neck spaces. For safe airway management, fibreoptic intubation or tracheostomy under local anaesthesia is recommended.[1]

Radiological investigations such as CT or ultrasound are commonly undertaken in the evaluation

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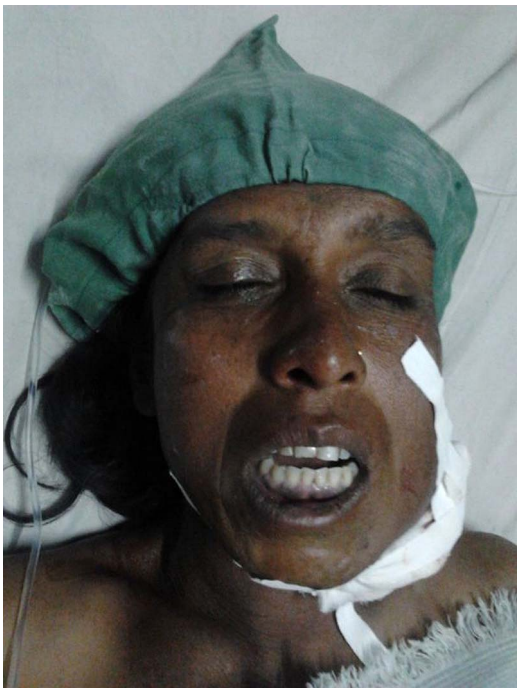

**Figure 1** Markedly restricted mouth opening (immediate postoperative period) in the reported case. Note the absence of visible swelling on the neck or perilaryngeal area; the fibreoptic image of the larynx revealed a swollen and narrow glottis. Airway involvement and narrowing can still occur without obvious neck or perilaryngeal swelling.

of Ludwig's angina by surgeons or emergency physicians to know the extension of disease. However, the airways and larynx are seldom included. Ultrasonography can be utilised to predict airway difficulty during induction of anaesthesia. There is a rapidly growing body of evidence showing its benefits.[2] The diameter of the subglottic upper airway has been reliably estimated by ultrasonography.[3] Lakhal *et al* studied 19 healthy


**Figure 2** Ultrasound image of the larynx (transverse midline axial scan over thyroid cartilage) of a healthy volunteer during phonation. Note the glottis opening of 4. 8 mm. VC, vocal cords.


**Figure 3** Axial scan of larynx of the same healthy volunteer. Note glottis opening of 9.2 mm during deep inspiration.

volunteers to compare the transverse diameter of the cricoid lumen, as assessed by ultrasonography and MRI, and found a strong correlation between the two techniques in assessing airway anatomy. In children, ultrasound can estimate the subglottic diameter more accurately. Shibasaki *et al* measured subglottic airway diameter with ultrasonography, which predicted optimal outer endotracheal tube diameter better than the standard age and height-based formulae.[4] Sonographic measurements of anterior neck soft tissue thickness at the level of hyoid bone and thyrohyoid membrane have been shown to be a better predictor of difficult laryngoscopy than clinical tests.[5]

Ultrasound is widely available, non-invasive, portable, repeatable, relatively inexpensive, pain-free and safe. Ultrasound has also been found to be useful for critical care procedures. It may aid preintubation assessment in critical care and is being used to guide percutaneous dilational tracheostomy.[6]

In our case, preoperative ultrasound as advised by surgeons revealed a 4×3 cm hypoechoic lesion in the left buccal space, but the larynx was not studied. Referral to the anaesthetist occurred after all investigations had been completed and the patient was to arrive in the operation theatre. In another case report of Ludwig's angina, bedside ultrasound revealed soft tissue collections in deeper planes of neck and submandibular region in a patient who presented with only jaw swelling without any trismus, tongue elevation or toxic symptoms. The CT scan performed immediately following bedside ultrasound in this patient revealed a narrowed and deviated airway, but ultrasound of the airway was not performed in this case.[7] Owing to the superficial location of the larynx, ultrasound is said to offer images of higher resolution than CT or MRI when examined with a linear high-frequency transducer. The thyroid and cricoid cartilages show progressive calcification with advancing age while the epiglottis stays hypoechoic. Vocal cords appear hypoechoic but are medially outlined by the hyperechoic vocal ligaments.[2] When ultrasound is used for assessment and diagnosis of upper airway problems, including epiglottitis, mucosal oedema or other disease states, it will allow areas not normally imaged to be seen because of the ultrasound reflectance of air-filled structures.[8]

As the lesson of performing ultrasound of airways in Ludwig's angina was learnt after we managed this case, we

performed an axial ultrasound scan of the upper airways on a healthy volunteer in our hospital to assess whether estimation of glottic diameter is possible with a routine linear probe (4–12 MHz). Figures 2 and 3 show estimation of glottic diameter with deep inspiration as well as phonation in a young healthy volunteer. Although airway ultrasound of healthy volunteers may not be comparable to an airway in Ludwig's angina, it demonstrates the fact that routinely available linear transducers may be used if curved low frequency transducers, ideal for supraglottic areas,[2] are not available. Further studies or large case series are required for airway ultrasound in Ludwig's angina. It is not only the glottic diameter, but extension of disease and involvement of airways that can help decide for early surgical intervention or definitive airway access by intubation.

Although airway evaluation naturally occurs during fibreoptic bronchoscopy, it fails to estimate the glottic diameter and may cause bleeding of friable tissues or lead to airway reactivity because of repeated fibreoptic brochoscope movements before intubation being used only to assess the airway or extension of disease. Thus, in radiological evaluation of a submental abscess, the upper airways as well as the larynx, glottis and subglottic area must be included to estimate the extension of the disease and estimation of glottic diameter. Whether the extent of reduction in mouth opening corresponds to the extent and severity of lower pharyngeal and laryngeal involvement is not known. Ultrasound is best undertaken dynamically in conjunction with airway procedures. Preoperative ultrasound for localisation of the trachea is especially useful in emergency cases if awake tracheostomy is being performed for difficult intubation.[2] Thus, whether fibreoptic intubation or tracheostomy is planned, ultrasound may provide useful information of the airway structures. An appropriate size tracheal tube can be selected from an estimation of glottic diameter with ultrasound, this may avoid unnecessary tube changes and repeated intubation attempts. This is especially important while doing fibreoptic intubation if an already railroaded enodtracheal tube fails to pass through the glottis, the entire procedure of passing the bronchoscope and intubation has to be repeated. It may also help to avoid airway trauma and subsequent haemorrhage, which would not complicate further intubation attempts but predispose for aspiration or airway irritation. Also, narrowing of airways or involvement of deeper structures in the neck as revealed by ultrasound may provide clues for an early decision on securing the airway safely and for surgical drainage even in mild cases without trismus or toxic symptoms. Although our patient was safely extubated, if severe airway and laryngeal involvement is identified earlier, either delayed extubation or elective tracheostomy may be planned at the end of the surgical procedure.

In a recent study, ultrasound marking of the cricothyroid membrane of healthy volunteers before simulated intubation accurately identified the cricothyroid membrane after neck manipulation that is expected during a failed intubation.[9] Prior ultrasound identification of cricothyroid membrane may be useful for emergency oxygenation in difficult cases. Similarly, if a CT is being performed preoperatively in Ludwig's angina, larynx and airways must be included to assess the extension of disease and estimation of glottic diameter.

## CONCLUSIONS

Preoperative or dynamic radiological evaluation of Ludwig's angina by ultrasound or CT must include airways, larynx and subglottic area. Assessing extension of disease, involvement of airways and estimation of glottic diameter may provide valuable clues for early decision-making towards safe and uncomplicated airway management and surgical drainage. Early referral to anaesthetists must occur before radiological investigations so that airways are included in the radiological assessment and preferably in the presence of an anaesthetist. Dynamic ultrasound in conjunction with airway procedures will assist in selection of an appropriately sized endotracheal tube and planning for postoperative extubation or tracheostomy.

### Learning points

- Ludwig's angina is an airway emergency.
- Preoperative radiological investigations such as ultrasound or CT are commonly ordered, but airways and larynx are not included as anaesthetic referral commonly occurs after radiological investigations.
- Early information to anaesthetists before radiological investigations is vital as airway assessment can be included in radiological investigations. Preoperative or dynamic radiological evaluation of Ludwig's angina by ultrasound must include airways, larynx and subglottic area.
- Ultrasound is non-invasive, pain-free, inexpensive, safe and portable, and examination can be completed in any part of the hospital. Assessing extension of disease, involvement of airways and estimation of glottic diameter may provide valuable clues for early decision-making towards safe and uncomplicated airway management and surgical drainage.

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**Competing interests** None.

**Patient consent** Obtained.

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## Reminder of important clinical lesson