Value of high resolution ultrasonography in assessment of laryngeal lesions

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Abstract

Objective: The aim of this study is to evaluate the value of high resolution ultrasonography (HRUS) in diagnosis of various laryngeal lesions which already diagnosed with rigid endoscopy. Study design: Prospective study with control group. Patients and methods: Sixty-six patients were suffering from throat symptoms and pre-examined by rigid endoscopy under local anesthesia and diagnosed to have a laryngeal lesion and 32 volunteers compose the control group. All 98 persons (patients and control groups) were examined by HRUS. Results: HRUS was helpful in describing various laryngeal lesions, vocal fold polyps (17) 25.7%, glottic cancer (6) 9.1%, epiglottic enlargement (2) 3.1% and one patient had laryngocele (1.5%). HRUS was highly significant in diagnosis of subglottic lesions (10) 15.2%. Also vocal fold mobility can be demonstrated by HRUS. While interarytenoid lesions (17) 25.8% and small laryngeal lesions as vocal fold nodules (13) 19.6% were difficult to be described. Conclusion: Rigid endoscopy in laryngeal examination gives us large, bright image but it is difficult to diagnose patients with a sensitive gag reflex, patients with neck or jaw diseases or stridor and very difficult in infants and children. HRUS is an alternative method in diagnosis of some laryngeal lesions, and it is superior in the diagnosis of small subglottic lesions.

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Introduction

Vocal folds (VF) visualized using a dental mirror for the first time by Manuel Garcia in 1854 [1]. Then rigid endoscope and different methods were used for laryngeal evaluations and examination with large, bright and clear image, which allowing earlier diagnosis [2-4]. Several viewing angles for laryngeal endoscopes including 0, 30, 70, 90 and 120 allowing visualization of specific regions during laryngeal examination [5]. But not all patients can tolerate rigid endoscopy especially patients with a sensitive gag reflex, patients with neck or jaw diseases, and patients suffering from stridor. It is also very difficult in most infants and children [6, 7]. Ultrasound became a very important diagnostic tool in all head and neck diseases including laryngeal diseases [8]. Also ultrasonography considered as a very safe diagnostic imaging modality during pregnancy [9]. High resolution ultrasonography (HRUS)
became a new diagnostic tool in the last several years with small, flexible ultrasound transducers [10]. The aim of this study is to evaluate the role of high resolution ultrasonography (HRUS) in diagnosis and assessment of various laryngeal lesions.

Patients and methods

The study was approved by the research ethics committee of the Faculty of Medicine, Minia University. Our study was conducted at Otolaryngology Department, Minia University Hospital.

The Study group consisted of 66 patients that had a laryngeal lesions diagnosed by history and rigid endoscopy at otorhinolaryngology and phoniatric units. Patients with previous laryngeal operation, infants and children under 6-year-old were excluded from the study. The age range of patients was 8–50-year-old.

The control group consists of 32 volunteers, not suffering from any laryngeal symptoms and with normal laryngoscopic appearance. The age of them match the patients group. The control group was examined using HRUS to acquaint the normal sonographic appearance of the larynx. Both patients and volunteers were subjected to a full history and examination and they all had an indirect rigid laryngoscopy using rigid laryngoscope Henke-Sass, wolf angle 90° Camera Lemke Mc 305.

HRUS was used to examine blindly both groups by tow radiologists. All subjects lied supine with neck slightly extended. Gel was applied on the linear probe. External identification of the thyroid cartilage was done and the examination started by putting the probe transversely on the mid part of the thyroid cartilage. The probe was moved upwards and downwards until the imaging of the laryngeal areas was clearly obtained.

The laryngeal US was performed with a TOSHIBA nemio XG US Machine (Toshiba medical Corporation, Ltd., Tokyo, Japan) equipped with a 7.5 MHz probe for the visualization of the laryngeal structure. The probe was placed on the cricothyroid membrane with a transverse view of the larynx. The standard scanning plane was predetermined: it should contain several landmarks, including the VF, false vocal folds, thyroid cartilage and arytenoids cartilage as demonstrated in Figs. 1–3. This sonographical technique could make a comparable and complete study possible through the unanimous anatomical-section plane by different investigators. VF surrounding soft tissues and the air passage were observed. The laryngeal air column width was defined as the width of air passed through the VF.

The VF were delineated, sonographically, in the transverse plane, through the anterior neck at the level of the cricothyroid membrane and the air-column was clearly demonstrated. The VF delineated as two triangular hypoechoic structures because they consisted of muscles. The false VF were also visualized, using HRUS, as paired, hyperechoic structures above the true vocal cords, due to the presence of fibrofatty tissues. The VF were examined during 2 phases: quiet breathing which allowed better assessment of vocal cord lesions and during phonation (long E) which allowed sonographic assessment of the vocal cords mobility.

The thyroid cartilage appears as reversed V-shaped structure. It is centrally hypoechoic with a hyperechoic margin. The arytenoid cartilage was shown as hyperechoic shadow. They are set on either side of the midline within the posterior margin of the thyroid lamina behind the VF, they were not
clearly identified using HRUS. The cricoid cartilage appears as round hyperechoic structure. The epiglottis appears as hype-
rechoic structure. The anterior superficial muscle of the neck (sternohyoid, omohyoid and thyrohyoid muscles) are easily
recognized in front of the thyroid lamina.

Data analyzed using SPSS program (statistical package
for social sciences). Sensitivity and specificity of the laryn-
geal HRUS were calculated.

Results

The control group with normal laryngoscopic appearance
was examined using HRUS to acquaint the normal sono-
graphic appearance of larynx.

Examination of the larynx was done through the mid
portion of the thyroid cartilage to identify both VF. In
addition, thyroid lamina, anterior commissure, vocal process
of the arytenoids, and glottic chink examined during normal
quiet breathing and phonation. Both the posterior parts and
the free margins of VF could not clearly identi-

fied. The normal sonographic picture of the larynx is shown in Figs. 1–3.

The study group included 66 patients with mean age 42.5
year (40 males and 26 females). All patients attended
Otolaryngology outpatient clinic and phoniatric unit. The
most common presenting symptom was hoarseness of voice
reported among all cases 66 (100%), chronic cough 30 cases
(45.5%) followed by dysphagia 10 patients (15.2%), chocking
attacks 8 (12.1%) and finally stridor in 6 cases (9.1%).

Indirect laryngoscopy revealed that 17 patients had an
interarytenoid edema, 17 patients with a unilateral vocal
fold polyp, 13 patient had vocal nodules, 6 patients had
 glottic cancer, 2 patients with epiglottic enlargement, one
patient had laryngocele, while 10 patients had subglottic
scleroma. Table 1 shows the distribution of laryngeal lesions
as detected by laryngoscope among the study group.

Fig. 4 shows transverse laryngeal HRUS of female patient
48-year-old revealing a rather well-defined left glottic hetero-
genous hypoechic mass with obliterated left para-glottic
space. Preserved related thyroid cartilage. It measures about
16 mm × 13.6 mm (cancer larynx). Fig. 5 shows transverse
laryngeal HRUS of male patient 45-year-old with an ill-
defined left heterogenous glottic mass with preserved para-
laryngeal space and thyroid cartilage but there is extension
to sub-glottic region (4b) – laryngoscleroma. Fig. 6 shows
transverse laryngeal HRUS of male patient 38-year-old with
right-sided sonolucent clear rounded cystic neck swelling

Table 1 – The distribution of laryngeal lesions as detected
by laryngoscopy among the study group

<table>
<thead>
<tr>
<th>Indirect laryngoscopy</th>
<th>Number of patients</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unilateral vocal cord polyp</td>
<td>17</td>
<td>25.7</td>
</tr>
<tr>
<td>Vocal cord nodules</td>
<td>10</td>
<td>19.6</td>
</tr>
<tr>
<td>Interarytenoid edema</td>
<td>17</td>
<td>25.8</td>
</tr>
<tr>
<td>Laryngeal cyst</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>Subglottic scleroma</td>
<td>10</td>
<td>15.2</td>
</tr>
<tr>
<td>Epiglottic enlargement</td>
<td>2</td>
<td>3.1</td>
</tr>
<tr>
<td>Cancer larynx</td>
<td>6</td>
<td>9.1</td>
</tr>
<tr>
<td>Laryngocele</td>
<td>1</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Fig. 4 – Transverse laryngeal HRUS of female patient 48 y
showed well-defined left glottic heterogenous hypoechoic
mass with obliterated left para-glottic space (cancer larynx)

Fig. 5 – Transverse laryngeal HRUS showing laryngoscleroma
with subglottic extension

Fig. 6 – Transverse laryngeal HRUS showing laryngocele

with laryngeal extension. It measures about 5.9 mm × 5.4 mm
(4a). It has well-defined outlines with thin walls representing
laryngocele. Fig. 7 shows transverse laryngeal HRUS of male
30-year-old shows well-defined sessile left hypoechoic glottic
polyp about 6.5 mm × 4.2 mm.

Fig. 8 shows well circumscribed cystic swelling in the
supraglottic area within the frame of the larynx (right
ventricular cyst) HRUS was unable to detect small laryngeal

Fig. 7 – Transverse laryngeal HRUS of male 30-year-old shows well-defined sessile left hypoechoic glottic polyp

Fig. 8 – Transverse laryngeal HRUS of male 45-year-old with ill-defined left heterogenous glottic mass with preserved para-laryngeal space and thyroid cartilage but there is extension to sub-glottic region (4b) – laryngoscleroma.
lesions, exactly vocal nodule in 100% and vocal polyp in 50% of patients as well as interarytenoid edema by 100%.

Discussion

Laryngeal ultrasonography at frequencies ranging from 10 to 30 MHz was demonstrated to be useful in the diagnosis of diseases of the vocal folds since 2007 by Huang et al. [11]. In addition, laryngeal US is a noninvasive, painless, anesthesia not necessary, and much less expensive than the other techniques [12].

The free margin of the vocal folds could not be well delineated in our study of the normal sonographic anatomy of the vocal folds. These results conforming the results of Garel due to the air-soft tissues interface [13]. The laryngeal space can be well seen if the thyroid cartilage was not calcified which is supported by Youssef. In complete calcification of the thyroid cartilage the laryngeal space was not clearly seen [14]. Garel, stated that complete anterior calcification of the thyroid cartilage created an acoustic shadow, which made it hard to analyze the larynx [15].

Laryngeal ultrasound was found to be unable to detect all cases of vocal cord nodules because it is too small to be detected by the resolution of the probe and they lie along the air-soft tissue interface. Schade et al., tried to prove whether results of laryngeal ultrasonography are better than those of laryngeal endoscopy or if there are any additional advantages when using ultrasonography. They concluded that ultrasonography is useful in cases of larger laryngeal lesions, while there was no advantage in the detection of small processes [16].

Our result showed that HRUS is more accurate than endoscopic laryngoscope in detecting small subglottic swellings that hide under vocal folds, this was appearing in early lesion of laryngoscleroma. Our results showed that HRUS has an advantage over laryngoscopy in detecting paraglottic, pre-epiglottic spaces as well as thyroid cartilage infiltration in cases of cancer larynx. Sheth et al, stated that HRUS could identify thyroid cartilage infiltration [17].

Gryczynski, stated that ultrasonography is effective in detection of metastases of laryngeal carcinoma to lymphatic system of neck [18, 19], this agree with our results as HRUS can detect lymphatic metastasis in the neck.

Other authors noted that HRUS is a sensitive, simple and inexpensive method for evaluating laryngeal cancers and sub-clinical cervical lymph node and metastasis [20, 21].

Our study agree with Zajkowski, who stated that Ultrasound is widely regarded as the first imaging method in the diseases of the thyroid, salivary glands (parotid gland, submandibular gland and sublingual gland), lymph nodes, muscles, soft tissues of the head and neck, and as valuable adjunct in some laryngeal pathologies. Real time ultrasound examination allows for dynamic assessment of organs and lesions [22]. Also our study showed how clear and precise the appearance of laryngocele by HRUS.

Conclusion

Rigid endoscopy in laryngeal examination gives us large, bright image but has many disadvantages in patients with a sensitive gag reflex, patients with neck or jaw diseases or stridor and very difficult in infants and children. HRUS is superior to laryngoscopy in detection of early subglottic lesions and differentiation between solid and cystic lesions. It is an alternative method in diagnosis of some laryngeal lesions.

Authors’ contributions/Wkład autorów

MAG was responsible for study design, acceptance of final manuscript version, MSH was responsible for study design, data collection, HM was responsible for study design, statistical analysis, NO and MGE was responsible for data interpretation, literature search.

Conflict of interest/Konflikt interesu

None declared.
Financial support/Finansowanie

None declared.

Ethics/Etyka

The work described in this article have been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; EU Directive 2010/63/EU for animal experiments; Uniform Requirements for manuscripts submitted to Biomedical journals.

References/Piśmiennictwo