# CLINICAL ASSESMENT OF LARYNGOMALACIA AND THE ROLE OF LARYNGEAL ULTRASOUND

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# ABSTRAK

***Pengenalan:*** Stridor dikalangan bayi merupakan masalah yang sering dirujuk kepada Jabatan Otorinolaringologi (ORL) dan kebanyakannya disebabkan oleh laringomalasia diikuti oleh lumpuh peti suara dan stenosis subglotik. Selain stridor, mereka boleh menunjukkan tanda-tanda tertentu seperti apnea, sianosis, kegagalan tumbesaran dan perkembangan, susah bernafas, apnea tidur obstruktif dan gangguan pemakanan yang juga menentukan keterukan laringomalasia. Nasofaringolaringoskopi fleksibel (FNPLS) adalah ujian standard bagi mendiagnosis punca stridor termasuklah laringomalasia. Ultrasound larinks (LUS) ialah pilihan pengimejan yang tidak invasif, tidak menyakitkan dan diterima dengan baik namun belum dijadikan ujian rutin untuk menilai pesakit stridor di Malaysia.

***Objektif*** : Untuk menilai perkadaran, keterukan, dan jenis-jenis laringomalasia di kalangan bayi yang mempunyai stridor di Hospital Universiti Sains Malaysia (HUSM) dan peranan diagnostik LUS bagi laringomalasia.

***Kaedah:*** Kami menjalankan kajian keratan rentas dari 2021-2022 ke atas bayi berumur 12 bulan dan ke bawah yang dirujuk untuk stridor di HUSM. Mereka melalui pemeriksaan ORL dan juga FNPLS. Pembolehubah berikut telah dikumpul; usia gestasi, berat lahir, umur semasa rujukan, berat semasa, komorbiditi, tanda-tanda dan gejala serta penemuan FNPLS. Pesakit kemudian dihantar untuk menjalankan LUS oleh pakar radiologi kurang dari seminggu dari tarikh skop, tanpa pengetahuan berkenaan keputusan FNPLS. Tahap keterukan laringomalasia dikelaskan mengikut simptom yang ditunjukkan dan

pemeriksaan fizikal. Penemuan endoskopik direkodkan, disemak dan ditentukan skor, manakala jenis laringomalasia ditentukan oleh Olney Classification.

***Keputusan:*** Seramai 47 pesakit memenuhi kriteria kajian. Komorbiditi seperti penyakit jantung kongenital, kana-kanak sindromik dan refluks gastroesofagus (GERD) adalah komorbiditi paling kerap dilihat. Perkadaran laringomalasia di kalangan bayi dengan stridor ialah 93.6% dengan ketepatan 0.1 dengan keyakinan 95%. Tujuh daripada pesakit laringomalasia telah didapati mempunyai penemuan lain. Enam dari mereka mempunyai lumpuh peti suara manakala seorang lagi mempunyai granuloma intubasi. Bagi tiga bayi yang tidak mempunyai laringomalasia telah didiagnosis dengan yang berikut: vallecula cyst (1), lumpuh peti suara (1) dan penemuan normal (1). Terdapat perkaitan yang signifikan antara Type 1 (p=0.005) dan Type 3 (p=0.032) dengan keterukan (sederhana-teruk) laringomalasia. Mereka yang mempunyai gabungan jenis-jenis juga menunjukkan perkaitan dengan tahap keterukan (p=0.022) di mana 75% bayi dengan gabungan Type (1+2, 2+3, 1+2+3) mempunyai laringomalasia sederhana–teruk. Terdapat perbezaan statistik yang signifikan bagi Laryngoscopic Score di antara tahap keterukan laringomalasia (p= 0.012) dengan skor median 1.00 untuk ringan, 2.00 untuk sederhana dan 3.00 untuk teruk. LUS sebagai alat tambahan dalam laringomalasia dimana ia mempunyai sensitiviti, spesifisiti, nilai ramalan positif, dan nilai ramalan negatif masing-masing adalah 100%, 66.7%, 97.7%, dan 100%.

***Kesimpulan***: Laringomalasia kekal sebagai punca yang paling kerap bagi stridor kongenital. FNPLS mendedahkan bahawa gabungan Type (1+2) dan Type 3 laryngomalacia dikaitkan dengan laryngomalasia tahap sederhana-teruk. Laringomalasia tahap teruk lebih cenderung mendapat skor yang lebih tinggi berbanding yang kurang teruk. LUS boleh digunakan dengan selamat dan tepat bagi menyaring laryngomalacia dikalangan bayi yang stridor, apabila FNPLS tidak dapat di jalankan.

# ABSTRACT

***Introduction:*** Stridor in infants is a common referral to the Department of Otorhinolaryngology (ORL) and are mostly due to laryngomalacia followed by vocal cord paralysis and subglottic stenosis. Besides stridor, they can also present with certain signs such as apnoea, cyanosis, failure to thrive, episodes of respiratory distress, obstructive sleep apnoea and feeding disturbances which also determines the severity. Flexible nasopharyngolaryngoscopy (FNPLS) is the gold standard diagnostic tool to determine the cause of stridor including laryngomalacia. Laryngeal ultrasound (LUS) is a non-invasive, painless, and well tolerated imaging option but is not routinely used to assess stridorous patients in Malaysia.

***Objectives:*** To evaluate proportion, severity, and types of laryngomalacia among stridorous infants in Hospital Universiti Sains Malaysia (HUSM) and the diagnostic role of laryngeal ultrasound (LUS) in laryngomalacia.

***Methods*:** We conducted a cross-sectional study from 2021-2022 on infants aged 12 months and below who were referred for stridor to HUSM. They were assessed clinically upon referral and via FNPLS. The following variables were collected; gestational age, birth weight, age at presentation, current weight, comorbidities, presenting signs and symptoms as well as FNPLS findings. Within one week after FNPLS, patients were seen by the radiologist for LUS, who was kept unaware of the previous findings. The severity of laryngomalacia were classified according to the presenting symptoms and physical examination. Endoscopic findings were recorded, reviewed and scored, while types of laryngomalacia were determined by Olney Classification.

***Results*:** A total of 47 patients met the criteria for the study. Congenital heart disease, syndromic child and gastroesophageal reflux (GERD) were the commonest comorbidity among them. The proportion of laryngomalacia among infants with stridor was 93.6% with the precision of 0.1 with 95% confidence. Seven of patients with laryngomalacia also had other concomitant findings such as vocal cord immobility (6) and granuloma (1). Three patients who had no laryngomalacia features were diagnosed with the following : vallecula cyst (1), left vocal cord paralysis (1) and normal findings (1). There is a significant association between Type 1 (p=0.005) and Type 3 (p=0.032) with severity (moderate-severe) of laryngomalacia. Those with combined types also show association with severity (p=0.022) where 75% infants with combined Type (1+2, 2+3, 1+2+3) had moderate-severe laryngomalacia. There was a statistically significant difference in laryngoscopic score between the different severity of laryngomalacia (p=0.012) with a median score of 1.00 for mild, 2.00 for moderate and 3.00 for severe. LUS as adjunct tool in laryngomalacia had the sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 66.7%, 97.7%, and 100% respectively.

***Conclusion*:**

Laryngomalacia is consistently the most common cause of congenital stridor. FNPLS revealed that combined Type (1+2) and Type 3 laryngomalacia were associated with moderate-severe laryngomalacia. A higher laryngoscopic score suggest a more severe laryngomalacia. LUS can safely be used to screen for laryngomalacia in stridorous infants when FNPLS is not feasible.

**CHAPTER 1:**

# INTRODUCTION

## 1.1 INTRODUCTION

Stridor in infants is a common referral to paediatric otorhinolaryngologists. It is a sign of partial obstruction of the airway at the level of pharynx, larynx and/or trachea and is characterised by the high pitched, harsh sound that occurs during inspiration, expiration or at both phase (biphasic stridor) depending on the level of obstruction. The most common cause of congenital stridor is laryngomalacia or “soft larynx”, followed by vocal cords paralysis, subglottic stenosis, localised oedema, laryngeal cysts, laryngeal haemangioma, and laryngeal polyps (Barazi, 2019; Botma et al., 2000; Jain and Jain, 2022; John, 1992; Shirley et al., 2019). The prevalence of laryngomalacia in patients who presented with stridor at birth was 45-75% (Barazi, 2019; Landry and Thompson, 2012). Stridor in laryngomalacia can present within 10 days of life but with varying ranges of presentation, progression, and eventual outcome (depending on treatment) (Alshumrani et al., 2020; Ayari et al., 2012; Landry and Thompson, 2012; Richter et al., 2009; Thompson, 2010).

Besides stridor, the clinical severity of laryngomalacia is represented by presence of several symptoms and signs such as apnoea, cyanosis, failure to thrive, episodes of respiratory distress, obstructive sleep apnoea and feeding disturbances where in most cases are mild disease and resolves before the age of two (Barazi, 2019; Shah and Wetmore, 1998; Thompson, 2010). Flexible nasopharyngolaryngoscopy (FNPLS), also known as awake flexible nasopharyngoscopy (FOS)/ flexible nasolaryngoscopy (FNL)/ flexible fibreoptic laryngoscopy (FFL) is an essential skill for any otorhinolaryngologist or doctors working in the otorhinolaryngology department (Alvi and Harsha, 2021; Botma et al., 2000; Kandil et al., 2016; Nielson et al., 2000). Otolaryngologists can distinguish laryngomalacia from other causes of inspiratory stridor, such as vocal cord paralysis or a laryngeal cyst, by observing the dynamic movement of the laryngeal structures during spontaneous breathing. Laryngomalacia is characterized by blockage and supraglottic tissue collapse during inspiration (Jain and Jain, 2022). FNPLS maintains to be the gold standard diagnostic tool and can help to further classify laryngomalacia into three types based on the characteristics of its laryngeal dynamic abnormalities (Ayari et al., 2012; Sivan et al., 2006).

There are various publications depicting classification of laryngomalacia, among them is the Olney Classification. It is commonly used in paediatric ORL which divides laryngomalacia into three types: Type 1- prolapse of mucosa overlying arytenoid cartilages, Type 2–foreshortened aryepiglottic folds and Type 3- posterior displacement of epiglottis(Olney et al, 1999.; Shah and Wetmore, 1998). There are also various combinations of the types seen among patients (Kusak et al., 2017). Sivan et al had scored the endoscopic findings based on two parts which were: a) “epiglottic score” (range, 0 to 4 points); and b) “arytenoids score” (range, 0 to 4 points), with maximal accumulative score of 8 points (Sivan et al., 2006). A detailed history, thorough physical examination and FNPLS will help determine the cause of stridor and alas decide on further management.

Infants with suspected upper airway obstruction require a careful yet prompt evaluation due to their smaller airway diameter. It can prove to be fatal in the event of obstruction or spasm due to its profound effect on airflow. The standard method to investigate the cause of stridor is still via the FNPLS. It is normally performed while patient is awake allowing us a preliminary dynamic evaluation of the upper airway. After our assessment, will we then decide the necessity for further examination under anaesthesia or for surgical intervention (Escobar and Needleman, 2015; Lee et al., 2007; Walner et al., 2015).

Nonetheless, during an awake FNPLS, a struggling child may hinder the inspection of laryngeal structures due to the varying dynamic motion which is affected by changing of positions, tolerance level and time constraints (Friedman et al., 2018; Shirley et al., 2019). Additionally, severe laryngeal diseases with oedema and spasm may hamper FNPLS from visualizing the glottic and subglottic structures while impairing the interpretative ability to achieve correct diagnosis. In certain cases, a direct laryngoscopy and bronchoscopy under general anaesthesia (GA) may be done to allow closer examination by obtunding the dynamic movement of vocal cord. The drawback is it requires allocated slot in the operation theatre, admission to the ward as well as venous access which all can be costly, time-consuming, and not without GA risks as well as risk of injury to the oral cavity upon insertion of laryngoscope (Chadha et al., 2015).

Furthermore, during the recent COVID-19 pandemic, the whole medical field struggled to limit and avoid all aerosol generating procedures like bedside endoscopy while still attempting to optimally treat patients without delay in various subspecialties (Noel et al., 2020; Sciancalepore et al., 2021). Ultrasound is a well-established imaging tool that is non-invasive, painless and radiation free. In LUS, it enables dynamic assessment of moving structures in the larynx especially among the paediatric group (Friedman et al., 2018; Huang et al., 2019; Kandil et al., 2016; Ongkasuwan et al., 2017; Shirley et al., 2019). Albeit an uncommon diagnostic tool, Garel et al had showed that laryngeal ultrasound (LUS) can effectively visualize normal laryngeal anatomy and vocal cord movements of infants and children (Garel et al., 1992). According to Shirley et al, LUS may be applied as an adjuvant diagnostic tool for ruling the laryngeal pathologies in children with dysphonia and stridor (Shirley et al., 2019).

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**CHAPTER 2:**

# OBJECTIVES

## 2.1 GENERAL OBJECTIVE

To evaluate proportion, severity, and types of laryngomalacia among stridorous infants in Hospital Universiti Sains Malaysia (HUSM) and the diagnostic role of Laryngeal Ultrasound (LUS) in laryngomalacia

## 2.2 SPECIFIC OBJECTIVES

1. To determine the proportion of laryngomalacia among infants with stridor

2. To determine the association between types and the severity of laryngomalacia

3. To determine the association between Laryngoscopic Score with severity of laryngomalacia

4. To determine the accuracy of LUS in diagnosing laryngomalacia

**CHAPTER 3:**

# MANUSCRIPT

## 3.1 TITLE PAGE

**Clinical Assessment of Laryngomalacia and The Role of Ultrasound**

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## 3.2 ABSTRACT

***Objectives:*** To evaluate proportion, severity, and types of laryngomalacia among stridorous infants in Hospital Universiti Sains Malaysia (HUSM) and the diagnostic role of laryngeal ultrasound (LUS) in laryngomalacia.

***Methods*****:** We conducted a cross-sectional study from 2021-2022 on infants aged 12 months and below who were referred for stridor to HUSM. They were assessed clinically upon referral and via FNPLS. The following variables were collected; gestational age, birth weight, age at presentation, current weight, comorbidities, presenting signs and symptoms as well as FNPLS findings. Within one week after FNPLS, patients were seen by the radiologist for LUS, who was kept unaware of the previous findings. The severity of laryngomalacia were classified according to the presenting symptoms and physical examination. Endoscopic findings were recorded, reviewed and scored, while types of laryngomalacia were determined by Olney Classification.

***Results*****:** A total of 47 patients met the criteria for the study. Congenital heart disease, syndromic child and gastroesophageal reflux (GERD) were the commonest comorbidity among them. The proportion of laryngomalacia among infants with stridor was 93.6% with the precision of 0.1 with 95% confidence. Seven of patients with laryngomalacia also had other concomitant findings such as vocal cord immobility (6) and granuloma (1). Three patients who had no laryngomalacia features were diagnosed with the following : vallecula cyst (1), left vocal cord paralysis (1) and normal findings (1). There is a significant association between Type 1 (p=0.005) and Type 3 (p=0.032) with severity (moderate-severe) of laryngomalacia. Those with combined types also show association with severity (p=0.022) where 75% infants with combined Type (1+2, 2+3, 1+2+3) had moderate-severe laryngomalacia. There was a statistically significant difference in laryngoscopic score between the different severity of laryngomalacia (p=0.012) with a median score of 1.00 for mild, 2.00 for moderate and 3.00 for severe. LUS as adjunct tool in laryngomalacia had the sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 66.7%, 97.7%, and 100% respectively.

***Conclusion*:** Laryngomalacia is consistently the most common cause of congenital stridor. FNPLS revealed that combined Type (1+2) and Type 3 laryngomalacia were associated with moderate-severe laryngomalacia. A higher laryngoscopic score suggest a more severe laryngomalacia. LUS can safely be used to screen for laryngomalacia in stridorous infants when FNPLS is not feasible.

**Keywords:** Laryngomalacia; stridor; severity; laryngoscopy; ultrasound

## 3.3 INTRODUCTION

Stridor in infants is a common referral to paediatric otorhinolaryngologists. It is a sign of partial obstruction of the airway at the level of pharynx, larynx and/or trachea and is characterised by the high pitched, harsh sound that occurs during inspiration, expiration or at both phase (biphasic stridor) depending on the level of obstruction. The most common cause of congenital stridor is laryngomalacia or “soft larynx”, followed by vocal cords paralysis, subglottic stenosis, localised oedema, laryngeal cysts, laryngeal haemangioma, and laryngeal polyps [1–4]. The prevalence of laryngomalacia in patients who presented with stridor at birth was 45-75% [5,6] . Stridor in laryngomalacia can present within 10 days of life but with varying ranges of presentation, progression, and eventual outcome (depending on treatment) [5,7–10].

Besides stridor, the clinical severity of laryngomalacia is represented by presence of several symptoms and signs such as apnoea, cyanosis, failure to thrive, episodes of respiratory distress, obstructive sleep apnoea and feeding disturbances where in most cases are mild disease and resolves before the age of two [6,9,11]. Flexible nasopharyngolaryngoscopy (FNPLS), also known as awake flexible nasopharyngoscopy (FOS)/ flexible nasolaryngoscopy (FNL)/ flexible fibreoptic laryngoscopy (FFL) is an essential skill for any otorhinolaryngologist or doctors working in the otorhinolaryngology department [1,12–14]. Otolaryngologists can distinguish laryngomalacia from other causes of inspiratory stridor or secondary airway lesions (SAL), such as vocal cord paralysis or a laryngeal cyst, by observing the dynamic movement of the laryngeal structures during spontaneous breathing. Laryngomalacia is characterized by blockage and supraglottic tissue collapse during inspiration [2]. FNPLS maintains to be the gold standard diagnostic tool and can help to further classify laryngomalacia into three types based on the characteristics of its laryngeal dynamic abnormalities [10,15].

There are various publications depicting classification of laryngomalacia, among them is the Olney Classification. It is commonly used in paediatric ORL which divides laryngomalacia into three types: Type 1-prolapse of mucosa overlying arytenoid cartilages, Type 2–foreshortened aryepiglottic folds and Type 3-posterior displacement of epiglottis [11,16]. There are also various combinations of the types seen among patients [17] . Sivan et al had scored the endoscopic findings based on two parts which were: a) “epiglottic score” (range, 0 to 4 points); and b) “arytenoids score” (range, 0 to 4 points), with maximal accumulative score of 8 points [15]. A detailed history, thorough physical examination and FNPLS will help determine the cause of stridor and alas decide on further management.

Infants with suspected upper airway obstruction require a careful yet prompt evaluation due to their smaller airway diameter. It can prove to be fatal in the event of obstruction or spasm due to its profound effect on airflow. The standard method to investigate the cause of stridor is still via the FNPLS. It is normally performed while patient is awake allowing us a preliminary dynamic evaluation of the upper airway. By this first assessment will we then decide the necessity for further examination under anaesthesia or for surgical intervention [18–20].

Nonetheless, during an awake FNPLS, a struggling child may hinder the inspection of laryngeal structures due to the varying dynamic motion which is affected by changing of positions, tolerance level and time constraints [4,21]. Additionally, severe laryngeal diseases with oedema and spasm may interfere FNPLS from visualizing the glottic and subglottic structures while impairing the interpretative ability to achieve correct diagnosis. In certain cases, a direct laryngoscopy and bronchoscopy under general anaesthesia (GA) may be done to allow closer examination by obtunding the dynamic movement of vocal cord. The drawback is it requires allocated slot in the operation theatre, admission to the ward as well as venous access which all can be costly, time-consuming, and not without GA risks as well as risk of injury to the oral cavity upon insertion of laryngoscope [22].

Furthermore, during the recent COVID-19 pandemic, the whole medical field struggled to limit and avoid all aerosol generating procedures like bedside endoscopy while still attempting to optimally treat patients without delay in various subspecialties [23,24]. Ultrasound is a well-established imaging tool that is non-invasive, painless and radiation free. In LUS, it enables dynamic assessment of moving structures in the larynx especially among the paediatric group [4,14,21,25,26]. Albeit an uncommon diagnostic tool, Garel et al had showed that laryngeal ultrasound (LUS) can effectively visualize normal laryngeal anatomy and vocal cord movements of infants and children [27]. According to Shirley et al, LUS may be applied as an adjuvant diagnostic tool for ruling the laryngeal pathologies in children with dysphonia and stridor [4].

This study aims first to establish the proportion of laryngomalacia among stridor patients referred to HUSM. Secondly to determine the association of clinical severity of laryngomalacia with its FNPLS findings, specifically according to types as well as the laryngoscopic score as there are only few studies available. We hope this study will be the start of further studies that may help determine how severity and scope findings predict our choice of treatment . Finally, as there are only sparse reports on role of LUS in laryngomalacia infants. Therefore we want to evaluate LUS as an adjunct tool to diagnose laryngomalacia especially in cases where optimal FNPLS is not permissible. After experiencing the long period of strict protocols during the COVID-19 pandemic, we strive to be able to provide best treatment option for laryngomalacia.

## 3.4 MATERIALS AND METHODS

### 3.4.1 Ethical consideration

The study was conducted at a tertiary referral centre, HUSM, for 1 year between 4$^{th}$ October 2021 until 4$^{th}$ October 2022. It was approved by the Human Research Ethics Committee, USM with code number **USM/JEPeM/21030224**. A written consent was obtained by the legal caretakers of each participating infant.

### 3.4.2 Study design

The cross-sectional study included all infants with stridor who were referred to Department of Otorhinolaryngology-Head and Neck Surgery (ORL-HNS), HUSM. History taking and examination were done followed by both FNPLS and LUS.

### 3.4.3 Inclusion and Exclusion Criteria

All infants with stridor were included except those that had undergone any surgical intervention, clinically unstable and/or with ventilator support.

### 3.4.4 History and General ORL Examination

Demographic characteristics, including age, gestational maturity, weight (birth and current) and comorbidities was obtained and general ORL examinations were performed. Severity of symptoms were determined using scoring by Sweeti et al (2019) where a score of 1 are given for stridor, cyanotic episode, choking, feeding difficulties, failure to thrive, and chest retraction while a higher score of 3 for apnea and pectus excavatum. The accumulative score determined the severity of symptoms and grouped them into mild (1-3), moderate (4-5) and lastly severe (>5).

### 3.4.5 Flexible Nasopharyngolaryngoscopy (FNPLS)

The FNPLS was done using Storz fiberoptic flexible scope sized 2.5mm with findings recorded. Infants were kept nil by mouth prior to procedure at least half an hour to avoid risk of reflux/ regurgitation. Baseline pulse oximetry was taken before scope and also continuous monitoring throughout procedure. During the 5-10 minutes procedure, patients were observed for signs of respiratory distress (i.e – apnoea, cyanosis) and resuscitation trolley kept on nearby. During outpatient setting, the awake infants were gently swaddled and held by caretakers in upright position. Warded infants on oxygen treatment were put in supine position on the procedure cot. Flexible scope were then introduced into the nose until proper visualization of the supraglottic structures and able to assess its dynamic motion. All recorded FNPLS findings were evaluated by investigators. Endoscopic findings were scored with Laryngoscopic score by Sivan et al (2019), while types were determined by Olney et al (1999) classification. Laryngoscopic Score were determined by degree of arytenoid collapse and epiglottis folding while types were divided into three, prolapse of mucosa overlying arytenoid (Type 2), foreshortened aryepiglottic fold (Type 2) and lastly posterior displacement of epiglottis (Type 3). All infants with stridor (laryngomalacia and non-laryngomalacia) were identified and sent for LUS appointment.

### 3.4.6 Laryngeal ultrasound (LUS)

LUS were performed by appointment, within seven days of FNPLS where findings were not informed to operator. A DC – 8EXP Mindray ultrasound unit and Shenzen Mindray Bio-Medical Electronics with a L14-6 WE linear transducer was used to perform the LUS. To seek reliability of the data and reduce interobserver variability, the LUS is performed by two ultrasound doctors, one radiology postgraduate student and one radiologist (co-investigator) who have established inter-rater reliability agreement. The swaddled infant was put in supine position exposing the neck with no sedation required. Image acquisition includes images of epiglottis and glottic region where angle of epiglottis curling, and epiglottis to inter-arytenoid distance were measured to determine laryngomalacia. Dynamic mobility of the vocal cords was also assessed including other probable abnormal laryngeal structures causing the stridor. All ultrasound findings were recorded, and interpretation were concluded and documented blinded to the FNPLS findings earlier. All patients referred for stridor will be further managed as per treatment protocol regardless of if selected for study or not.

### 3.4.7 Data and statistical analysis

In this analysis, all categorical data were presented in frequency and percentage, while the numerical data were presented in median & Interquartile. We used Chi Square test, Fisher's exact test and Kruskal-Wallis H test accordingly. The p level of less than 0.05 was considered statistically significant. Statistical analysis was performed using version 26 of the SPSS software (SPSS Inc, Chicago, IL).

### 3.5 RESULTS

A total of 47 patients met the criteria for the study. Descriptive statistics was used to summarise the socio-demographic characteristics of subjects (Table 1). Median gestational age was 38 weeks with median age referred were 51 days old. No procedure related complications or desaturation occurred throughout the procedures nor after completion of assessment and in attendance of paediatric resident. All patients except one had stridor during our reassessment (97.9%) while the second most common findings were chest retraction (70.2%) followed by interrupted feeding (63.8%), choking (48.9%), failure to thrive (27.7%), cyanosis (14.9%), pectus excavatum (6.4%) and lastly apnoea which were only seen in two patients (4.3%).

Most of the patients with feeding difficulties and failure to thrive were been treated in neonatal intensive care unit (NICU) hence were already on assisted feeding upon our review. Among these 47 patients, 20 patients (42.5%) were found to have underlying comorbidities with commonest ones being congenital heart disease (27.7%), syndromic child (21.3%) and GERD (17.7%). Severity symptoms score had a median score of 3.00 with majority of subjects classified as mild (57.4%) followed by moderate (34%) and lastly severe (8.4%).

*Table 1. Demographics, clinical presentation and comorbidities.*

| **VARIABLE** | **N** | **(%)** | **MEDIAN** | **(IQR)** |
|---|---|---|---|---|
| DEMOGRAPHIC | | | | |
| Gestational Age (Weeks) | | | 38.00 | 3.0 |
| Age Referred (Days) | | | 51.00 | 56.0 |
| Birth Weight (kg) | | | 3.08 | 1.03 |
| Current Weight (kg) | | | 4.00 | 1.64 |
| COMORBIDITIES | **N** | **(%)** | | |
| Syndromic | 10 | 21.3 | | |
| Congenital Heart Disease | 13 | 27.7 | | |
| GERD | 8 | 17.0 | | |
| Secondary airway lesion (SAL) | 7 | 16.3 | | |
| CLINICAL PRESENTATION | **N** | **(%)** | | |
| Stridor | 46 | 97.9 | | |
| Cyanosis | 7 | 14.9 | | |
| Choking | 23 | 48.9 | | |
| Interrupted Feeding | 30 | 63.8 | | |
| Apnoea | 2 | 4.3 | | |
| Failure To Thrive (FTT) | 13 | 27.7 | | |
| Chest Retraction | 33 | 70.2 | | |
| Pectus Excavatum | 3 | 6.4 | | |

Detailed ORL assessment discovered that the proportion of laryngomalacia among infants with stridor was 93.6% with the precision of 0.1 and 95% confidence (Table 2). Seven patients with laryngomalacia (16.3%) also had SAL where six patients also had vocal cord paralysis and one with intubation granuloma. The three patients with no laryngomalacia each following findings: vallecula cyst (1), left vocal cord paralysis (1) and normal findings (1).