

## Pediatric Dysphonia - A Review

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Received - 25 December 2018

Initial Review - 27 January 2019

Accepted - 28 January 2019

### ABSTRACT

Dysphonia or hoarseness of voice is defined as a disorder characterized by altered voice quality, loudness, pitch, or vocal effort which impairs the communication or hamper voice-related quality of life. Dysphonia or hoarseness of the voice is a commonly encountered vocal symptom among children. The etiological profiles of dysphonia among children are variable. The laryngoscopic examination is required for identification of the lesions. Pediatric dysphonia is a common cause for referral to pediatric otolaryngologists and management sometimes vary. Voice disorders in children are often due to strenuous speaking, screaming, singing, excess coughing, and habit of clearing throat. Endoscopic and physical examinations are the key behind the assessing dysphonic child. Flexible nasopharyngolaryngoscopy is suitable for accurate diagnosis. Additional examinations are sometimes needed during the assessment. There several treatment options for pediatric dysphonia and often based on the etiology.

**Key words:** *Dysphonia, Pediatric, Hoarseness of voice, Vocal fold*

Communication or speech of children plays a key role in everyday life. Dysphonia and hoarseness are the terminology used for altered voice quality. Dysphonia is a commonly encountered a clinical problem in pediatric otolaryngology practice. Hoarseness or dysphonia is around 6–9% of all childhood voice problems [1]. Pediatric dysphonia represents a broad-spectrum disorder ranging from hoarseness to inability to communicate. Hoarseness or dysphonia is a disorder characterized by the altered quality of voice, loudness, pitch, or vocal effort which reduces the voice quality so impairs the communication [2]. Hoarseness can be seen in all age groups. The incidence of hoarse voice in the school going children was reported as 2–23% [3]. Dysphonia has a negative effect on the health of the child, communication, social and educational development, self-image, and self-esteem. Endolaryngeal microlaryngoscopic excision by minimal stripping or CO<sub>2</sub> laser is helpful for vocal fold lesions such as nodules and polyps. The variable causes and its effects on the social, educational, and emotional part of the life prompted us to write this review. The purpose of this review article is to discuss the epidemiology, etiopathology, anatomical considerations, diagnosis, and treatment of dysphonia in pediatric age group on the basis of the data from world medical literature.

### EPIDEMIOLOGY

Epidemiological studies on pediatric dysphonia are rare in medical literature. The prevalence of pediatric dysphonia is 6%–38% [4].

The peak incidence of dysphonia in childhood is in between 8 and 10 years (43–44%) although approximately 30% of patients aged 7 or under [5]. It is difficult to determine the exact age of onset for dysphonia in pediatric patients. Dysphonia is predominantly seen among male child of about 60% cases [6] whereas it is less marked <7 years of age, followed by a male predominance and equalizes by 11 years and then turns into female predominance at around 13 years [7]. Vocal nodules (Fig. 1) are common pathology for pediatric dysphonia followed by congenital dysphonia [7].

### ANATOMICAL CONSIDERATION IN DYSPHONIC CHILD

The characteristic head and neck anatomy in children has an impact on voice production and dysphonia. The newborn baby has a small mandible, smallmouth, large head, more fat pads at the cheeks, and tongue filling the entire oral cavity. All these anatomical characteristics have an impact on the speech of the child. The larynx of the child is present high in the neck in relation vertebra of the neck and cricoid cartilage at the fourth cervical vertebra (C4), in comparison to C6–C7 vertebra in adults. There is also a closer relationship between the epiglottis and soft palate and a shorter length vocal tract than adults.

The laryngeal cartilages and vocal folds of the larynx changes as the child grow or mature. The higher position of the larynx makes a tighter oral seal and helps the infants to breathe while feeding. The connective tissue layers of the lamina propria in vocal folds are not well delineated or not well defined and vocal

ligament not fully developed in children. In growing infant, the functions of the larynx evolve from primary airway protection to complex phonatory function along with airway protection. The vocal fold usually consists of five layers, and these are epithelium, three layers of lamina propria (superficial, intermediate, and deep), and the thyroarytenoid muscle.

According to Hirano's cover-body theory of the vocal fold vibration, the epithelium and superficial layer of the lamina propria form the "cover," the vocalis muscle form the body, and the intermediate and deep layers of the lamina propria constitute the vocal ligament, which are the "transition" layer [8]. The cover layer is often involved in the mucosal wave vibration of the vocal folds. The basement membrane zone (BMZ) consists of extracellular matrix which attaches and secures the overlying epithelium of the vocal fold. The BMZ is divided into two layers, the superficial lamina lucida and deep lamina densa. The superficial lamina lucida unite the basal epithelium by hemidesmosomes and deep lamina densa is attached to the superficial layer of lamina propria by anchoring fibers consisting of collagen Type VII. The superficial lamina lucida and deep lamina densa of the BMZ are joined by anchoring filaments, which consists of collagen type IV and fibronectin [9].

Hemorrhagic polyps (Fig. 2) in the vocal fold are usually due to phonotrauma such as voice abuse or misuse. Vocal nodules are usually formed due to excessive vibration of the vocal fold at the junction of anterior one-third to the posterior two-third. The trauma or phonotrauma affects the capillaries of the vocal fold mucosal layer, which leads to variations in the dynamic of the fluid at lamina propria and forms edema which triggers the process for vocal nodule formation. Histologically, the vocal nodules show proliferation of the epithelial layers, thickening of the basement membrane, and formation of abundant fibronectin in the lamina propria [10].

## ETIOPATHOLOGY

The etiologies of pediatric dysphonia are classified into organic, infectious, inflammatory, traumatic, iatrogenic, congenital, and functional [11]. The functional causes for voice changes in children are emotional or psychological problems such as personality disorders, adjustment problems, or anxiety. The organic causes for pediatric voice disorders are laryngeal papilloma, laryngeal web, stenosis, malignant lesions, polyp (Fig. 3), cysts (Fig. 4), and nodules whereas allergic or infectious laryngitis and laryngitis due to gastroesophageal reflux are other common causes for hoarseness of voice in children [12]. Trauma to larynx either external (blunt) or internal as in endotracheal intubation or prolonged nasogastric tube injury cause injury to vocal fold and lead to change in voice or dysphonia. Vocal nodules are a common cause of dysphonia during childhood. Vocal fold nodules are seen in 40% of the cases suffering from voice disturbances [13]. Vocal fold nodules have a strong relationship with allergic rhinitis, upper respiratory tract infections and gastroesophageal reflux are major predisposing factors [14].

Children with chromosomal defects cause dysphonia as in case of cri du chat syndrome. In the pediatric age group, the

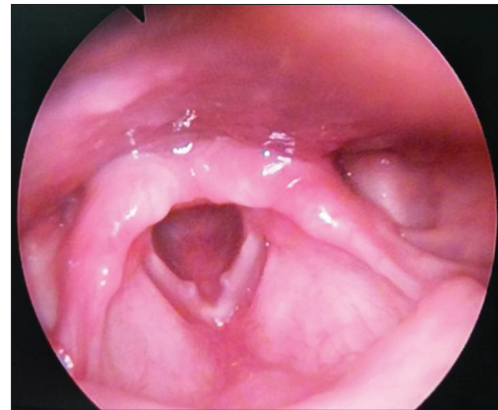


Figure 1: Vocal nodules

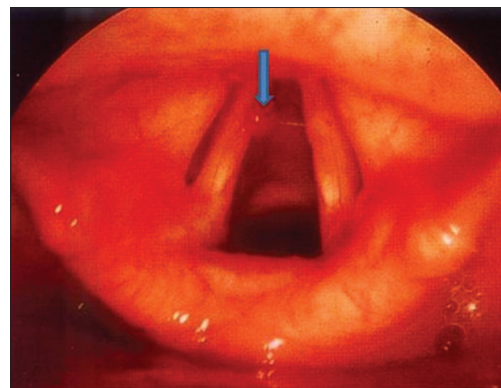


Figure 2: Left vocal fold hemorrhagic polyp (arrow mark)

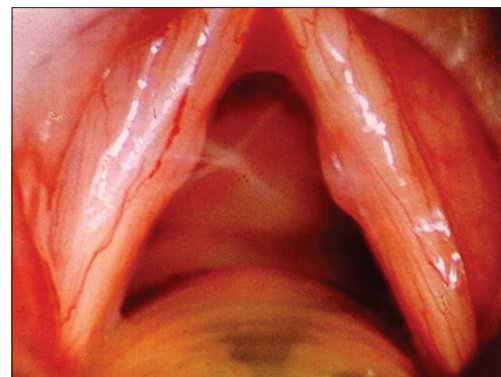


Figure 3: A small right vocal fold polyp

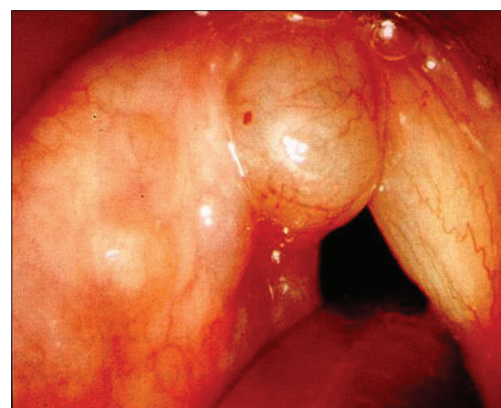


Figure 4: Left vocal fold cyst

behaviors of the male child are more impulsive and aggressive than a female child and are allied to anxiety, spirit of leadership, and excessive hyperactivity. These profiles of male child directly reflect in phonatory mechanisms, leading to vocal abuse [15]. As age increases in childhood, the larynx undergoes structural changes due to masculine hormones in adolescence, leading to enlargement of laryngeal dimension. In male adolescent, the new glottic configuration is characterized by longer vocal folds along with the acute angle of thyroid cartilage approximately  $90^\circ$ . During the adolescent period of male child, symptoms of dysphonia tend to decrease, and vocal nodules begin an involution process.

Such types of changes are not seen in adolescent girls. In adolescent girls, the vocal folds elongate 3–4 mm whereas in boys, it increases by 1 cm [16]. Children in family with siblings are often prone for dysphonia [6]. One study showed that 65% of the children suffering from dysphonia belonged to large families, i.e., more than two children, 30% of the children had a family history of dysphonia, and 57% of them are male child [17]. Outcomes of this study suggest that noisy surroundings need excessive demand for loud talking which makes the risk for the formation of vocal nodules and dysphonia [17]. Phonotrauma in noisy environment is an important risk factor for causing dysphonia among children [18].

The most common etiology for hoarseness of voice among children is vocal fold nodules, which have been seen in 38–78% of the pediatric patients evaluated for dysphonia [1]. Other vocal fold lesions such as localized edema and irregular surface at the junction of the anterior and middle third of the vocal fold are found in 13.3% of children of those evaluated for dysphonia [15]. Common causes of dysphonia in adults such as recurrent laryngeal nerve paralysis, vocal fold polyps or cysts are rarely seen in children [1]. There were equivalent results documented by other studies such as Connelly *et al.* (45.2%) [19] and Angelillo *et al.* (90.3%) [17]. Vocal abuse is an important factor for the development of vocal fold lesions due to phonotrauma, especially vocal nodules. Vocal fold polyps occur mainly among children those use their voices very intensively and develop at the site of maximum muscular and aerodynamic forces exerted during phonation, and it is considered as the squeal of phonotrauma.

The metabolic or endocrinal causes may lead to dysphonia in children by metabolic errors which cause disruption of normal enzymatic activity and cause abnormal infiltration or faulty muscle and nerve function. In Urbach–Wiethe's disease or mucopolysaccharidosis, dysphonia occurs laryngeal involvement. In a hypothyroid child, there is generalized hypotonia and myxoedematous infiltrations in the vocal folds. Extrinsic administration or abnormal secretion of testosterone or estrogen interfere with normal laryngeal function and often lead to dysphonia. Recurrent respiratory papillomatosis (Fig. 5) is common during childhood. It is common in a first born child, young primigravid mothers, and low socioeconomic groups [20].

Psychogenic causes such as emotional disturbances, psychic trauma, and disturbed parent-child relationship are sometimes

caused for dysphonia among children. Psychogenic causes such as family conflict and exacerbated expectations are major causes for dysphonia in children [20]. In the case of psychogenic dysphonia, vocal strain is usually not seen and vocal folds are normal. The cough sounds and laugh of the children are usually normal whereas disturbed mutation often associated with psychogenic dysphonia.

Congenital lesions of the pediatric larynx are webs and cysts whereas neoplastic lesions of the vocal folds help for visualization of the larynx. One of the congenital etiologies is vocal fold sulcus where vocal fold shows a furrow on the medial edge. The common symptom of vocal fold sulcus is a hoarse and breathy voice. Persistent pediatric dysphonia is sometimes associated with airway obstruction, dysphasia or pain, which should be investigated promptly. Visualization of the larynx is an important requirement for managing such cases. Attention deficit hyperactivity disorder (ADHD) is seen in 3–5% of the children [21]. Children affected with ADHD are often talkative, scream, and yell more often. Children suffering from ADHD have significantly higher perceptual hoarseness, strain, breathiness, loudness, and lower fundamental frequency in the acoustic analysis [21]. The details of etiologies are given in Table 1.

## CLINICAL PRESENTATIONS

Hoarseness of voice is a common clinical symptom seen among children of all age groups. The vocal symptoms or dysphonia may be manifested in the 1<sup>st</sup> year of life or later on and aggravated by vocal abuse. The chronic evolution of the dysphonia among children is usually due to the poor perception of the parents or caretakers which lead to delayed diagnosis and treatment. The prevalence of hoarseness in the children of age group between 8 and 14 years varies from 3.9% to 23.4% [2]. Dysphonia has a negative impact on effective communication, general health, educational development, self-image, self-esteem, and participating in a social environment. Parents of the children and peers often judge the dysphonia among children more negatively than other child of healthy voices [7].

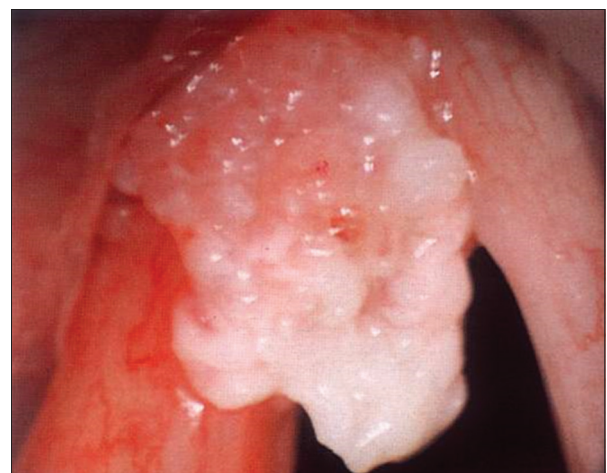


Figure 5: Papilloma over both vocal folds

**Table 1: Etiological profile of pediatric dysphonia**

Acquired lesion	Congenital lesion	Functional	Syndromic
Vocal fold nodule	Anterior commissure synechia	Impaired laryngeal mobility	Cri du chat syndrome
Vocal fold polyp	Glottic stenosis	Psychogenic	
Vocal fold cyst	Vocal fold cyst	Adolescent voice disorders	
Laryngopharyngeal reflux	Vocal fold sulcus		
Vocal fold hemorrhagic polyp			
Laryngeal papilloma			
Vocal fold sulcus			
Vocal cord paralysis			
Glottic carcinoma			
Spasmodic dysphonia			

Histories of pre-maturity or family history of dysphonia are in favor of congenital lesions of the larynx causing dysphonia which often associated with respiratory symptoms. Dysphonia in children limits their active participation in school activities due to embarrassment [22,23]. The most common clinical presentation in vocal nodules is a raspy or hoarse voice. Child often presents straining and pitch breaks in voice during singing or talking. Children those are singers have a hard time to reach higher octaves as in vocal nodules reduce their range. Laryngopharyngeal reflux (LPR) is often associated with symptoms such as throat clearing, coughing, and hoarseness of voice. Hoarseness is usually a fluctuating symptom which occurs in the morning and improves during day time [24]. The laryngeal picture in LPR shows congested and swollen arytenoids and interarytenoid membrane. Hence, clinician should be aware of the LPR during assessing the pediatric dysphonia. In functional dysphonia, patients present with voice disturbance without any structural or neurological laryngeal pathology. It is not an uncommon clinical presentation in otolaryngological practice.

### Behavioral Problems of Dysphonic Child

Communication skills among the children are interconnected with social behavior. The voice of the individual presents his or her psychological status and emotional contents of the child [25]. Dysphonia in children triggers the identity problem and compromise the personality of the child. It also reduces the quality of life [26]. Dysphonic children often have potential risk for emotional or behavioral abnormalities.

### Diagnosis

The etiological diagnosis for pediatric dysphonia is usually done by clinical assessment and endoscopic examination. The poor cooperation of the children during laryngoscopic examination is often a hindrance to the diagnosis. The laryngoscopic examination is not only useful for the diagnosis of the laryngeal lesions but also helpful for correct treatment. Endoscopy with transnasal flexible scope is often useful in all cases of pediatric dysphonia for identifying the morphodynamic alterations. Stroboscopy is carried out only in the older age group of children. Videolaryngoscopy examination gives a better view of the larynx

and particularly vocal fold as compared to indirect laryngoscopy. Videolaryngoscopy examination gives large magnification, better angle of visualization, better illumination, and resolution. Ultrasound is a non-invasive test useful for assessing the upper respiratory anatomy and pathological findings in infants and children. Laryngeal ultrasound is a help to assess the subglottic diameter as well as laryngeal stenosis, subglottic hemangiomas, and vocal fold paralysis. Computed tomography (CT) and magnetic resonance imaging are usually advised for any neoplastic assessment in the larynx. Any laryngeal stenosis is assessed by CT scan. Virtual endoscopy has been advised and nowadays used as a replacement for classical laryngeal endoscopy during follow-up. It is often helpful for assessing the topography of stenosis and tumors. Diagnostic biopsy of the tumor or papillomatosis lesions is done to find out the pathological diagnosis. The differential diagnosis of the pediatric dysphonia is broad. A thorough and careful evaluation is essential for the exact diagnosis of the etiology.

### TREATMENT

The treatments of pediatric dysphonia need individual basis. The therapeutic options available are counseling, voice re-education, medical treatment, psychotherapy, and surgical intervention.

### Surgical Treatment

CO<sub>2</sub> laser is quite effective for the treatment of vocal fold polyp and nodules. It will completely excise the polyp without injuring adjacent tissue and bleeding. A combination of vocal hygiene and CO<sub>2</sub> laser is highly effective treatment for vocal fold lesions such as polyp and nodules. In the case of spasmodic dysphonia, there is focal dystonia affecting the laryngeal muscles during speech. It may be adductor spasmodic dysphonia (common) or abductor one (rare) [27]. Child presented with adductor spasmodic dysphonia often present with voice breaks and usually treated with botulinum toxin. Vocal fold granuloma is occasionally associated with LPR, voice abuse, intubation, infection, multifactorial, and idiopathic. Treatment of vocal fold granuloma options varies and includes antireflux medication, voice rest, surgical excision, and speech therapy. Botulinum toxin injection is useful in these cases, particularly in recalcitrant granuloma especially in idiopathic cases [28].

## Medical Treatment

Proton pump inhibitors (PPIs) are the treatment of choice in dysphonia due to LPR. The lifestyle modification in LPR includes avoidance of heavy meals, alcohol, smoking, and late meals. Sleeping with head end elevation of the bed and reduction of the body weight shows benefit to the patient [29]. Although H2 receptor blockers are still used today, PPIs are the most common medications prescribed in the treatment of LPR. In the case of functional dysphonia, the etiology is usually multifactorial such as misuse of voice or strain and laryngeal muscle tension [30]. Voice therapy is often the treatment of choice in functional dysphonia.

## VOICE THERAPY IN PEDIATRIC PATIENTS

The aim of the voice therapy is to return the child's voice from hoarseness to normal or best possible voice of the child within normal physiologic and anatomic capabilities and satisfy the children's social, occupational, and emotional vocal requirements [31]. Voice therapy is usually given by professional speech and language pathologists once or twice per week and each session is approximately 30 min. The type of voice therapy and frequency of sessions are planned on basis of requirement of the child. The voice therapy is classified into three types [32]. Hygienic voice therapy is made to enhance the behaviors which protect the vocal folds from injury. Symptomatic voice therapy is designed to treat abnormal voice quality; physiological voice therapy is designed to optimize the voice production.

## CONCLUSION

Hoarseness of voice or dysphonia among children is not an uncommon clinical entity. Hoarseness of the voice is defined as altered voice quality, loudness, pitch, or vocal effect which impairs communication and decrease voice-related quality of life. Pediatric dysphonia accounts for a good number of referrals. There are variations in the protocol of management among different centers. A structures protocol is needed for the diagnosis and management of the pediatric dysphonia. There is often challenge in the management of the pediatric dysphonia due to difficulties in distinguishing lesions which may be quite similar in look but have different etiologies and need quite different treatment.

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*Funding: None; Conflict of Interest: None Stated.*

**How to cite this article:** Swain SK, Nahak B, Sahoo L, Munjal S, Sahu MC. Pediatric Dysphonia - A Review. *Indian J Child Health*. 2019; 6(1):1-5.

Doi: 10.32677/IJCH.2019.v06.i01.001