Chula Med J Vol. 51 No. 1 January 2007

# Validity of clinical diagnosis in isolated laryngomalacia in infants with congenital stridor

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**Wachiraphaet W, Samransamruajkit R, Deerojanawong J, Sritippayawan S, Prapphal N. Validity of clinical diagnosis in isolated laryngomalacia in infants with congenital stridor. Chula Med J 2007 Jan; 51(1): 13 - 25**

**Objective** : *To determine the accuracy of clinical diagnosis for isolated laryngomalacia in infants with congenital stridor and to further identify the clinical predictors of other associated airway anomalies in infants with laryngomalacia.*

**Subjects and Methods** : *We retrospectively reviewed medical records of patients who underwent complete flexible fiberoptic bronchoscopy (FFB) under the indication of congenital stridor and suspected to have laryngomalacia at King Chulalongkorn Memorial Hospital during January 2000 – December 2004 (5 years).*

**Results** : *One hundred and twenty-six infants presented with congenital stridor were identified. According to the inclusion criterias, 38 infants with clinical diagnosis of laryngomalacia were recruited. There were 23 boys and 15 girls. The median age at diagnosis was 4 months (9 days – 35 months); the median age at the onset of stridor was 0.5 month (birth – 12 months) and the median duration of stridor was 2.5 months (7 days – 30 months). The patients were classified into 3 groups, namely:*

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*isolated laryngomalacia 18 cases (47.4 %), laryngomalacia with associated airway anomalies 13 cases (34.2 %), and non laryngomalacia 7 cases (18.4 %). The typical clinical symptoms of isolated laryngomalacia including stridor related to body position or activity, absence of feeding problems, normal growth and absence of hoarseness were 50.0 %, 53.8 % and 51.6 % of sensitivity, specificity and accuracy, respectively. Six patients with typical clinical features of isolated laryngomalacia had associated airway anomalies. These anomalies were tracheomalacia (4), vocal cord paralysis (1) and subglottic stenosis (1). Our study demonstrated that wheezing was the only single clinical sign which can predict the presence of associated airway anomalies in infants with laryngomalacia with 100 specificity and 71% accuracy.*

**Conclusions** : *Isolated laryngomalacia can be accurately diagnosed by typical clinical presentation in 51% of infants with congenital stridor. Wheezing is the only significant clinical sign predicting associated airway anomalies in infants with laryngomalacia. Our study suggests that all infants with congenital stridor should undergo complete airway evaluation by FFB to exclude other airway anomalies despite having typical presentations of laryngomalacia and had no other clinical abnormalities.*

**Keywords** : *Bronchoscopy, Laryngomalacia, Congenital stridor, Clinical diagnosis.*

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Received for publication. September 25, 2006.

**วิธาน วชิรแพทย์, รุจิภัตต์ สำราญสำรวจกิจ, จิตลัดดา ดีโรจนวงศ์, สุชาดา ศรีทิพยวรรณ, นวลจันทร์ ปราบพาล. ความถูกต้องในการใช้ลักษณะทางคลินิกเพื่อวินิจฉัย laryngomalacia ในเด็กที่มีอาการหายใจเสียงดังผิดปกติแต่กำเนิด. จุฬาลงกรณ์เวชสาร 2550 ม.ค; 51(1): 13 – 25**

**วัตถุประสงค์** : *เพื่อที่จะศึกษาถึงความถูกต้องของการใช้อาการและอาการแสดงในการวินิจฉัย laryngomalacia ในเด็กที่มีอาการหายใจเสียงดังผิดปกติแต่กำเนิด และหาลักษณะที่ช่วยในการทำนายว่ามีความผิดปกติของทางเดินหายใจอย่างอื่นร่วมด้วย*

**ผู้ป่วยและวิธีการวิจัย** : *การศึกษานี้เป็นการศึกษาย้อนหลัง จากบันทึกการส่องกล้องตรวจทางเดินหายใจ (fiberoptic bronchoscopy) ด้วยข้อบ่งชี้คือหายใจเสียงดังผิดปกติแต่กำเนิด และสงสัยว่าจะมีภาวะอ่อนตัวของกล่องเสียง (laryngomalacia) ในผู้ป่วยเด็กอายุแรกเกิด–15 ปีที่เข้ารับการรักษาในโรงพยาบาลจุฬาลงกรณ์ ตั้งแต่เดือนมกราคม 2543 - เดือนธันวาคม 2547*

**ผลการวิจัย** : *ผู้ป่วยที่มีอาการหายใจเสียงดังแต่กำเนิดที่ได้รับการส่องกล้องตรวจทางเดินหายใจทั้งหมด 126 ราย มี 38 รายที่ได้รับการวินิจฉัยจากลักษณะทางคลินิกว่าเป็น laryngomalacia เป็นเด็กชาย 23 ราย และเด็กหญิง 15 ราย อายุ 9 วัน - 35 เดือน (median age 4 เดือน) ผู้ป่วยส่วนใหญ่เริ่มมีอาการหายใจเสียงดังที่อายุ 15 วัน (range 0 - 12 เดือน) ค่ามัธยฐานของระยะเวลาที่มีเสียงหายใจผิดปกติก่อนที่จะได้รับการตรวจวินิจฉัยคือ 2.5 เดือน (7 วัน -30 เดือน) ร้อยละ 47.4 (18 ราย) มีความผิดปกติของกล่องเสียงอ่อนตัวอย่างเดียว ร้อยละ 34.2 (13 ราย) มีกล่องเสียงผิดปกติร่วมกับมีความผิดปกติแต่กำเนิดอย่างอื่นของทางเดินหายใจด้วย และร้อยละ18.4 (7 ราย) ตรวจไม่พบความผิดปกติของกล่องเสียงเลย ลักษณะทางคลินิกที่บ่งว่าผู้ป่วยน่าจะมี laryngomalacia เดียวคือการหายใจเสียงดังผิดปกติที่สัมพันธ์กับท่านอนและการเคลื่อนไหว, ไม่มีปัญหาในเรื่องการดูดนมหรือการกินอาหาร, มีการเจริญเติบโตที่ปกติ, ไม่มีเสียงแหบ โดยพบว่าถ้าใช้ลักษณะทางคลินิกดังกล่าวในการวินิจฉัย isolated laryngomalacia จะมีความไว (sensitivity) ร้อยละ 50, ความจำเพาะ (specificity) ร้อยละ 53.8, และความแม่นยำ (accuracy) ร้อยละ 51.6 นอกจากนี้พบว่าผู้ป่วย 6 ราย*

ซึ่งได้รับการวินิจฉัยโดยใช้ลักษณะทางคลินิกว่าเป็น laryngomalacia มีความผิดปกติของทางเดินหายใจอย่างอื่นร่วมด้วยคือพบว่ามี tracheomalacia 4 ราย, vocal cord paralysis 1 ราย และ subglottic stenosis 1 ราย สำหรับอาการแสดงที่ช่วยในการคาดเดาว่าน่าจะมีความผิดปกติอื่น ๆ ในทางเดินหายใจผิดปกติร่วมด้วยมีเพียงอย่างเดียว คือ wheezing โดยมีความแม่นยำ และความจำเพาะในการวินิจฉัย ร้อยละ 71 และ 100 ตามลำดับ

**สรุป** : สามารถให้การวินิจฉัยภาวะ laryngomalacia ในเด็กที่หายใจเสียงดังแต่กำเนิดได้ถูกต้องโดยการใช้อาการทางคลินิกอย่างเดียวเพียงร้อยละ 51 และการตรวจพบว่ามี wheezing เป็นเพียงปัจจัยเดียวที่จะสามารถทำนายได้ว่ามีโอกาสตรวจพบทางเดินหายใจผิดปกติอย่างอื่นร่วมด้วย ดังนั้นเด็กที่มีอาการหายใจมีเสียงผิดปกติตั้งแต่เกิด ควรได้รับการตรวจประเมินโดยการส่องกล้องตรวจในทางเดินหายใจ ถึงแม้ว่าจะมีอาการและอาการแสดงที่เข้าได้กับ laryngomalacia อย่างชัดเจน และไม่พบอาการทางคลินิกอื่น ๆ ร่วมด้วย

**คำสำคัญ** : การส่องกล้องตรวจทางเดินหายใจ, ภาวะอ่อนตัวของกล่องเสียง, การหายใจเสียงดังผิดปกติ, wheezing.

Laryngomalacia is the most common cause of congenital stridor in pediatric patients.[1-5] The diagnosis of this condition in most patients is based on typical clinical symptoms and signs which consist of noisy breathing with inspiratory stridor on physical examination. Inspiratory stridor is precipitated by crying, sucking or being placed in supine position and improves when they are changed to prone position. Laryngomalacia may occur as an isolated lesion or associated with other anomalies of the airway or other organ systems. Studies in the past [4, 6] found that infants with stridor had higher portion of congenital airway anomalies than normal infants. In addition, Friedman EM. *et al* [7] found that 18.8 % of infants with stridor had multiple airway anomalies. Some studies found that laryngomalacia was associated with 19-24 % of tracheobronchial anomalies.[8-11] Laryngobronchoscope was used to diagnose laryngomalacia and ruled out associated and other airway anomalies.[12] We often found other airway anomalies with laryngomalacia in patients presenting with stridor. Futhermore, in some patients, the initial diagnosis was actually misleading and resulted in delay diagnosis. However, in general pediatric practices, pediatric laryngobronchoscope is not always available in most community hospitals.

Thus, this study is designed to determine the accuracy of clinical diagnosis of isolated laryngomalacia in infants with congenital stridor and to further identify clinical predictors of associated airway anomalies in infants with laryngomalacia.

## Methods

We retrospectively reviewed medical records of patients aged under 15 years old who underwent flexible fiberoptic bronchoscopy (FFB) under various indications at King Chulalongkorn Memorial Hospital, during January 2000 - December 2004 (5 years) following all of the inclusion criteria : 1) Congenital stridor; 2) Suspected to have laryngomalacia ; and 3) Need for completely examined of both the upper and lower airways by flexible fiberoptic bronchoscope (FFB). Missing medical records or incomplete data were excluded.

The recruited patients were later classified into 3 groups according to the findings of flexible fiberoptic bronchoscopy as follows: Group I, isolated laryngomalacia because laryngomalacia was the only bronchoscopic finding; Group II, airway anomalies associated with laryngomalacia because to laryngomalacia was found associated with at least 1 airway anomaly; and Group III, No laryngomalacia was found but bronchoscopy detected other airway anomalies. The patients in group I and II were compared to identify the accuracy of clinical diagnosis of isolated laryngomalacia with typical presentations which consists of: 1) stridor related body position or activity; 2) No feeding problem; 3) No failure to thrive; and, 4) No hoarseness of voice. Also, we tried to identify clinical factors that helped us predict associated airway anomalies in infants with laryngomalacia.

**Data collection:** The collected data were consisted of demographic information such as age, sex, past medical history and treatment, as well as their current illness such as onset and duration of stridor, characteristics of the stridor, precipitating factors, associated symptoms, physical examination, radiologic findings, and the detaile of bronchoscopic procedure including complications and further investigations when more information were needed to reach the final diagnosis.

**Statistical analysis:** All data were recorded by using Microsoft Access software (version 2003). It was shown as median (age, onset and duration of stridor), percentage (gender, history of stridor, current illness and physical examination). All statistical analyses were performed using SPSS software (version 11.5). We analyzed categorical variables by Chi-square test and continuous variables by Mann-Whitney U Test. A $p$ value of $<.05$ was considered significant.

## Results

There were 126 infants presented with congenital stridor. According to the inclusion criteria, 38 infants (30.1 %) with clinical diagnosis of laryngomalacia were recruited (Fig. 1). There were 23 boys and 15 girls. The median age at diagnosis was 4 months (9 days – 35 months); the median age at onset of stridor was 0.5 month (birth – 12 months) and the median duration of stridor was 2.5 months (7 days – 30 months) (Table 1-3). Most all patients had no underlying diseases; the most common underlying diseases were congenital heart diseases and neurodevelopmental delayed. (Table 4). The patients were classified into 3 groups as followings: isolated laryngomalacia 18 cases (47.4 %); laryngomalacia with associated airway anomalies, 13 cases (34.2 %); and non laryngomalacia, 7 cases (18.4 %). Airway anomalies consisted of tracheomalacia 7 cases (53.8 %), tracheobronchomalacia 3 cases (23.1 %), subglottic stenosis 2 cases (15.4 %), vocal cord paralysis, laryngeal cyst and tracheal bronchus 1 case (7.7 %) for each lesion. The diagnosis of the-non-laryngomalacia group comprised of the following: normal study, 4 cases (57.1 %), 2 cases (28.6 %); for adenoid hypertrophy with collapsing upper airway, and mild tracheomalacia 1 case (14.3 %). (Table 5).

**Accuracy of clinical diagnosis of isolated laryngomalacia:** The typical clinical symptoms of isolated laryngomalacia including stridor related to body position or activity, absence of feeding problems, normal growth and absence of hoarseness gave 50.0 %, 53.8 % and 51.6 % of sensitivity, specificity and accuracy, respectively. Six patients with typical clinical features of isolated laryngomalacia had associated airway anomalies. These anomalies were, namely: tracheomalacia (4 cases), vocal cord paralysis (1 case) and subglottic stenosis (1 case). These findings confirm the necessity of performing flexible fiberoptic bronchoscopy in these young children. (Table 6).

**Clinical predictors of other airway anomalies in infants with laryngomalacia:** In addition, our study demonstrated that wheezing was the only single clinical sign that can predict the presence of associated airway anomalies in infants with laryngomalacia with 100 % specificity and 71 % accuracy. However, the patient's age at the time of diagnosis, onset and duration of stridor, stridor related to body position, stridor related to feeding, feeding problems and hoarseness were not the significant predictors (Table 7).

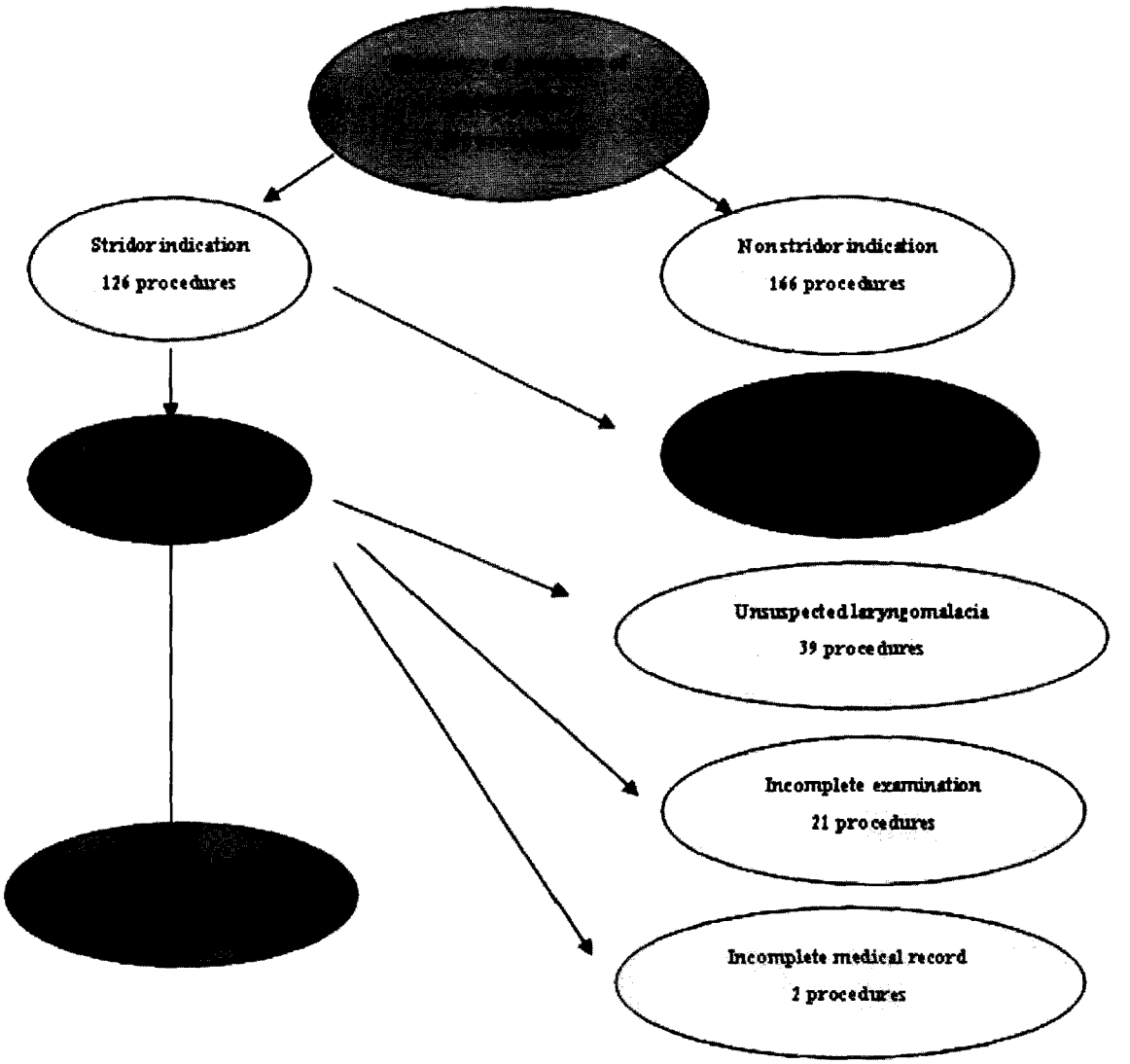


**Figure 1.** Diagram of patient selection.

**Table 1.** Age (months) distribution of enrolled patients.

| Age (month) | Number (%) |
|---|---|
| 0 - 3 | 14 (36.8) |
| 4 - 6 | 9 (23.7) |
| 7 – 9 | 2 (5.3) |
| 10 – 12 | 3 (7.9) |
| 13 – 15 | 5 (13.2) |
| 16 – 18 | 1 (2.6) |
| 19 – 21 | 1 (2.6) |
| 22 – 24 | 1 (2.6) |
| > 24 | 2 (5.3) |

**Table 2.** Onset (months) of stridor.

| Onset of Stridor (Month) | Number (%) |
|---|---|
| 0-1 | 19 (50.0) |
| 1 | 4 (10.5) |
| 2 | 5 (13.1) |
| 3 | 2 (5.3) |
| 4 | 2 (5.3) |
| 5 | 3 (7.9) |
| 9 | 2 (5.3) |
| 12 | 1 (2.6) |

**Table 3.** Duration (months) of stridor at the time of evaluation.

| Duration of stridor (month) | Number (%) |
|---|---|
| 1 | 13 (34.2) |
| 2 | 6 (15.8) |
| 3 | 5 (13.2) |
| 4 | 3 (7.9) |
| 7 | 2 (5.3) |
| 8 | 1 (2.6) |
| 12 | 3 (7.9) |
| 18 | 2 (5.3) |
| 19 | 1 (2.6) |
| 24 | 1 (2.6) |
| 30 | 1 (2.6) |

**Table 4.** Underlying diseases of the infants with congenital stridor.

| Underlying diseases | Number of patients (%) (N=38)* |
|---|---|
| No underlying disease | 23 (60.5) |
| Congenital heart disease | 6 (15.8) |
| Craniofacial anomalies | 4 (10.5) |
| Epilepsy | 3 (7.9) |
| Down syndrome | 3 (7.9) |
| Neurodevelopmental delay | 2 (5.3) |
| GERD / swallowing dysfunction | 2 (5.3) |
| CCAM** | 1 (2.6) |
| ALL s/p BMT** | 1 (2.6) |

* Some patients had more than 1 underlying disease.

** GERD : Gastroesophageal reflux disease
CCAM : Congenital cystic adenomatoid malformation
ALL : Acute lymphocytic leukemia
s/p : status post
BMT : Bone marrow transplantation

**Table 5.** Group classification of FFB findings.

| Group | Findings |
|---|---|
| Group 1 | Isolated laryngomalacia |
| Group 2 | Airway anomalies associated laryngomalacia |
| Group 3 | No laryngomalacia |

**Table 6.** Accuracy of clinical diagnosis of isolated laryngomalacia.

| Clinicalsymptoms | Laryngomalacia | | Total |
|---|---|---|---|
| | Isolated | Airway anomalies | |
| Typical | 9 | 6 | 15 |
| Atypical | 9 | 7 | 16 |
| Total | 18 | 13 | 31 |

**Table 7.** Clinical predictors of other airway anomalies in infants with laryngomalacia.

| Clinical Characteristics | Laryngomalacia | | *P* Value |
|---|---|---|---|
| | Isolated (N=18) | Airway anomalies (N=13) | |
| Age (months) | 5 | 6 | ns |
| Onset (month) | 0.5 | 1 | ns |
| Duration (months) | 3 | 3 | ns |
| Gender | | | |
| Boy : Girl | 12:6 | 8:5 | |
| History | | | |
| Stridor related to activity/body position | 14 | 15 | ns |
| Stridor related to feeding (sucking) | 3 | 9 | ns |
| Feeding problems | 4 | 5 | ns |
| Hoarseness | 0 | 3 | ns |
| Physical examinations | | | |
| Failure to thrive | 7 | 3 | ns |
| Pectus excavatum | 1 | 4 | ns |
| Chest retraction | 7 | 8 | ns |
| Biphasic stridor | 2 | 1 | ns |
| Wheezing | 0 | 4 | 0.023** |

**Table 8.** Validity of clinical predictors of airway anomalies associated laryngomalacia.

| Clinical factors | Sensitivity | Specificity | PPV | NPV | Accuracy |
|---|---|---|---|---|---|
| Feeding problems | 39 | 78 | 56 | 64 | 61 |
| Hoarseness | 23 | 100 | 100 | 64 | 68 |
| Failure to thrive | 23 | 61 | 30 | 52 | 45 |
| Pectus excavatum | 31 | 94 | 90 | 65 | 68 |
| Chest retraction | 62 | 61 | 53 | 69 | 61 |
| Biphasic stridor | 8 | 89 | 33 | 57 | 55 |
| Wheezing | 31 | 100 | 100 | 67 | 71 |

## Discussion

We retrospectively reviewed our findings of fiberoptic bronchoscope at King Chulalongkorn Memorial Hospital during the past 5 years. Compared to the study of Deerojanawong *et al*[13], this study focuses on the patients who presented with congenital stridor. We have found the number of our patients were twice of Deerojanawong's. The Increased number of patients may due to our higher convenience and safety to perform FFB as well as more number of the staff, better equipment and monitoring procedures. In addition, we also had more patients, especially the immunocompromised ones, e.g., hematologic malignancy or primary immuno-compromised hosts such as HIV infection.

Most patients who experienced multiple FFB had lower airway anomalies such as tracheal stenosis. Multiple corrections and post-operative re-evaluation with FFB were needed. The present study showed that laryngomalacia was the most common findings in infants presenting with stridor similar to previous study.[9, 14] The total number of patients diagnosed with laryngomalacia were 67 (53.2 %) cases (36 were excluded). There were 38 patients enrolled in our study (30.2 % of stridor patients), 31 patients had laryngomalacia (24.6 %). Compared to previous studies, that found ranged between 36-65 % depended on the study and inclusion criteria.[4, 13, 15-16] However, the number of our patients that we proved to have laryngomalacia was higher when compared to that of Ungkanont K. *et al.*[6] (19.3 %) in which all their patients were infants less than 1 month old while whwreas the patients in this study were more older. We found isolated laryngomalacia in 47 % and 34.2 % of laryngomalacia which were associated with airway anomalies similar to previous reports.[8, 15-16] Their age of patients with isolated laryngomalacia was ranged between 9 days – 35 months, onset of stridor was found since birth – 12 months and the duration of stridor before diagnosis was made were 7 days – 30 months that were also consistent with that of Daniel RO. *et al.* [8]

Generally, FFB is a very safe procedure and may have a few complications with non serious events such as transient desaturation, brief apnea, minor tissue trauma which rapidly resolved within a short period after removal of FFB together with oxygen supplement. In our study, a few complications occurred including transient desaturation (6), airway edema (3). However, there was no serious adverse detected. This therefore revealed a high index of safety of the procedure.[7, 14, 17-20]

Ours study demonstrated 50.0 % sensitivity, 53.8 % specificity and 51.6 % accuracy in the use of clinical symptoms alone to diagnose isolated laryngomalacia. (Table 8). This is not surprising. The low validity may be resulted from inaccuracy of history taking and physical examination by a number of general physicians. Important factors that might cause low accuracy by using clinical diagnosis alone were the variation and severity of associated airway anomalies. Its symptoms could vary from asymptomatic to mark respiratory distress especially when having respiratory tract infections. In addition, associated airway anomalies in some could present with clinical symptoms and signs like laryngomalacia. Thus, these could make accurate diagnosis even more difficult. The present study found six patients with associated airway anomalies which were misdiagnosed as having isolated laryngoamalacia.

Associated airway anomalies were found in 34.2 % of the patients with laryngomalacia which was consistent with previously reports.(19-35 %).[8, 15-16] Major pathologies of these patients were located in large airways such as tracheomalacia and tracheobronchomalacia. The less common one was located in the upper respiratory tract. We found only one patient with vocal cord lesion which is considered the second most common cause of stridor in children.[1, 21-22] Apart from patients with vocal cord lesions concomitant with hoarseness of voice which were excluded from this study. Our patients found with only vocal cord lesions seemed to be less than other studies.

Another purpose of this study is to further identify clinical predictors of other associated airway anomalies in infants with laryngomalacia to prevent future complications from undiagnosed airway anomalies. So far, we found only wheezing the significant clinical predictor that could help in diagnosis of associated airway anomalies. From our study, there were four infants detected with wheezing, i.e.,tracheomalacia (2) and tracheobronchomalacia (2). As we known from the physiology, wheezing is a sign of lower airway obstruction. Therefore, infants with laryngomalacia together with wheezing should be regarded as having higher hidden risk of associated lower airway anomalies. They should be promptly referred to pediatric pulmonologists for further evaluation.

Hoarseness of vice is another clinical factor that had high specificity (100 %) of associated airway anomalies, but it did not reach the level of statistically significance (Table 4) due to too the small number of studied patients (n=3). However, in general, a number of healthy infants who have upper respiratory tract infections may also experience a period of hoarseness. Thus, we could not make any conclusion that associated hoarseness is the clinical predictor of associated airway anomalies in infants with laryngomalacia. Future large prospective clinical trial may be required to further identify the association between clinical indicators and associated airway anomalies of infants with laryngomalacia.

**Acknowledgements**

We thank all the attendants and fellows of the Pediatric Pulmonary and Critical Care Divisions, King Chulalongkorn Memorial Hospital, Bangkok, Thailand. for assisting us in performing flexible fiberoptic laryngobronchoscopy.

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