

Received: 2014.02.14
Accepted: 2014.04.30
Published: 2014.08.23

Arytenoid Cartilage Dislocation from External Blunt Laryngeal Trauma: Evaluation and Therapy without Laryngeal Electromyography

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

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Source of support: This work was supported by grants from Science Technology Department (NO. 2013C33208) and Traditional Chinese Medicine Administration (NO. 2012ZA085) of Zhejiang Province, China

Background: Intubation trauma is the most common cause of arytenoid dislocation. The aim of this study was to investigate the diagnosis and treatment of arytenoid cartilage dislocation from external blunt laryngeal trauma in the absence of laryngeal electromyography (LEMG) and to explore the role of early attempted closed reduction in arytenoids cartilage reposition.

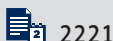
Material/Methods: This 15-year retrospective study recruited 12 patients with suspected arytenoid dislocation from external blunt laryngeal trauma, who were evaluated through 7 approaches: detailed personal history, voice handicap index (VHI) test, indirect laryngoscope, flexible fiberoptic laryngoscope, video strobolaryngoscope, and/or high-resolution computed tomography (CT), and, most importantly, the outcomes after attempted closed reduction under local anesthesia. They were divided into satisfied group (n=9) and dissatisfied group (n=3) based on their satisfied with voice qualities at 1 week after the last closed reduction manipulation.

Results: Each patient was diagnosed with arytenoid dislocation caused by external blunt laryngeal trauma. In the satisfied group, VHI scores and maximum phonation time (MPT) at 1 week after the last reduction were significantly improved compared with those before the procedure ($P<0.05$). Normal or improved mobility and length of the affected vocal fold were also noted immediately after the end of the last closed reduction. The median time interval between injury and clinical intervention in satisfied group was 43.44 ± 34.13 days, much shorter than the median time of 157.67 ± 76.07 days in the dissatisfied group ($P<0.05$).

Conclusions: Multimodality assessment protocols are essential for suspected arytenoid dislocation after external blunt laryngeal trauma. Early attempted closed reduction should be widely recommended, especially in health facilities without LEMG, mainly, because it could be helpful for early diagnosis and treatment of this disease. In addition, early closed reduction could also improve the success of arytenoid reduction.

MeSH Keywords: **Arytenoid Cartilage – injuries • Electromyography • Wounds, Nonpenetrating – diagnosis • Wounds, Nonpenetrating – etiology • Wounds, Nonpenetrating – therapy**

Full-text PDF: <http://www.medscimonit.com/abstract/index/idArt/890530>



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Background

As an uncommon injury, laryngeal trauma accounts for less than 1% of blunt trauma in adult patients [1]. Possible sequelae of laryngeal trauma include soft-tissue edema, ruptures of ligaments, fractures of laryngeal cartilage, and dislocation of arytenoid cartilage. Dislocation of the arytenoid cartilage results in reduced mobility of the vocal fold and incomplete glottic closure that mimic vocal fold paralysis. It has been rarely reported to be caused by external blunt forces [1–5]. Diagnosis of arytenoid dislocation with indirect laryngoscopy, flexible fiberoptic laryngoscopy, videostrobolaryngoscopy, high-resolution CT, and LEMG is generally accepted [6,7]. LEMG is recommended as a major diagnostic tool, although it still has some limitations in distinguishing arytenoid dislocation from laryngeal nerve injury [3]. However, as LEMG requires special equipment and skills as well as considerable experience, it is still rarely used in many clinics and hospitals. As such, we investigated whether it is possible to definitively diagnose and effectively treat arytenoid dislocation due to external laryngeal trauma without using LEMG.

Material and Methods

Patients

This retrospective study was performed over a period of 15 years from January 1997 to December 2011. From all patients who visited our department during this period, 97 patients in total were considered to have arytenoid cartilage dislocation, of which 85 (87.6%, 85/97) had received tracheal intubations. In the current study, we re-visited the records of the 12 patients who had a known histology of external neck trauma. The general data of these patients are shown in Table 1. Written informed consent was obtained from each patient, and the study was approved by the Institutional Review Board of Second Affiliated Hospital, School of Medicine, Zhejiang University. They were divided into the satisfied group (n=9) and dissatisfied group (n=3) based on patients' self-satisfied with voice qualities at 1 week after the last closed reduction manipulation.

Evaluation and treatment

The 12 patients underwent a complete head and neck examination and a thorough voice evaluation using the VHI scale, indirect laryngoscope, flexible fiberoptic laryngoscope, video strobolaryngoscope, and/or high-resolution CT. The VHI scale, including functional (F), physiological (P), emotion (E), and the sum denoted by T [8], was applied in self-assessment before initial closed reduction and at 1 week after the last closed reduction, and MPT was measured as well. The laryngoscopic examinations were selectively performed before initial closed

reduction, immediately after the last closed reduction, and 1 week after the last closed reduction. Laryngoscopic findings in arytenoid dislocation include impaired or absent vocal fold mobility and the asymmetric position and different length of vocal cords with poor glottic closure. In addition, arytenoid dislocation should be highly suspected if video strobolaryngoscopy further shows shortened MPT, normal vocal fold vibration, discrepancy between vocal cord heights, and absence of a jostle phenomenon (a symptom of vocal cord paralysis characterized by lateral movement of the arytenoid on the immobile side, caused by contact with the mobile side during adduction). CT scan of the larynx was used to reveal arytenoid dislocation by interarytenoid asymmetry and clouding or obliteration of cricoarytenoid joint space.

Attempted closed reduction, as a diagnostic and therapeutic method, was performed by indirect laryngoscope and laryngeal forceps under local anesthesia. Anterior dislocations were reduced with posterior-upward push on the arytenoids during phonation and posterior dislocations with anterior-upward push during inspiration. Arytenoid dislocation was thought to be confirmed in patients who experienced immediate improvement in laryngeal symptoms such as hoarseness after attempted closed reduction. After each closed reduction manipulation, patients were encouraged to speak as much as they could, and taught to hold the larynx gently with fingers and shake it side to side while making a strong sound as if coughing up phlegm from the throat. Attempted closed reduction was usually performed once a week and no more than 7 times totally.

Statistical analysis

Data are presented as mean \pm standard deviation. The means were compared using paired *t*-test, Wilcoxon match-pair signed-ranks test, or Mann-Whitney *U*-test. Statistical significance was indicated by $P < 0.05$. All analyses were performed using SPSS 16.0 statistical software (SPSS Inc., Chicago, IL).

Results

Voice change occurred immediately after injury in 10 cases, and in the other cases at 4 and 7 days after injury. There were no obvious external signs of laryngeal trauma, neither subcutaneous emphysema nor signs of hematoma and fractures, in these patients. The soft tissues of the larynx were intact on palpation.

Examination with indirect laryngoscope, flexible fiberoptic laryngoscope, and video strobolaryngoscope revealed immobility of vocal cords in 8 patients and impaired movement of vocal cords in 4 patients. The typical observations were the asymmetric position and different length of vocal cords with poor

Table 1. Clinical features of all patients in the study.

Case	Age (yr)/sex	Etiology	Direction	Side	Interval to treatment	Self-satisfaction evaluation
1	25/M	Mechanical pressing	Anterior	Left	90d	Satisfaction
2	22/M	Traffic accident	Anterior	Left	24d	Satisfaction
3	43/F	Traffic accident	Anterior	Right	68d	Satisfaction
4	35/M	Traffic accident	Anterior	Right	18d	Satisfaction
5	53/F	Mechanical pressing	Anterior	Right	143d	Dissatisfaction
6	32/M	Punch	Anterior	Left	102d	Satisfaction
7	29/M	Traffic accident	Anterior	Right	34d	Satisfaction
8	43/M	Traffic accident	Left: Anterior Right: Posterior	Both	14d	Satisfaction
9	28/F	Stick fighting	Anterior	Right	14d	Satisfaction
10	31/M	Punch	Anterior	Left	90d	Dissatisfaction
11	47/F	Mechanical pressing	Anterior	Left	27d	Satisfaction
12	33/M	Traffic accident	Anterior	Right	240d	Dissatisfaction

glottic closure (Figures 1A, 1B and 2A, 2B). Arytenoid cartilage was anteriorly displaced in 11 patients (5 on the left side and 6 on the right side). One patient had both left-sided anterior and right-sided posterior displacement of the arytenoid cartilages (Table 1). Vocal cords were located at the intermediate, paramedian, and lateral positions in 7, 1, and 3 patients, respectively. In the patient with affected bilateral vocal cords, the left vocal cord was located at the intermediate position and the right one at the lateral position. The mucous membranes of the affected vocal cords were intact. Video strobolaryngoscopic examination demonstrated that MPT was longer than 5 s in 8 patients with normal vocal fold vibration, and MPT for the other 4 patients was too short for us to observe vibration of vocal folds during phonation. The sensibility of the endolaryngeal mucosa was unaffected in all patients, indicating a normal function of the internal branch of the superior laryngeal nerves. Jostle sign was absent, and discrepancy between vocal cord heights was noticeable in these patients (Table 2). Typically, the level of the affected vocal cord was lower than that of the normal one during phonation in 9 of the 11 patients with unilateral lesion. The different length between both vocal cords was observed in 12 patients. The affected vocal cord was shorter than the normal one in the cases with anterior malposition of arytenoid cartilage. Conversely, the affected vocal cord was longer in the cases with posterior malposition. Seven patients underwent high-resolution CT scans of the larynx. Among them, anterior displacement of the arytenoid cartilage was confirmed in 4 patients (Figure 3).

As illustrated in Table 3, VHI scores at 1 week after the last closed reduction were lower than those before initial reduction in the satisfied group ($P<0.05$), but these scores were not statistically significantly different from those in the dissatisfied group. Among the 9 patients in the satisfied group, fiberoptic laryngoscopic and video strobolaryngoscopic examination demonstrated that 5 patients obtained normal movement of the vocal cord and the symmetric position and equal length of both vocal cords, with tight closure of the glottis during phonation instantly after closed reduction (Figure 1C, 1D). Impaired movement of the vocal cord was still visible and vocal cords were located almost at the same level, with improved glottic closure in the other 4 patients (Figure 2C, 2D). MPT (20.11 ± 6.11 s) in the satisfied group was significantly lengthened at 1 week after the last closed reduction ($P<0.05$). Hoarseness, together with immobility of the vocal cord and incomplete glottic closure, remained in the dissatisfied group. The time interval between injury and closed reduction in this group was 157.67 ± 76.07 days, which was significantly longer than that in the satisfied group ($P<0.05$).

Discussion

Most laryngeal injuries are caused by internal trauma from improper endolaryngeal procedures. Laryngeal trauma caused by external forces is relatively rare, with an incidence of 1 in every 22 900 emergency room visits [9–11]. In this report, the

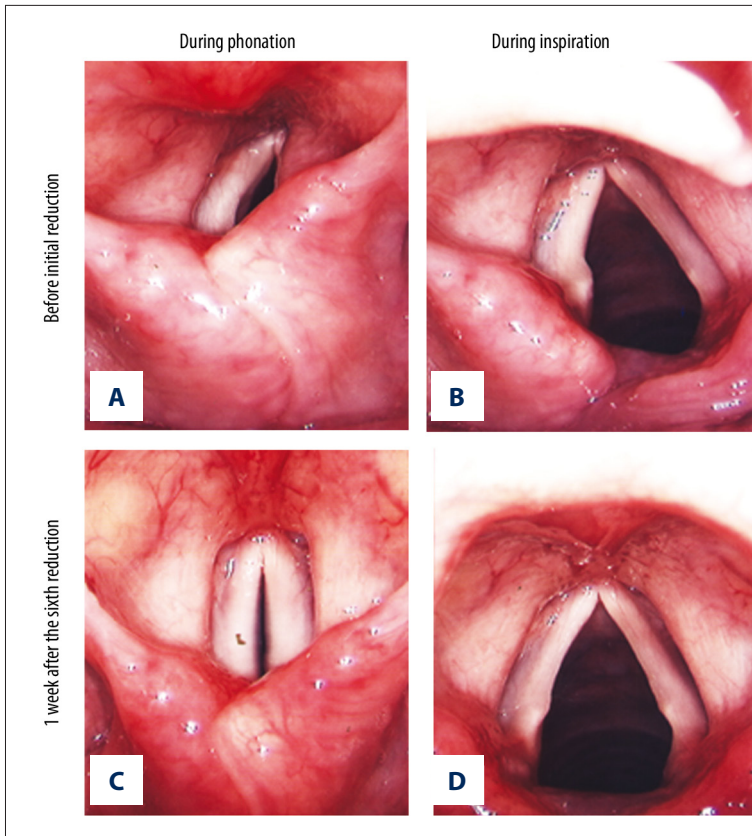


Figure 1. Anterior dislocation of the left arytenoid cartilage before attempted closed reduction (A, B). Normal mobility of the vocal cord, equal length of both vocal cords, and tight glottic closure after the treatment (C, D).

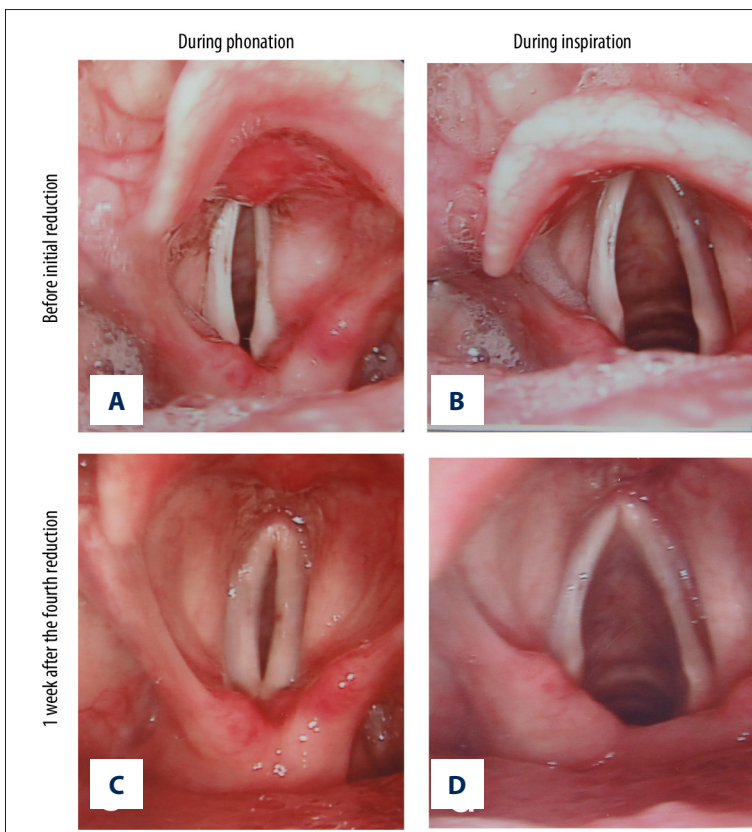


Figure 2. Anterior dislocation of the left arytenoid cartilage before attempted closed reduction (A, B). Improved mobility of the vocal cord and improved glottic closure after the treatment (C, D).

Table 2. The level of affected vocal cord to normal vocal cord in 11 patients*.

Phase	Affected level		
	Lower	Higher	Equal or no distinct
Inspiration	5/11(45.4%)	3/11(27.3%)	3/11(27.3%)
Phonation	9/11(81.8%)	0/11(0%)	2/11(18.2%)

* Numerals stand for the number of patients involved. The patient with displaced vocal cords on both sides was not included in the table.



Figure 3. Laryngeal CT revealed anterior displacement of the left arytenoid cartilage (arrow head), obliteration of cricoarytenoid joint space, and the arc-shaped left vocal cord (arrow).

finding of 12 out of 97 (12.4%) patients with arytenoid dislocation caused by external trauma is similar to an earlier finding by Rubin that 15.9% of their arytenoid dislocation cases were attributed to external neck trauma [3].

It is worth noting that vocal cord immobility may originate either from neurological paralysis or joint abnormalities, or even from both. LEMG could be useful in differentiating these 2 causes by indicating the presence of an innervated vocal cord. However, as pointed out by Rubin et al., LEMG has its limitations, with 39.7% of their patients with arytenoid cartilage dislocation displaying abnormalities on LEMG [3]. This is possibly due to co-occurrence of denervation and a joint dislocation, nerve susceptibility to inflammatory mediators infiltrating after trauma, and/or hematoma and scarring in the posterior portion of the thyroarytenoid muscle, leading to the appearance of denervation on LEMG [3]. Importantly, LEMG alone may fail to establish the diagnosis of laryngeal paralysis, because cross-innervation may occur in a paralyzed vocal fold [12–14]. The time interval between injury and initial medical examination in our patients was 14–240 days (median time 72.00±67.59 days), which might be long enough for the occurrence of reinnervation. Furthermore, LEMG is unavailable in the majority of the hospitals in China, including our hospital. Therefore, combined with our video strobolaryngoscopic observation showing good muscle tension with vibration of vocal folds in our patients, LEMG was not included in the current study.

Except for In addition to LEMG, flexible fiberoptic laryngoscopy, videostrobolaryngoscopy, and computed tomography are

Table 3. The VHI scores and MPT at the different time points and the time interval between injury and closed reduction in two groups.

Group	n	F		P		E	
		Before reduction	After reduction	Before reduction	After reduction	Before reduction	After reduction
Satisfaction	9	19.89±4.76	4.22±2.95*	29.44±3.00	4.78±3.67*	15.22±3.07	3.22±2.33*
Dissatisfaction	3	25.67±4.04	27.00±4.58	33.33±1.53	32.67±2.89	15.67±4.04	16.33±3.79

Group	n	T		MPT (s)		Time interval (d)
		Before reduction	After reduction	Before reduction	After reduction	
Satisfaction	9	64.56±6.25	12.22±8.41*	7.89±3.06	20.11±6.11*	43.44±34.13#
Dissatisfaction	3	74.67±8.50	76.00±10.54	6.67±2.52	7.33±3.21	157.67±76.07

The VHI scale includes functional (F), physiological (P), emotion (E), and the sum denoted by T. MPT – maximum phonation time.

* P<0.05 compared to before reduction. # P<0.05 compared to dissatisfaction group.

also helpful in the diagnosis of arytenoid cartilage dislocation [2,6,7]. According to Rubin et al., the most useful examination is video strobolaryngoscopy, which allows evaluation of jostle sign, flickering of muscle activity associated with an intact nerve supply, and submucosal hematoma that can result in scarring and vocal cord stiffness [3]. More importantly, video strobolaryngoscopy permits evaluation of vocal cord level and glottic closure. Most of the studies investigating the difference in level between paralyzed and innervated vocal cords reported that the paralyzed vocal fold presented at a higher level than a normally innervated one [15–19]. In our cases with arytenoid dislocation, none of them showed such a change during phonation. Conversely, the level of affected vocal cords was lower than that of normal ones in 9 of the 11 patients with a unilateral lesion. As such, therefore, we would suggest that an obvious discrepancy in height between vocal cords is an important feature in the differential diagnosis between arytenoid dislocation and laryngeal paralysis.

During the 15-year period, we preferred to perform attempted closed reduction by indirect laryngoscope and laryngeal forceps manipulation under local anesthesia. Firstly, it is a feasible method to facilitate diagnosis when patients are highly suspected of arytenoid dislocation, especially in the medical institutions without LEMG. The diagnosis of arytenoid dislocation can be confirmed in patients who experience instantaneous improvement in laryngeal symptoms such as hoarseness after attempted closed reduction. More importantly, it can shorten the time interval between the diagnosis and treatment of arytenoid dislocation, which is helpful to achieve a successful reduction. Secondly, it prevents the larynx from being further injured by tracheal intubation under general anesthesia. Thirdly, it is impossible to judge the position of arytenoid cartilage after reduction and to monitor the patient's voice under general anesthesia. Fourthly, most of patients can tolerate the procedure by indirect laryngoscope and laryngeal forceps under local anesthesia, and high cure or improvement rate (78.4%, 76/97) was achieved during our 15-year experience. Rubin et al. [3] reported that 7 out of 10 patients (70%) with arytenoid dislocation due to external trauma regained normal or improved voice only by closed reduction using direct laryngoscope under local anesthesia and/or voice therapy. In our series, the patients obtained similar outcomes (75%, 9/12). Therefore, closed reduction for patients with arytenoid cartilage dislocation under local anesthesia is practicable and effective.

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Early treatment of arytenoid cartilage dislocation is crucial for good clinical recovery of voice quality [3]. We have found that VHI scores and MPT were significantly improved in the satisfied group, who had a median time interval between injury and treatment of 43.44 ± 34.13 days, whereas the dissatisfied group showing no voice improvement had a median time interval of 157.67 ± 76.07 days. A critical difference between the 2 groups was immobility of the vocal cord in the latter, probably related to scarring and fixation of the cricoarytenoid joint that occurred due to the delayed treatment. Similar results were also found by Sataloff, who reported that the average time interval between injury and surgical treatment for patients who regained their normal voice was 10 weeks and an average time interval of 29 weeks for patients who had no response to treatment, although the causes of laryngeal trauma were different [5]. Nevertheless, it is obvious that recovery will become more difficult if clinical intervention is delayed, regardless of whether arytenoid cartilage dislocation is caused by internal or external forces. In addition, in our study, the 3 patients had no voice improvement by using a diagnostic reposition approach. There may be another possibility – that arytenoid cartilage dislocation and associated vocal fold paralysis could occur among them.

Conclusions

Arytenoid dislocation after external blunt laryngeal trauma does occur, although rarely, and is often associated with impaired mobility of the vocal cord. Attempted closed reduction should be considered as a diagnostic approach for highly suspected arytenoid dislocation, especially in the clinics or hospitals without LEMG. Furthermore, early closed reduction under local anesthesia is also a practicable and effective treatment option for this kind of disorders as well.

Acknowledgments

We thank Prof. Shu Wang (National University of Singapore) for helpful discussion and review of this manuscript. This paper is dedicated to the memory of Professor Hui-e Wang, our much beloved mentor, who passed away on February 14, 2007.

Conflicts of interest statement

None declared.

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