Bamboo Node: Primary Vocal Fold Lesion as Evidence of Autoimmune Disease

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**Summary:** Descriptions of vocal fold lesions related to autoimmune diseases are rare in the literature, and focus mainly on rheumatoid nodules. This is the first report in which autoimmune diseases were promptly suspected by the observation of a unique white transverse submucosal lesion in the vocal fold during clinical examination. This lesion, reported only in autoimmune disease, has been called the bamboo node and its features are different from those of rheumatoid nodules. We report here on two patients who did not have a diagnosis of systemic disease before investigation of their main complaint of hoarseness. At the patients’ first visit, vocal fold bamboo nodes were seen in the vocal fold and the otolaryngologist suspected the presence of an autoimmune disease. We requested clinical investigation to clarify our suspicion that there was an underlying systemic disease. After the investigation, both patients were shown to have autoimmune disease, Sjögren’s syndrome and systemic lupus erythematosus, respectively. This paper emphasizes the important role of the otolaryngologist in the detection of these unique lesions in the vocal folds through the conventional laryngeal methods. These methods consisted of direct observation with a rigid laryngeal endoscope and investigation of the patient’s distinctive vibratory pattern by means of laryngeal stroboscopy. The method of treatment we used to obtain the best outcome in terms of voice improvement is also discussed.

**Key Words:** Hoarseness—Bamboo node—Autoimmune disease—Systemic lupus erythematosus (SLE)—Sjögren’s syndrome.

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INTRODUCTION

Hoarseness, a change in the voice quality, has been described previously in the literature as the very first symptom in autoimmune disease.1,2 Vocal fold lesions in autoimmune diseases are also described in the literature, although rarely. Mikkelsen3 described these lesions, which were mainly small submucosal
vocal fold nodules, in a rheumatoid arthritis patient and they were histopathologically similar to rheumatoid nodules found in other sites. Following this description, these sort of vocal fold nodules, which have been called rheumatoid nodules, were found in rheumatoid arthritis patients,\textsuperscript{4-7} in systemic lupus erythematosus (SLE),\textsuperscript{7-9} and in Sjögren’s syndrome\textsuperscript{1} patients.

In 1993, Hosako et al described a transversal cream-yellow band lesion at the midpoint of the upper surface of each vocal fold in a SLE patient. The vocal folds resembled the appearance of bamboo and its nodes.\textsuperscript{10} Following this case, this unique feature in the vocal folds was also seen in five other cases of autoimmune disease,\textsuperscript{2,11,12} which suggested that the lesions might be related to a disease of autoimmune activity.

We report here on two patients whose main complaint on visiting a doctor was hoarseness; the unique feature of bamboo nodules in the vocal folds led the otolaryngologist to suspect autoimmune disease in patients in whom systemic disease was not diagnosed. The lesions, which were promptly visualized using a rigid laryngeal endoscope at the first visit to our hospital, emphasize how important it is to suspect the presence of disease. The diagnosis of autoimmune disease in each case was confirmed after detailed clinical and serological investigation. Furthermore, evaluation of the main complaint of hoarseness and other clinical complaints, as well as serology and pathology, provided some evidence that there is a good correlation between the manifestations of these unique lesions in the vocal folds of patients with autoimmune disease activity. This paper emphasizes the important role of the otolaryngologist in recognizing these macroscopically visible lesions and discusses their treatment for the improvement of hoarseness.

Case 1

On July 20, 1996, a 36-year-old female opera singer realized that she had difficulty maintaining high tones during a performance. Two months later she developed constant hoarseness and had to cancel all further performances. She visited an otolaryngologist who suspected a submucosal vocal fold cyst and referred her to our hospital for removal of the lesion under laryngomicrosurgery. She came to the Voice Clinic at the University of Tokyo Hospital in November 1996. The rigid laryngeal endoscopic examination showed a white transverse band lesion in the submucosal space at the junction of the anterior and middle thirds of her right vocal fold, which protruded slightly to the surface (Figure 1A) Stroboscopic visualization of the vibratory pattern revealed decreased right vocal fold mucosal wave and vibration amplitude, absence of mucosal wave at the site of the lesion, and a slit anterior to the lesion. The stroboscopic evaluation was frequently disrupted due to the onset of diplophonia, mainly at the end of the phonatory task. The macroscopic feature of the white submucosal lesion could not be classified as one of the lesions usually seen, but resembled the rare lesion previously described as a vocal fold bam-

![FIGURE 1. Endoscopic view of patient 1’s vocal folds using a 70° lens rigid laryngeal endoscope and xenon lamp light source. Black and white arrows indicate the transverse white lesion at the submucosal level of the vocal folds (bamboo nodes). View A was taken on January 21, 1997, before the first surgery; view B was taken on May 19, 1997, when the patient started to complain of hoarseness, fatigue, and arthralgia; view C was taken on March 9, 1998 after the second surgery and when good clinical control has been achieved; view D was taken on July 6, 1998 when clinical symptoms of fatigue and hoarseness were present.](image-url)
boo node. Although at first the history seemed to indicate an unusual case of nodules or other lesions in the vocal folds due to voice abuse, the unique appearance of the white transverse lesion, which had been previously reported only in autoimmune disease patients, led us to look for the presence of these systemic diseases. The patient was then referred to the internal medicine clinic.

Autoimmune disease diagnosis

The patient was free of any other clinical signs associated with autoimmune disease, although she mentioned that she had already experienced dryness of the mouth and decreased tear production for over 10 years, which was not bothersome to her. She had never sought treatment to solve the problem of mouth dryness. Blood examination in January 1997 showed that antinuclear antibodies (ANA) speckle was positive at a dilution of 1:320 and nucleo at 1:320, serum antibodies were positive for Sjögren’s syndrome-A (SS-A) and Sjögren’s syndrome-B (SS-B) (Table 1). Sjögren’s syndrome was diagnosed as a result of the lip biopsy, which showed grade 4 chronic sialoadenitis with more than one focus showing infiltration of 50 or more histiocytes and lymphocytes per 4 mm² of salivary tissue (Figure 2). In addition, keratoconjunctivitis sicca was detected with rose bengal dye in the ophthalmology examination.

Initial treatment

Since the patient did not have any clinical symptoms to contraindicate the surgery, even after the diagnosis of autoimmune disease, the lesion in the vocal fold (Figure 1A) (which was the cause of her main complaint of hoarseness) was excised on January 31, 1997 under microlaryngoscopy. Under microscopic view, a white submucosal transverse striped band at the junction of the anterior and middle thirds of her right vocal folds was observed. It was slightly prominent. The surgical technique consisted of a longitudinal incision lateral to the lesion on the superior surface of the vocal fold, followed by

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<td>No complaints</td>
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<td>Treatment with steroid started</td>
<td>Maintenance of steroid</td>
<td>Steroid dosage increased</td>
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<td>Second surgery in November 1997</td>
<td>Returned to profession</td>
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<td>Stopped profession</td>
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Abbreviations: RA, rheumatoid factor; +, present.

*GRBAS 4-point scale: 0—normal, 1—mild, 2—moderate, 3—extreme; G—grade, R—roughness, B—breathiness, A—asthenia, S—strained.
undermining the mucosal layer along the lesion. A whitish soft, crumbly substance without an encapsulating structure was found under the mucosal layer, which adjoined the vocal ligament transversally. Although this visible white substance was withdrawn, the absence of any distinct margin led to some doubts about whether the lesion had been completely removed during the surgery. Nevertheless, these doubts were discarded in the follow-up.

Histopathology of the vocal fold
Specimens were stained with hematoxylin and eosin, and fibrosis around granulomatous lesions with central amorphous eosinophilic material was observed (Figure 3).

Follow-up
In March 1997, 2 months after the surgery, the patient was allowed to resume professional voice training. However, 1 month later she began to complain of fatigue and hoarseness. In May 1997 she complained of arthralgia, back pain, and a more evident hoarseness. Another transverse white lesion, or bamboo node, was detected in the vocal fold opposite the one from which the first lesion had been surgically excised (Figure 1B). Treatment with steroids (prednisolone 20 mg/day) was instituted to improve the clinical symptoms. In October 1997, the patient’s disease was brought under control with a maintenance dose of 5 mg of prednisolone. In November 1997, a second microsurgical surgery was performed since her voice, although acceptable for normal conversation, was not suitable for professional use. The laryngeal and histological findings of the second microlaryngoscopy were very similar to those of the first procedure. In March 1998, the patient’s voice was considered normal and the disease was under control, so she was allowed to go back to professional training (Figure 1C). Nevertheless, during 1998 she experienced frequent periods of hoarseness, which seemed to be highly related to fatigue and arthralgia. By July 1998, a tiny new lesion was observed in the left vocal fold (Figure 1D). Although her voice was almost normal for conversation, it was unacceptable for use in professional performances. Subsequently, she retired in 1999. Perceptual voice hoarseness examination according to the Japan Society of Logopedics and Phoniatrics GRBAS (Grade, Roughness, Breathiness, Asthenia, Strain) system,13 serum results, and clinical findings are summarized in Table 1.
Case 2

In August 1994, a 28-year-old female primary school music teacher had a sudden onset of hoarseness. One month after the sudden hoarseness onset, she consulted an otolaryngologist and received some nonhormonal anti-inflammatory drugs, which did not change her voice quality. She came to the Voice Clinic at the University of Tokyo Hospital on July 6, 1995 complaining of hoarseness. During the first examination at the University of Tokyo hospital, her voice was diplophonic and hoarse. The rigid laryngeal endoscopic view showed bilateral whitish transverse band stripes in the submucosa, which lent a slightly protruded aspect to the vocal folds. One lesion was seen at the junction of the middle and posterior thirds of the right vocal fold and another was observed in the middle of the left vocal fold (Figure 4A). The site of the bilateral lesion within the vocal folds became more evident during the stroboscopic examination. Moreover, the stroboscopic view during chest voice phonation demonstrated a decreased amplitude vibration throughout the vocal folds, except in the lesion, where no vibration at all could be seen. Furthermore, phase shift in the vibratory pattern between the portions anterior and posterior to the transverse lesion in vocal fold was seen in the continuous image of the videostroboscopy (Figure 5). Glottal width measurement was used to make the distinctive vibratory pattern of the vocal folds clear for presentation purpose. The principle of this method is commonly used in the analysis of laryngeal images obtained in high-speed digital imaging system. A total of four points at the free edge were selected frame-by-frame and their displacements were tracked and plotted over time for the purpose of comparing the glottal width between the portions anterior and posterior to transversal lesions. To obtain these points, two scan lines, one in the anterior and another posterior to the transverse lesion, were set and the points where the free edges of the vocal folds cross these scan lines were selected for glottal width measurement (Figure 6). Although the vibratory pattern of the right and left anterior portions of the vocal folds could be considered almost normal due to complete closure and the absence of almost any phase shift, the reverse occurs in the right and left posterior portions. In these portions, both vocal folds dislocate to the same direction and no closure is seen. The left anterior and left posterior portions have almost a 180° shift.

FIGURE 3. Pathology of case 1 vocal fold lesion: granulomatous lesions surrounded by fibrosis are shown. These peculiar granulomatous lesions have a central area of amorphous eosinophilic material surrounded by histiocytic cells and multinucleated giant cells. (Hematoxylin and eosin stain, ×10.)
FIGURE 4. Endoscopic view of patient 2’s vocal folds using a 70° lens rigid laryngeal endoscope and xenon lamp light source. View A was taken on July 6, 1995 when the autoimmune disease was suspected through the transversal white lesion in the submucosa of the bilateral vocal fold, shown by a slight protuberance (bamboo nodes); view B was taken on March 24, 1997 after intensive treatment with steroids and absence of any sort of voice or clinical complaints; view C was taken on May 24, 1999 when the patient had ongoing hoarseness and serological changes were detected without any other clinical complaints. Black and white arrows indicate the transverse lesion in the vocal folds.

FIGURE 5. Sequence of stroboscopic images utilizing a 70° rigid laryngeal endoscope during chest voice phonation of the patient 2. It is possible to observe the existence of a glottal chink posterior to the bilateral bamboo node lesions, as well as a phase shift and a difference in the vocal fold amplitude along the anterior and posterior portions of each vocal fold.

FIGURE 6. Three entire glottal cycles represented by displacement in the x-axis of the free edge of the vocal folds over time obtained from video-stroboscopic images of patient 2. The four points shown were selected visually by frame-by-frame video-image analysis of the intersection between the free edge of the vocal folds and two arbitrary scan lines, traced anterior and posterior to the transversal band lesion, respectively. Three measurements of each video frame image were performed and the average of these selected points was then plotted over time resulting in a graph which enabled us to analyze and compare the glottal cycle, vocal fold amplitude, and phase shifts. Two instants, A and B, were selected to compare the phase shifts between the anterior and posterior portions of the vocal folds: A represented the open period and B the closed period at the anterior portion. Note that at time A, the posterior portion of the left vocal fold tends to be 180° delayed from the anterior portion of the same vocal fold. At time B, while the anterior portion is closed, both right and left posterior portions are phase delayed from the anterior portion.
As the macroscopically observed lesions were similar to what had been previously described as a vocal fold bamboo node, we suspected autoimmune disease and referred the patient to the internal medicine clinic for investigation.

**Autoimmune disease diagnosis**

Several examinations were performed and the patient was diagnosed with systemic lupus erythematosus (SLE) due to high titers of ANA. In addition, speckle was positive at a dilution of 1:2560, there was a low level of complement, and Raynaud’s phenomenon was present, as well as arthritis (Table 3).

**Initial treatment**

The patient received steroids (prednisolone at a dose of 30 mg/day) as an exclusive treatment and both the arthritis and hoarseness resolved.

**Follow-up**

On March 24, 1997, no lesions in the vocal folds could be seen (Figure 4B) and her voice was perceptually normal (Table 2). At that time she was receiving 7.5 mg prednisolone as a maintenance dose and there were no clinical symptoms or complaints. She returned to her teaching activities. Nevertheless, in May 1999, she noticed hoarseness during conversational speech which was not related to prior vocal abuse. There were no other clinical complaints simultaneously. To our surprise another bamboo node lesion in the right vocal fold was observed in the laryngological examination (Figure 4C) and SS-A and single-stranded DNA (SS-DNA), which were absent in the previously performed blood test, were detected (Table 2). As clinical complaints other than the hoarseness were absent, the prednisolone dosage was not increased and the patient was advised to undergo a period of strict vocal hygiene. Although the lesion is still present, the patient is working normally.

**DISCUSSION**

Laryngeal manifestations in autoimmune disease are described in the literature. These are cricoarytenoid arthritis,9,15-17 laryngeal mucosal inflammation,9 epiglottitis,18 laryngeal edema,19 and rheuma-

| TABLE 2. Four Year Follow-Up of Patient 2 with Perceptual Evaluation of Voice Hoarseness, Clinical Symptoms, Most Important Examinations, and Outcomes* |
|-----------------|-----------------|-----------------|
| **Case 2**      | **July 6, 1995** | **March 24, 1997** | **May 24, 1999** |
| Evaluation of hoarseness | G2, R2, B2, A0, S0 | G1, R1, B0, A0, S0 | G1, R1, B1, A0, S0 |
| Clinical symptoms | Arthralgia, fever, fatigue | No complaints | No complaints |
| Examinations | ANA + | ANA + | ANA + |
| | Speckle 1:2560 dilution | Speckle 1:2560 dilution | Speckle 1:2560 dilution |
| | SS-A | SS-A | SS-A |
| | SS-B | SS-B | SS-B |
| | DS-DNA 5.0 (0-10) | DS-DNA 5.0 | DS-DNA 9.0 |
| | SS-DNA 5.0 (0-10) | SS-DNA 5.0 | SS-DNA 20.2 |
| | C3 46 mg/dL (44-102) | C3 35 mg/dL | C3 38 mg/dL |
| | C4 11 mg/dL (14-49) | C4 11 mg/dL | C4 11 mg/dL |
| | ESR 25 mm/h (2-16) | ESR 9 mm/h | ESR 12 mm/h |
| Outcome | SLE diagnosed | Maintenance dose of steroid | Maintenance dose of steroid |
| | Steroid treatment started | Voice rest |

*GRBAS defined in Table 1.

Abbreviations: C3, complement 3; C4, complement 4; DS-DNA, reactive to double-stranded DNA; ESR, erythrocyte sedimentation rate. Numbers in parentheses are the nl values.
toid vocal fold nodules. Vocal fold lesions in autoimmune disease have been described in SLE and Sjögren’s syndrome, and these lesions were called vocal fold rheumatoid nodules. Mikkelsen used this term in a rheumatoid arthritis patient in 1955, and he described them as bilateral cystic rounded masses in the submucosal space at the junction of the anterior and medial thirds of each vocal fold. He removed one of these lesions under direct laryngoscopy and the histological examination revealed focal areas of necrosis and lime salt deposition surrounded by an epithelioid zone and an outer area of fibrous connective tissue and inflammatory cells.

In 1993, Hosako described a case of SLE in the literature in which the submucosal lesions in the vocal folds did not resemble the rounded nodules, and called these unusual lesions bamboo-joint-like. These unique lesions were also reported in other female patients with autoimmune disease. (Table 3). Each author had described the same unusual feature, which is much like a bamboo node. In this paper, we propose the term vocal fold bamboo node to simplify the nomenclature of the same feature.

As far as we know, this is the first report in the literature in which a primary vocal fold lesion was the evidence of autoimmune which lead to the diagnosis of systemic disease. In previously reported cases, the relationship of the lesion in vocal folds and autoimmune disease was demonstrated after the review of the surgically excised nodule’s pathology or in a patient who had at least one diagnosis of autoimmune disease. In the present paper, we reported two cases in which the main complaint was hoarseness and the vocal fold inspection was sufficient for the otolaryngologist to suspect autoimmune disease in patients who had never been diagnosed with autoimmune disease or any other systemic disease.

The whitish transverse band lesion in the submucosal layer of the vocal folds was neither necessarily localized at the junction of the anterior and middle thirds nor was it symmetrical when present in both vocal folds. Nevertheless, it showed a preference for appearance in the middle third of the vocal fold mucosa where larger mucosal wave and vibration amplitude is found. In fact, both patients used their voices professionally and vocal abuse might be related to the patients’ pathophysiology. The stroboscop-
ic examination provided important information on the vibratory pattern of the mucosa and permitted us to estimate the depth of the lesion in the mucosal layer. The 180° phase shift of the vibration between the posterior segments of the vocal fold seen by stroboscopic view was important to clearly localize the position of the lesion within the length of the vocal folds. Differences in vibratory pattern of the anterior and posterior portions of the vocal folds in cases of bamboo nodes have already been described using a high-speed digital imaging technique, a method that allows a detailed evaluation of the vibratory pattern even when the patient’s voice is completely diplophonic. Direct visualization of the macroscopic features of the vocal fold bamboo node with the rigid laryngeal endoscope and the vibratory pattern of the vocal folds by the stroboscopic methods in the otolaryngology office were the main keys to describing and confirming the unique characteristics of the lesion and led us to suspect autoimmune disease in these patients at their first visit to the clinic.

Although the number of the cases described in the literature is still scarce, the lesion was more frequently described in SLE patients. Sjögren’s syndrome might be the second most frequently described entity, because patient 6 in Table 3 developed Sjögren’s syndrome secondary to Hashimoto’s thyroiditis.

Follow-up over several years also suggested that the vocal fold bamboo node is related to autoimmune activity. In case 1, the second vocal fold lesion that appeared in May 1997 seems to be concomitant with the complaint of fatigue and arthralgia, which required the introduction of steroid therapy. On the other hand, in case 2 the vocal fold lesions appeared in May 1999 when serologic changes were also observed.

Our experience with these two cases and previous reports lead us to believe that clinical treatment with steroids should be tried first. Steroids and voice rest can improve hoarseness and a complete remission of the lesion can be expected. Surgery should be done if there is an incomplete disappearance of the lesion or if the patient has an urgent reason to improve voice quality. In addition, surgery should be performed only if the underlying disease is well controlled. However, it is important to consider that the detection of lesion boundaries intraoperatively is an arduous task and there is a huge risk of definitively harming the vocal ligament or even the mucosal layer, causing scarring. Nevertheless, it is not yet clear what the best treatment is leading to the best outcome. This requires further investigation. The absence of lesion boundaries raises the possibility that the chronic inflammatory process might be spread throughout the vocal folds but is more evident in some portions, which could appear as the transverse band stripe or bamboo node lesion. Follow-up over several years has allowed us to realize that we should not treat a localized vocal fold lesion; instead we should treat the patient for a systemic disease. If this is not done, recurrence of bamboo nodes in the same or other sites of the vocal folds is prone to occur.

CONCLUSION

Our experience with two patients with vocal fold bamboo nodes has provided us some clues on vocal fold bamboo node lesions:

1. In both patients, the rigid laryngeal endoscopic and stroboscopic observation of the vocal folds and their vibratory pattern led to the diagnosis of autoimmune disease in patients without a previous diagnosis of autoimmune disease. We were led to suspect this diagnosis by visualization of the bamboo node, a white transverse band lesion in the submucosal space of the vocal folds.

2. Steroids seem to be effective in obtaining a good outcome, resulting in voice improvement and alleviation of clinical symptoms.

3. Although the pathophysiology is not yet clear, highly demanding voice use may be related to the appearance of bamboo nodes in autoimmune disease patients.

4. These case reports illustrate the importance of distinguishing the vocal fold bamboo node from other common vocal fold lesions, since it seems to be highly related to autoimmune disease; efforts to locate underlying autoimmune disease should be instituted when a vocal fold bamboo node is found.

5. Additional cases of bamboo nodes in the vocal folds are necessary if it is to be considered a pathognomonic lesion of autoimmune disease.

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