

Diagnosis of Recurrent Laryngeal Nerve Paralysis Using Dynamic Digital Radiography (DDR)

— Clinical Experience and Perspectives on Quantitative Assessment



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Introduction

Recurrent laryngeal nerve paralysis (RLNP) is a neurological disorder that can result from head and neck or thoracic surgery, or from the invasion of malignant tumors, and it causes hoarseness and dysphagia. Traditionally, flexible laryngoscopy (FL) performed by otolaryngology specialists has been widely used for the diagnosis of RLNP. FL is a reliable method that enables direct visualization of vocal cord movement; however, it presents several challenges in clinical practice. These include patient discomfort due to strong gag reflexes, the requirement for considerable time and specialized expertise, and an increased risk of infection exposure to medical staff. In this context, dynamic digital radiography (DDR) has recently attracted attention as a simpler and less invasive alternative. DDR is a radiographic technique that acquires continuous X-ray images, and it has been increasingly applied in the thoracic field for functional evaluation, such as assessing respiratory motion and diaphragmatic mobility. In the cervical region, the frequency enhancement processing (FE-MODE) implemented in the Dynamic Digital Radiography Analysis Workstation DI-X1 of Konica Minolta allows for improved visualization of the vocal cords, which are soft-tissue structures, by emphasizing their edges. This facilitates easier assessment of vocal cord movement. Here, we report two cases where DDR enabled safe, and less invasive diagnosis of RLNP, a potentially life-threatening condition, leading to timely and appropriate management.

Case Presentation

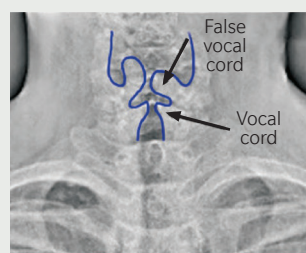
Case 1: A 54-year-old female presented with hoarseness, stridor, and dyspnea. As the patient had significant respiratory distress, evaluation with FL was considered difficult. Therefore, as an alternative, upright cervical and chest DDR was performed (entrance surface dose: 1.16 mGy) (Figure 1A). FE-MODE imaging revealed fixation of the left vocal cord in the paramedian position, suggesting left RLNP. Chest CT demonstrated a tumor in the middle thoracic esophagus, with cervical and mediastinal lymph node metastases and distant pulmonary metastases. The cervical lymph node mass was found to invade the thyroid and trachea, which was suspected to be associated with left RLNP. On day 9 of hospitalization, the patient reported a sensation of throat discomfort, and repeat DDR was performed (Figure 1B). The examination confirmed fixation of both vocal cords in the paramedian position, and the patient was diagnosed with BRLNP. On the same day, tracheal intubation was performed under bronchoscopy, followed by tracheostomy. Although tumor progression was observed thereafter, serious complications such as airway obstruction or aspiration due to vocal cord paralysis were successfully avoided.

Figure 1: DDR FE-MODE Image ^[1]

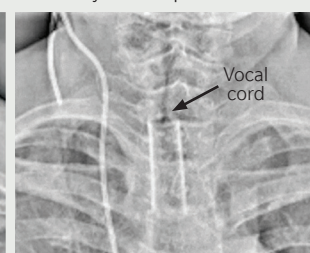


A: At admission

B: On day 9 of hospitalization



The left vocal cord showed paramedian fixation

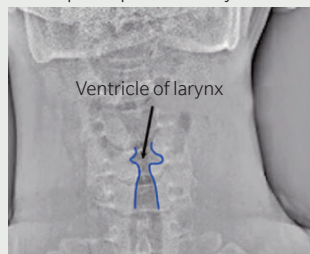


Both vocal cords were fixed in the paramedian position, leading to a diagnosis of BRLNP

Case 2: A 20-year-old male underwent total thyroidectomy for drug-resistant Basedow's disease. During surgery, the left recurrent laryngeal nerve was identified, and nerve monitoring confirmed preservation of its function. However, because of severe adhesions, the right recurrent laryngeal nerve was transected and anastomosed to the ansa cervicalis. On postoperative day 2, the patient presented with hoarseness, and cervical DDR was performed during phonation (entrance surface dose: 1.15 mGy). DDR revealed that both vocal cords were fixed in the median position (Figure 2A). FL performed on the same day demonstrated identical findings, and the patient was diagnosed with BRLNP. A tracheostomy was immediately performed. The postoperative course was favorable, and at 2 months after surgery, follow-up DDR and FL examinations revealed clear improvement in the mobility of the left vocal cord (Figure 2B). Subsequently, the tracheostomy cannula was removed, and the tracheostomy site was closed.

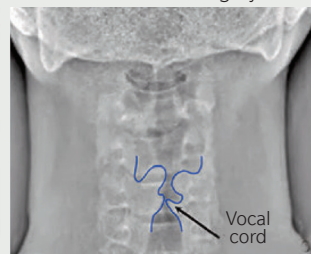
Figure 2: DDR FE-MODE Image^[1]

A: On postoperative day 2



Both vocal cords were fixed in the median position

B: At 2 months after surgery



Improvement in left vocal cord mobility was confirmed

Discussion

As demonstrated in these two cases, DDR enabled early diagnosis of BRLNP and rapid transition to appropriate treatment, which is of considerable clinical significance. Although FL has long been regarded as the gold standard for evaluating vocal cord movement due to its high diagnostic accuracy, its use requires a skilled otolaryngology specialist, and it is associated with patient discomfort from gag reflexes, environmental constraints, and infection control concerns. In contrast, DDR can be performed by radiological technologists alone, either in a general radiography room or at the bedside. The examination requires only about 10 seconds, and the radiation dose is very low, resulting in minimal physical and psychological burden on the patient. Furthermore, with the use of FE-MODE, the visibility of soft structures such as the vocal cords is enhanced, allowing even non-specialists to visually assess whether the cords are mobile. This simplicity, minimal invasiveness, and cost-effectiveness represent major advantages. Additionally, as shown in Case 2, DDR is useful not only for initial diagnosis but also for postoperative monitoring and visualization of the recovery process. This highlights its potential as a functional assessment tool not readily achievable with other imaging modalities. At present, our group is also working on the development of quantitative analysis techniques for vocal cord movement, based on findings from our prospective clinical study^[2]. The imaging protocol has been standardized as previously reported: the patient's head is elevated by 10° and fixed, with an anteroposterior view obtained. During the examination, the patient is instructed to follow verbal commands and phonate the vowel sound "/i/" twice following resting respiration, enabling clear visualization of vocal cord abduction and adduction. With further accumulation of cases and dissemination of quantitative analysis methods, DDR is expected to contribute to improvements in diagnostic accuracy and prognostic prediction after surgery.

Conclusion

DDR is a novel imaging modality for the evaluation of RLNP, offering a simple, minimally invasive, and infection-free diagnostic approach. As demonstrated in these two cases, the ability of DDR to visualize vocal cord movement rapidly and with low patient burden provides substantial advantages for both acute clinical decision-making and postoperative monitoring. Because the assessment of vocal cord mobility can be performed visually even by non-specialists, the threshold for clinical adoption is low, and its utility in daily practice is high. Moreover, with the future development of quantitative assessment techniques, DDR has the potential to be applied in monitoring postoperative recovery and predicting prognosis. DDR has the potential to become a new standard in the diagnosis and management of RLNP.

References

- [1] Shibuya Y, et al. Bilateral recurrent laryngeal nerve paralysis diagnosed using dynamic digital radiography during the COVID-19 pandemic. *Clin Case Rep.* 2022;10:e06124.
- [2] Shibuya Y, et al. Comparison of the diagnostic and prognostic abilities of flexible laryngoscopy and dynamic digital radiography for vocal cord paralysis: A prospective observational study. *Head & Neck.* 2024;46:1280–1293.

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