American Journal of
Oral Medicine and Radiology

ISSN - 2394-7721

www.mcmed.us/journal/ajomr

Research Article

# FEASIBILITY AND DIAGNOSTIC ACCURACY OF ULTRA-FAST DYNAMIC MRI IN THEEVALUATION OF VOCAL CORD MOTILITY IN PERSISTENT HOARSENESS

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**ABSTRACT**

Endoscopy is the commonly used to assess hoarseness, yet it is an invasive technique, which highly relies on patient cooperation. Anatomical difficulties, ill health, or blood clotting disorders can also restrict its success. This paper set out to discuss the possibility of applying ultra-fast magnetic resonance imaging (MRI) as a non-invasive substitute in the detection of the vocal cord movement disorders. It employed a custom-made coil array and a high signal-to-noise ratio (SNR) imaging sequence. A prospective, blinded examination was done on 12 patients (eight males and four females, aged 24 to 80 years, average age 60) who presented with persistent hoarseness and vocal cord paralysis was suspected. Signal detection was undertaken using two carotid phased-array coils. Each participant was scanned in two real-time steady-state free precession (SSFP) MRI sequences: one in silence and the other one producing the sound heee. Results of Laryngoscopic examination were then compared to those of MRI. The preparation, scanning and instructions took less than 10 minutes in total. MRI was able to detect all the seven unilateral vocal cord paralysis cases confirmed by endoscopy. The other five patients, whose hoarseness had been caused by other factors, had normal movement of the vocal cords both on MRI and endoscopy. The present study established that the image quality obtained was optimized because of the high SNR afforded by the particular coils and SSFP sequence which were better than other frequently utilized sequences. A larger study of the participants should be done to identify that this technique can become an alternative to endoscopy in a selected group of patients.

**Key words: -** Hoarseness, Vocal cord palsy, Magnetic resonance imaging (MRI), Signal-to-noise ratio (SNR), Steady-state free precession (SSFP).

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| Received:25.06.2015 | **Revised**:10.07.2015 | **Accepted**:06.08.2015 |
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## INTRODUCTION

Hoarseness is a commonly presented symptom, and it may be linked to a number of non-serious reasons, including infection, inflammation caused by upper respiratory disease, vocal cord paralysis, or trauma. Nevertheless, it can also signify more severe diseases such as malignant tumors.

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Medical guidelines commonly advise that when hoarseness lasts more than three weeks, it should be examined by an ear, nose, and throat disorder specialist to check serious underlying illness. Although the current endoscopic instruments involved in the examination of the vocal cords have become extremely advanced and versatile, the procedure is invasive [1]. It is highly dependent on cooperation of a patient during the procedure. What is more, there are some conditions, including abnormal

anatomy, strong gag reflex, poor physical state, or blood clotting disorders, which can make the procedure not be performed successfully. Due to these issues, radiological imaging techniques have traditionally been considered as alternative diagnosis tools. Fluoroscopy is one of these techniques; it demonstrates the real-time image of the vocal cord's movement in the process of phonation. Its disadvantage though is that it does not image the surrounding anatomical structures so it is required to perform further imaging studies in order to determine any accompanying abnormalities [2]. Ultrasound is also occasionally used to examine the possible causes of vocal cord paralysis, which may include tumors in the suspected cases. However, ultrasound imaging in adults can be limited by calcified cartilage or by the effect of air-tissue interfaces in the laryngeal region. Computed tomography (CT) is most often employed when it is necessary to determine the degree of tumors or visualize anatomical variations that include blood vessels or nerves, and can also be utilized within the method of virtual laryngoscopy [3]. There is some prior research that has been done by obtaining successive images when various vocalizations are made, and it has been indicated that recreating the coronal views when the speaker says the vowel hee can enhance the diagnosis of vocal cord immobility. Compared to MRI, there are multiple possible benefits of using MRI to study the functioning of vocal cords. Notably, MRI can be used to perform real-time dynamic imaging and thus movements of the vocal cords can be imaged with suitable time resolution. Flexible choice of imaging planes other than the conventional axial slices is also feasible, and this is especially useful in the demonstration of the complex structures in the neck. Although there have been a few studies done regarding the use of MRI in the examination of the vocal cords, the initial outcomes have been encouraging. Conventional MR techniques have mostly implied triggered sequences, which may be time consuming. More recently, though, there has been exploration of real-time MRI sequences, with either spoiled gradient-echo or echo-planar imaging [4]. All these techniques have been found capable of detecting vocal cord paralysis, however, certain ones needed special modifications to assure quality of the image. More recently, ultra-fast sequences with small phased-array coils, as used in vascular imaging, have enabled a large gain in image quality, because of the higher signal-to-noise ratios. Faster imaging speeds, improved spatial and temporal resolution have become possible with such technology advances [5]. Through these developments, the current study had an aim to determine the feasibility and efficiency of ultra-fast MRI in detecting the vocal cord movement disorders in patients with chronic hoarseness.

## MATERIALS AND METHODOLOGY

Twelve patients (eight men and four women) identified in this prospective study were between the ages of 24-80 years with an average age of 60 years and had hoarseness lasting over two weeks. A preliminary investigation in the ear, nose, and throat department was followed by a referral of suspected cases of vocal cord paralysis to undergo magnetic resonance imaging (MRI). All of the imaging has been done on a 1.5-Tesla MRI scanner with high-performance gradients. In order to improve the quality of signal detection more than that provided by conventional neck coils, two small phased-array coils (each with a surface area of around 105 by 60 millimeters and a penetration depth of 35 millimeters) were positioned on opposite sides of the neck of the patient. Patients were lying down on their backs and their heads were scanned first. Coils were fixed using supports and sandbags to make them stable during scanning. Imaging protocol: Imaging protocol started with fast scout scans through turbo spin-echo sequence in the three planes to accurately identify the vocal cords. This was followed by real time imaging, which entailed the use of steady state free precession (SSFP) sequence, with balanced gradients. A repeat acquisition was done in two consecutive coronal slices at a temporal resolution of four images/second during 14 seconds, resulting in a total of 56 images. The first scan was made in silence when the cords were at rest and the second when there was the sustained pronunciation of the sound heee, which is often applied in throat scans as it helps to activate the movement of the vocal cords. Two experienced radiologists employed jointly interpreted the MRI data. They evaluated clearness of the images, the ability to identify vocal cord mobility or lack of it and possible causes of paralysis. The clinical finding of the patients was blinded to reviewers in order to reduce bias. Vocal cord palsy was diagnosed when one or both cords remained unmoved during phonation. After MRI, each patient passed through a laryngoscopic examination by a specialist who also did not know the outcomes of MRI. The results of the MRI scans were subsequently compared to the results of the laryngoscopy, which is nonetheless considered as the standard of reference when it comes to the diagnosis of vocal cord disorders. Any extra observations made by the dynamic imaging sequences or the contrast-enhanced views were also reported in order to ascertain their diagnostic usefulness.

## RESULTS

The entire imaging protocol, comprising of patient preparation, positioning, localization scans and real-time dynamic MRI with SSFP sequence, was achieved in each of the 12 participants, with the total examination time of less than 10 minutes. The procedure was well-tolerated by all people, and no incidents or complications were registered. The dynamic MRI scans gave clear interpretable images, and the vocal cord motion could accurately be assessed in all cases. Analysis of the dynamic sequences made it possible to identify the normal vocal cord functioning or paralysis correctly. Among the 12

patients, seven had a diagnosis of unilateral vocal cord paralysis using laryngoscopic examination as the reference standard. The dynamic MRI sequences were found to correctly identify these same seven patients as having vocal cord paralysis. In both of these instances, fixation of one vocal cord during phonation was obvious to the eye, with the opposite cord moving normally. As an illustration, Figure 2 shows a typical instance of right-sided vocal cord immobility but normal motion on the left. Conversely, five patients had normal bilateral vocal cord movement by dynamic MRI and laryngoscopic examination, and these patients did not have vocal cord palsy. The causes of hoarseness in these people were not related to neuromuscular dysfunction of the vocal cords and included vocal cord leukoplakia, early laryngeal tumors, benign growths on the vocal cords such as papillomas and postoperative alterations of the voice. The Figure 3 below gives a reference Image of symmetrical and normal vocal cord movement during phonation. These results uphold the capability of dynamic MRI in distinguishing true motility disorders and other structural or inflammatory reasons of vocal impairment. It is interesting to note that in one instance (Patient VII), MRI and endoscopic examination could not ascertain the definite etiology of the hoarseness that was persistent in a patient, even though normal movement was noted. It is indicating a possible functional voice disorder or subclinical pathology that cannot be identified yet by available imaging or endoscopic procedures. The results of the MRI were fully concordant with laryngoscopic results with a diagnostic concordance rate of 100% in this small group. The clarity and reliability of the assessment of the vocal cord motion was facilitated by the high temporal resolution and good soft tissue contrast of the real-time SSFP sequence in addition to focused coil placement. These findings confirm that ultra-fast dynamic MRI is feasible, and in addition to being practical, it can effectively reveal abnormalities in vocal cord motility in patients with unexplained or persistent hoarseness, and it may replace or supplement endoscopy in some clinical cases as it is non-invasive.

**TABLE 1: Summary of Dynamic MRI and Laryngoscopic Findings in 12 Patients with Persistent Hoarseness**

| Patient ID | Laryngoscopic Diagnosis | Dynamic MRI Findings | Vocal Cord Motion | Final Diagnosis | Concordance with Laryngoscopy |
|---|---|---|---|---|---|
| I | Unilateral vocal cord paralysis | Right vocal cord immobile | Asymmetric (R ↓, L normal) | Vocal cord palsy | Yes |
| II | Unilateral vocal cord paralysis | Left vocal cord immobile | Asymmetric (L ↓, R normal) | Vocal cord palsy | Yes |
| III | Unilateral vocal cord paralysis | Right vocal cord immobile | Asymmetric (R ↓, L normal) | Vocal cord palsy | Yes |
| IV | Unilateral vocal cord paralysis | Left vocal cord immobile | Asymmetric (L ↓, R normal) | Vocal cord palsy | Yes |
| V | Unilateral vocal cord paralysis | Right vocal cord immobile | Asymmetric (R ↓, L normal) | Vocal cord palsy | Yes |
| VI | Unilateral vocal cord paralysis | Left vocal cord immobile | Asymmetric (L ↓, R normal) | Vocal cord palsy | Yes |
| VII | Normal vocal cord movement | Normal bilateral movement | Symmetric | Hoarseness of unknown origin | Yes |
| VIII | Leukoplakia of vocal cords | Normal bilateral movement | Symmetric | Vocal cord leukoplakia | Yes |
| IX | Early-stage glottic tumor | Normal bilateral movement | Symmetric | Laryngeal tumor | Yes |
| X | Papillomatosis | Normal bilateral movement | Symmetric | Benign vocal cord lesion | Yes |
| XI | Postoperative hoarseness | Normal bilateral movement | Symmetric | Post-surgical voice change | Yes |
| XII | Postoperative hoarseness | Normal bilateral movement | Symmetric | Post-surgical voice change | Yes |

**Table 2: Quantitative Summary of MRI and Laryngoscopic Findings in 12 Patients with Hoarseness.**

| Parameter | Value |
|---|---|
| Total number of patients | 12 |
| Gender distribution | 8 Male / 4 Female |
| Age range | 24 – 80 years |
| Mean age | 60 years |

| | |
|---|---|
| MRI examination time | < 10 minutes |
| Patients with unilateral vocal cord paralysis (confirmed by laryngoscopy) | 7 |
| Patients with vocal cord paralysis identified by MRI | 7 |
| Patients with normal vocal cord motion (MRI + endoscopy) | 5 |
| Other causes of hoarseness (non-paralysis) | 5 (leukoplakia, tumor, papilloma, post-op) |
| Unresolved etiology despite imaging and endoscopy | 1 (Patient VII) |
| Diagnostic concordance (MRI vs. laryngoscopy) | 100% (12/12 patients) |
| Adverse events or complications | None |
| Image clarity/interpretable scans | 100% of cases |

**Figure 1: Laryngoscopy vs Dynamic MRI: Vocal Cord Assessment Study, Comparative analysis of 12 patients showing diagnostic concordance between laryngoscopy and dynamic MRI.**

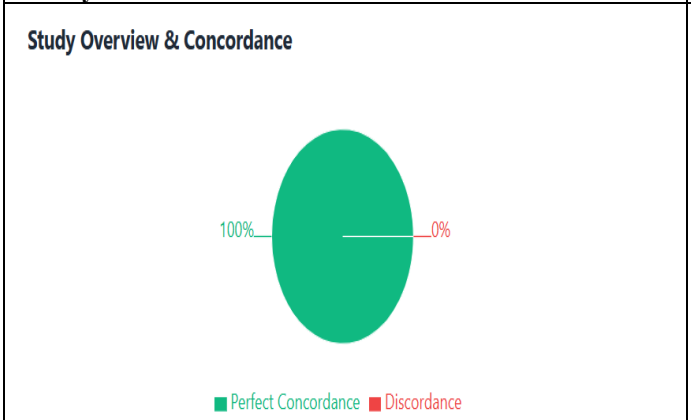
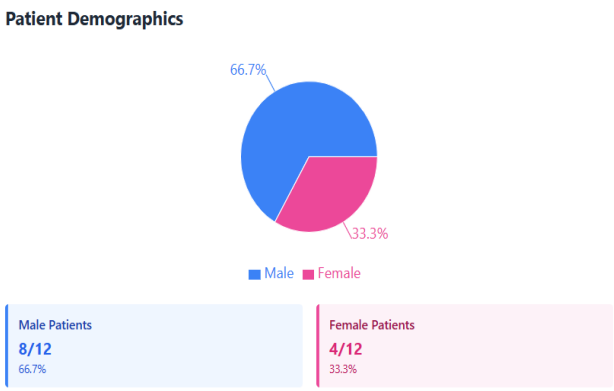



**Figure 2: Dynamic MRI vs Laryngoscopy: Vocal Cord Assessment Study, Comprehensive analysis of 12 patients (age 24-80, mean 60 years) with 100% diagnostic concordance.**




## DISCUSSION

This study highlights the potential of ultra-fast dynamic MRI using real-time steady-state free precession (SSFP) sequences as a reliable, non-invasive technique for evaluating vocal cord motility in patients presenting with persistent hoarseness. The complete concordance between MRI findings and standard laryngoscopic examinations in this cohort strongly supports the diagnostic accuracy of this imaging approach [1]. All 12 patients completed the MRI protocol without difficulty, and the imaging produced high-quality, interpretable results in every case. Notably, all seven patients diagnosed with unilateral vocal cord paralysis through laryngoscopy were accurately identified using dynamic MRI, demonstrating the method's sensitivity for detecting motility impairment. Furthermore, the five patients whose vocal cords moved normally on MRI were found to have other causes of hoarseness unrelated to paralysis, such as vocal cord leukoplakia, benign tumors like papillomas, glottic lesions, and post-surgical changes [2]. These cases reinforce the ability of dynamic MRI not only to confirm vocal cord paralysis but also to rule it out when the symptoms are due to other pathologies. In one case, where both MRI and endoscopy showed normal findings, no definitive diagnosis could be made, raising the possibility of a functional or subclinical voice disorder undetectable by current imaging techniques. The main advantages of this MRI protocol include its rapid execution, high temporal resolution, and excellent soft tissue contrast [3]. The entire imaging process, from preparation to acquisition, was completed in less than ten minutes, which enhances clinical efficiency and patient comfort. In contrast to invasive laryngoscopy, dynamic MRI is particularly valuable for patients who are unable to tolerate endoscopy due to anatomical limitations, strong gag reflex, or general health concerns. Additionally, the ability to evaluate structures in multiple planes allows for better visualization of the larynx and adjacent tissues, potentially improving the detection of underlying abnormalities. While the small sample size limits the generalizability of the findings, the results are nonetheless promising [4,5]. The complete agreement between MRI and laryngoscopic findings suggests that dynamic MRI can serve as a dependable alternative or adjunct to traditional endoscopic evaluation, especially in challenging clinical cases. Further research with larger populations and varied clinical scenarios will be essential to fully establish its role in routine diagnostic workflows. However, this study supports the integration of ultra-fast dynamic MRI into clinical practice for non-invasive, accurate assessment of vocal cord function.

## CONCLUSION

The present study proves that the ultra-fast dynamic MRI with real-time SSFP sequences is a feasible, non-invasive, and precise protocol of evaluating the vocal cord motility in patients with chronic hoarseness. The whole process involves the preparation of the sample and acquisition of the image and lasts ten minutes only, which makes it applicable in clinical practice. The results of the dynamic MRI were directly coupled to laryngoscopy with no deviation or changes recorded and all cases of unilateral vocal cord paralysis were identified with the dynamic MRI and all the other causes of hoarseness were identified which includes benign lesions, early tumors, and post-operative changes. Phased-array coils increase its temporal resolution and spatial resolution, making it clear to visualize the movement of uttering vocal cords during phonation. The method is a good alternative to endoscopy especially when a patient is in a position where he or she cannot be subjected to invasive procedures. Although the number of the sample is rather small, the findings are encouraging. The prospective larger studies should confirm the diagnostic value, evaluate cost-effectiveness and facilitate its incorporation into the clinical practice due to the better control of hoarseness.

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**Cite this article:**
Dr. Donepudi Rajeev. (2015). Feasibility And Diagnostic Accuracy of Ultra-Fast Dynamic Mri in Theevaluation of Vocal Cord Motility in Persistent Hoarseness. *American Journal of Oral Medicine and Radiology*, 2(4), 289-293.