Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/gyaxwb50

THE ROLE OF DYNAMIC MRI SLEEP STUDIES IN GUIDING THE MANAGEMENT OF OBSTRUCTIVE SLEEP APNEA: AN OBSERVATIONAL ANALYSIS.

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Abstract:

Background: Obstructive sleep apnea (OSA) prevalence is increasing due to sedentary lifestyles. Dynamic MRI sleep studies offer detailed anatomical evaluation, identifying the level and pattern of airway obstruction, which can optimize surgical planning. This study investigates the efficacy of dynamic MRI in guiding OSA management.

Methods: This retrospective observational study analyzed dynamic MRI findings in 66 patients previously diagnosed with OSA via polysomnography. The levels and patterns of airway collapse were correlated with apnea-hypopnea index (AHI) severity, and the impact on treatment planning was assessed.

Results: Dynamic MRI revealed significant retropalatal collapse in 62 patients and lateral pharyngeal wall collapse in 53 patients. Retroglossal collapse, often concurrent with retropalatal collapse, was observed in 6 patients. Multilevel collapse (retropalatal, retroglossal, and hypopharyngeal) was present in 3 patients. Based on MRI findings, 48 patients were recommended for surgical intervention. Of the 30 patients who underwent surgery, promising clinical improvement was noted at 6-month follow-up.

Conclusion: Lateral pharyngeal wall collapse was frequently associated with AHI severity. Dynamic MRI provides valuable anatomical information for surgical planning in OSA patients, demonstrating its potential to improve treatment outcomes. Therefore, dynamic MRI is a useful tool in the preoperative assessment of OSA patients.

Keywords: Obstructive Sleep Apnea, Dynamic MRI, Apnea-Hypopnea Index, Retropalatal Collapse, Lateral Pharyngeal Wall Collapse.

Introduction:

Obstructive sleep apnea (OSA), a prevalent sleep disorder characterized by repetitive episodes of upper airway collapse during sleep, has emerged as a significant public health concern. Its association with cardiovascular disease, metabolic disorders, cognitive impairment, and reduced quality of life underscores the importance of accurate diagnosis and effective management. The increasing

prevalence of OSA, attributed to factors such as obesity, sedentary lifestyles, and aging populations, necessitates the development and refinement of diagnostic and therapeutic strategies.

The pathophysiology of OSA is complex, involving a dynamic interplay of anatomical and neuromuscular factors. While polysomnography (PSG) remains the gold standard for diagnosing OSA and quantifying its severity through the apnea-hypopnea index (AHI), it provides limited information regarding the specific anatomical sites and mechanisms of airway obstruction. Traditional clinical evaluations, including physical examination and static imaging modalities, often fail to capture the dynamic nature of airway collapse during sleep.

Dynamic magnetic resonance imaging (MRI) sleep studies have emerged as a promising tool for visualizing and characterizing the dynamic changes in upper airway anatomy during simulated sleep. Unlike static imaging, dynamic MRI allows for the real-time assessment of airway collapse during simulated breathing maneuvers, providing valuable insights into the specific levels and patterns of obstruction. This information is crucial for optimizing treatment strategies, particularly in patients considering surgical interventions.

The ability of dynamic MRI to identify the precise anatomical sites of obstruction, such as the retropalatal, retroglossal, and hypopharyngeal regions, enables surgeons to tailor surgical procedures to address the specific needs of individual patients. By visualizing the dynamic interplay between soft tissues and bony structures during simulated sleep, dynamic MRI can guide surgical planning and improve the likelihood of successful outcomes.

Furthermore, dynamic MRI can provide valuable information regarding the severity and pattern of airway collapse, which may not be readily apparent on PSG alone. This information can aid in the selection of appropriate treatment modalities, such as continuous positive airway pressure (CPAP) therapy, oral appliances, or surgical interventions.

Despite the potential benefits of dynamic MRI in the management of OSA, its clinical utility and efficacy remain a subject of ongoing investigation. This observational study aims to evaluate the efficacy of dynamic MRI sleep studies in guiding the management of OSA patients. By analyzing dynamic MRI findings in a cohort of patients previously diagnosed with OSA via PSG, we seek to determine the correlation between anatomical obstruction patterns and AHI severity, as well as the impact of dynamic MRI on treatment planning and clinical outcomes.

This study will contribute to the growing body of evidence supporting the use of dynamic MRI in the comprehensive evaluation and management of OSA. By demonstrating the clinical utility of dynamic MRI in identifying specific anatomical sites and patterns of airway obstruction, this study will provide valuable insights for clinicians seeking to optimize treatment strategies and improve patient outcomes. Ultimately, this research aims to enhance our understanding of the complex pathophysiology of OSA and refine our approach to its management.

Materials and Methods:

Study Design and Setting:

This retrospective observational study was conducted at the Department of ENT, Head and Neck Surgery, GIMSH, Durgapur.

Study Period:

Data were collected from February 2023 to January 2025.

Study Population:

The study population consisted of 66 patients presenting with clinical symptoms of obstructive sleep apnea (OSA).

Inclusion Criteria:

- Age: 18 to 80 years.
- Body mass index (BMI): 18.5 to 39.9 kg/m².

- Clinical symptomatology suggestive of OSA.
- Apnea-hypopnea index (AHI) > 5, as determined by polysomnography (PSG).

Exclusion Criteria:
- BMI ≥ 40 kg/m².
- Contraindications to MRI.

Data Collection:
- Demographic data (age, sex).
- Detailed medical history, including comorbidities and personal history.
- STOP-BANG questionnaire.
- Epworth Sleepiness Scale (ESS).
- Physical examination, including height, weight, and BMI calculation (classified according to WHO criteria for the Asian population).
- Ear, nose, and throat examination.
- Diagnostic nasal endoscopy.
- Video laryngoscopy.
- CT paranasal sinuses (PNS).
- Polysomnography (PSG).
- Dynamic MRI sleep study.

Assessment of Anatomical Obstruction:
- Endoscopic evaluation was used to identify anatomical obstructions, including deviated nasal septum, hypertrophied turbinates, adenoid hypertrophy, nasal polyps, reduced oropharyngeal isthmus, circumferential collapse, and lateral pharyngeal wall collapse.
- Dynamic MRI sleep studies were used to assess the level and pattern of airway collapse.

Dynamic MRI Protocol:
- Dynamic MRI sleep studies were performed on a 3 Tesla scanner.
- Imaging was performed in the supine position during natural sleep (no sedation).
- T1-weighted (T1W) sequences were acquired in axial and sagittal planes.
- Dynamic sequential images were obtained at a rate of one image per second for one minute in the midsagittal section to visualize retropalatal, retroglossal, and hypopharyngeal obstructions, correlated with dynamic axial cuts.
- Total MRI study duration was approximately 15 minutes.

Sample Size and Sampling:
- Sample size was calculated using Andrew Fisher's formula.
- Simple random sampling was used.

Statistical Analysis:
- Data were entered into Microsoft Excel and analyzed using SPSS.
- Pearson's chi-square test was used to analyze the relationship between AHI severity and the level of collapse on dynamic MRI.
- Descriptive statistics were used to summarize demographic and clinical data.
- The $\chi 2$ test or Fisher exact test and independent 2-tailed t-tests were used to compare the clinico-pathological parameters and surgical outcomes, wherever appropriate.
- Continuous variables were stratified and analyzed as categorical data.
- Statistical significance was set at $p < 0.05$.

Results:

Patient Demographics:
- Of the 66 patients, 17% were female, and 83% were male (Figure 1).
- The most common age group was 41-60 years (53%) (Figure 2).
- Class I obesity was the most frequent presentation (n=42) (Figure 3).

Clinical Symptoms and Comorbidities:
- Primary symptoms:
  - Snoring: 98% (n=65)
  - Apneic spells: 70% (n=46) (Table 1)
- Comorbidities:
  - Systemic hypertension: 42% (n=28)
  - Dyslipidemia: 33% (n=22)
  - Type II diabetes mellitus: 24% (n=16)
  - Coronary artery disease: 6% (n=4)
  - Bronchial asthma: 5% (n=3)
  - Hypothyroidism: 3% (n=2)

Anatomical Obstructions:
- Significant symptomatic deviated nasal septum: 89% (n=59)
- Reduced oropharyngeal isthmus: 76% (n=50)
- Tonsillar hypertrophy: 55% (n=36)
- Hypertrophied turbinates: 53% (n=35)
- Adenoid hypertrophy: 9% (n=6)

Dynamic MRI Findings:
- Retropalatal collapse: 62 patients
- No noticeable collapse: 4 patients (with AHI suggestive of OSA) (Tables 4-7)

Polysomnography (PSG) Results:
- Mild OSA: 17% (n=11)
- Moderate OSA: 29% (n=19)
- Severe OSA: 54% (n=36) (Table 3)

Correlation of MRI and PSG:
- Two patients with mild OSA (by AHI) had no collapse but had a deviated nasal septum.
- Four patients with mild OSA had mild retropalatal collapse and were advised lifestyle modifications.
- Four patients with mild OSA had retropalatal and lateral wall collapse. One patient with mild OSA had collapse at all levels.
- Two patients with moderate and severe OSA had no collapse on dynamic MRI.
- Seven patients with Class II obesity were advised weight reduction and CPAP before surgery.
- Surgery was advised for 48 patients, and 30 patients underwent surgery.

Discussion:
Obstructive sleep apnea (OSA) results from a combination of static anatomical obstructions and dynamic soft tissue collapse during sleep. Dynamic MRI sleep studies offer valuable insights into these dynamic factors, complementing polysomnography (PSG).
Our study confirmed the male predominance in OSA, consistent with epidemiological findings. Obesity was also a significant risk factor, with most patients falling within the BMI 30-34.9 range. This supports the established link between obesity and OSA pathophysiology.
Systemic hypertension was the most common comorbidity, followed by dyslipidemia and diabetes, aligning with previous research on the cardiovascular consequences of OSA. Snoring was the

predominant symptom, followed by apneic spells, highlighting their importance in clinical presentation.
PSG confirmed the diagnosis of OSA in all patients, with 54% presenting with severe OSA. Dynamic MRI revealed retropalatal collapse as the most common finding, followed by lateral pharyngeal wall collapse. These findings are consistent with previous studies, though variations exist in the frequency of multilevel collapse.
Dynamic MRI guided surgical planning, with 48 patients recommended for surgery. 30 patients underwent surgery with symptomatic improvement. The surgical procedures were tailored to the specific anatomical obstructions identified on MRI.
A significant finding was the association between lateral pharyngeal wall collapse and AHI severity, suggesting its critical role in OSA pathophysiology. This highlights the importance of assessing lateral wall collapse in addition to retropalatal and retroglossal obstructions.

Limitations: This study has limitations, including its retrospective design and the exclusion of patients with BMI > 40 kg/m² due to MRI gantry limitations. Dynamic MRI cannot differentiate between upper airway resistance syndrome (UARS) and OSA, necessitating PSG for diagnosis.

Clinical Implications: Dynamic MRI sleep studies are a valuable adjunct to PSG in the evaluation and management of OSA. They provide detailed anatomical information for surgical planning and can identify specific patterns of airway collapse. The association between lateral pharyngeal wall collapse and AHI severity emphasizes the importance of comprehensive airway assessment.

Conclusion: Dynamic MRI sleep studies are a non-invasive tool for assessing OSA, providing valuable information for surgical planning. Retropalatal collapse is the most common finding, and lateral pharyngeal wall collapse significantly influences AHI severity. Dynamic MRI complements PSG and improves patient selection for surgical intervention.

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