Role of dynamic MR imaging in obstructive sleep apnoea

Bhawna · Roy Santosham · Sujai Anand · Santhosh Joseph

Abstract The purpose of this study is to assess the role of dynamic MR imaging in the evaluation of obstructive sleep apnea. In this prospective study, MRI was performed in 22 patients (eighteen male and four female, ranging in age from 26 to 70 years) suspected of having obstructive sleep apnoea (OSA). 18 of them had a polysomnography study prior to MRI evaluation, which confirmed the presence of OSA. Positive cases were classified according to anatomic location and cause of narrowing. Patients with isolated retropalatal narrowing on MRI were advised uvulopalatopharyngoplasty (UPPP). Two patients had normal findings on MRI, 8 patients had retropalatal narrowing, five had retroglossal narrowing and seven had narrowing at multiple levels. All twenty-patients had collapse of lateral pharyngeal wall. Four patient with isolated retropalatal narrowing, who underwent UPPP after MRI evaluation were found to be cured on 6 month postoperative follow up.

Dynamic MR imaging can accurately diagnose the cause and level of upper airway narrowing in patients with OSA. It can characterize and anatomically classify the level of narrowing for planning reparative surgery.

Keywords MR imaging · Obstructive sleep apnoea · Uvulopalatopharyngoplasty

Bhawna · R. Santosham · S. Anand ·
S. Joseph
Department of Radiology and Imaging Sciences and Department of
Otolaryngology
Sri Ramachandra Medical College and Research Institute,
Chennai – 600 116, India

Bhawna (✉)
Associate Professor, Department of Radiology and Imaging Sciences
FF 1 Casa – XS
Manapakkam
Chennai – 600 116, India
e-mail: bhawnadev@gmail.com
Tel: +91 / 44 / 24766917 Ext 339 +91 / 98400 18243 (M)

Introduction

Obstructive sleep apnea is a very common but unspeakable disorder, especially amongst Radiologists with serious complications such as early morning drowsiness, headache, cardiovascular disorders such as myocardial infarction, hypertension, deterioration in memory and behavioral changes. There is 2 to 4% community prevalence. Before the advent of the MRI radiological assessment of the airway was restricted to fluoroscopy, cephalometry and acoustic reflection complemented by nasopharyngoscopy and CT. However each of these investigations were dominated by pitfalls inherent to the technique used. MRI is rapid and non-invasive, compared with polysomnography; it is similar in accuracy in diagnostic evaluation of upper airway pathology and superior in delineating upper airway anatomy in OSA. No other test can predict the outcome of UPPP in present day scenario.

The purpose of our study is to assess the role of dynamic MRI in evaluating patients suffering from OSA, to identify the cause and level of obstruction, to determine patients who would benefit from uvulopalatopharyngoplasty and to determine the rate of success of UPPP following MRI of the upper airway as compared to UPPP performed without prior MRI correlation.

Materials and methods

22 patients with clinical findings suggestive of OSA underwent dynamic MR imaging. Clinical symptomatology in these 22 patients included early morning drowsiness (n = 13), headache (n = 16), snoring (n = 12) and deterioration in memory and behavioral changes (n = 6). Eighteen patients had a polysomnography study prior to MRI evaluation which confirmed the presence of OSA.

Eighteen patients were male and four patients were females, their ages ranged from 26 to 70 years. Patients were specially instructed not to move and swallow during the course of the study.

Technique

The study was performed on a 1.5 Tesla Scanner (Siemens Magnetom), capable of a very high speed studies as well as dynamic imaging. A head and neck coil was used on all patients. All patients were imaged in the supine position with the patient awake or sleep. No conscious attempt was made to put the patient to sleep. No contrast injection was used. TIW and 2D Turbo Flash sequences were performed in axial and sagittal planes and run in dynamic mode. A midsagittal section was taken as a localizer to obtain appropriate axial sections. Single level dynamic sequential acquisitions were done at the retroglossal (Fig. 1) and retropalatal (Fig. 2) levels in the axial and sagittal planes. The images were obtained at the rate one acquisition per second for duration of one minute at each level. The images thus acquired were run in an interloop mode. The duration of each study was approximately four minutes.

Image recoding and display

Image recording was performed on a VCR from the video signal from the MRI scanner. Alternatively recording of still images and dynamic loop motion images in DICOM format was performed on a CD ROM by directly transferring the signal from the MRI scanner to the personal computer equipped with a CD recording device. Selected still images were recorded on a "14 × 17" infrared Laser film using a 3M Laser camera. Images were displayed using a VCP when the recording was made on a video cassette. A personal computer was used to play back the CDs when the recording was made on them. Still images on the Laser film could be easily viewed on an X-ray lobby.

Interpretation

All examinations were interpreted clinically at the time of patient presentation by two experienced head and neck imaging Radiologists without knowledge of any other radiologic investigations whose final decisions were reached by consensus. The MR imaging findings were then compared with polysomnography study performed prior to MRI.

Results

In the 22 patients we studied, MRI showed twenty patients to have OSA and the remaining two were just habitual snorers without OSA. It was found that MRI was as sensitive as polysomnography, detecting OSA. It was found that OSA is more common in the age group 36–40 years (Table 1). Sixteen of these affected were males and the rest were females.

When the twenty patients were categorized by the factors associated with OSA, twelve patients had hypertension, 15 patients had obesity and 19 had a large collar size (Table 2). Hence the factor most commonly associated with OSA was a large collar size (greater than 17 inches in males and 15 inches in females). The most common location of airway narrowing was retropalatal (Table 3). Of the twenty patients with abnormal findings, all had collapse of lateral pharyngeal walls (100%), 16 had thickened fat pads (80%), four had soft palate abnormalities (20%) and two had retrognathia (10%). This finding of ours confirms that collapse of lateral pharyngeal walls is the most common course of obstructive sleep apnea. None of our patients had macroglossia and maxillary retrusion through they may cause OSA (Table 4).

Of the twenty patients diagnosed to have OSA, eight patients with retropalatal level of narrowing were found

Fig. 1 Normal airway at the retroglossal level.

Fig. 2 Normal airway at the retropalatal level

Table 1 Age distribution of patients who were diagnosed to be suffering from OSA on MRI

Total no. of patients = 20		
S.No	Age group	No. of patients
1.	26–30	1
2.	31–35	4
3.	36–40	6
4.	41–45	3
5.	46–50	2
6.	51–55	1
7.	56–60	2
8.	61–65	0
9.	66–70	1

Table 2 Factors Associated with OSA

S.No	Associated condition	No. Of patients	Male	Female	Total %
1.	Hypertension	12	10	2	60
2.	Obesity	15	11	4	75
3.	Increased collar size	19	15	4	95

Table 3 Level of narrowing

Total no. of patients = 20			
S.No	Level of narrowing	No. of patients	%
1.	Retropalatal	8	40
2.	Retroglossal	5	25
3.	Multiple level	7	35

to benefit from uvulopalatopharyngoplasty. But only four patients underwent the surgery. All patients (n = 4), who underwent UPPP after MRI evaluation of the upper airway

were found to be cured on a 6 month follow up period (Tables 5, 6).

Discussion

Sleep apnea is a condition characterized by episodic cessation of breathing during sleep. Total collapse and occlusion of the upper airway continued with respiratory effort is a form of sleep-disordered breathing, referred to as obstructive sleep apnea. The primary pathology in OSA is collapse of the pharyngeal airway.

Of the 22 patients referred to our study 18 patients underwent a prior polysomnography study, which showed the presence of OSA in all these patients. The remaining

4 patients had a direct MRI performed based on clinical diagnosis. Amongst these four patients only two had OSA while the other two were found to be just snorers without any features of OSA. This emphasizes on a need to confirm the presence of OSA by polysomnography studies before performing the MRI study. Though the presence of OSA in most cases was detected by polysomnography studies, an MRI evaluation of the upper airway was still performed to demonstrate the cause and level of obstruction, since this would be helpful in determining the approach to surgical management of OSA which in turn may go a long way in

Fig. 3 The retroglottal level in a patient with obstructive sleep apnoea

Fig. 4 The retropalatal level in a patient with obstructive sleep apnoea

Table 4 Causes of OSA

Total no. of patients = 20			
S.No	Cause	No. of patients	%
1.	Collapse of lateral pharyngeal walls	20	100
2.	Thickened fat pads	16	80
3.	Macroglossia	0	0
4.	Retrognathia	2	10
5.	Softpalate anomalies	4	20
6.	Maxillary retrusion	0	0

Table 5 Sensitivity of MRI in detecting OSA in comparison with polysomnography

Total number of patients = 18		
No. of cases diagnosed as OSA on polysomnography	No. of cases diagnosed as OSA on MRI	Sensitivity of MRI (%)
18	18	100

Table 6 Success of surgical management in patients who underwent UPPP, on 3 months follow up

Total number of patients = 4		
No. of surgeries performed	No. of patients cured	Success rate
4	4	100%

presenting the occurrence of cardiac and CNS- problems especially in the middle aged population.

Our study showed that OSA was most common in the age group 36–40 years correlating the findings of the epidemiological studies by Young TB et al [1]. OSA was more common in male patients (90%) than female patients (10%) failing in line with the gender study of OSA by Redline and Co-workers [2].

Multiple epidemiologic studies like those of Coy et al [3], Young TB et al [1] & Stooch et al [4] have associated OSA with systemic hypertension, obesity and an increased collar size. In our study increased collar size was seen in 95% of the patients while about 60% of patients had hypertension. 75% of the patients with OSA were obese. All the women diagnosed to have OSA in our study were obese.

MRI evaluation is helpful in determining the level of obstruction i.e. whether the collapse of airway is retropalatal or retroglossal or at multiple levels. A retropalatal level of narrowing can be rectified by UPPP while retroglossal narrowing due to retrognathism may require mandibular advancement. Macroglossia may require genioplasty. Multiple levels of obstruction may require more than one surgery. In our clinical setting the surgery routinely performed is UPPP and this is successful only when there is isolated

retropalatal narrowing. However it should be remembered that surgery is an option to be considered only after conventional positive airway pressure etc have failed or when there is no patient compliance.

Our study demonstrated an isolated retropalatal narrowing (Fig. 4) in 40% of patients while 25% of our patients had a retroglossal (Fig. 3) narrowing and 35% had multiple level involvement 40% of patients (n = 8) with an isolated retroplatal collapse were advised UPPP whereas the remaining 60% (n = 12) who had either a retroglossal or multiple level involvement were not considered suitable candidates for isolated UPPP surgery. But only 4 of our patients were willing to undergo surgery and a UPPP was performed, 6 month follow up showed 100% success in these patients who underwent UPPP after correlation with dynamic MRI of the upper airway. This was in comparison to the previous success rate of 67% (6 out of 9 cases) achieved by our ENT surgeons when they performed the surgery without any prior MRI evaluation. According to a study conducted by Schwab & Goldberg [5] they were very successful in identifying patients fit for UPPP based on prior MR studies.

The main pathology associated with OSA is collapse of the lateral pharyngeal walls, which was seen in all our patients. Thickened fat pads were contributory. It was possible to demonstrate the former on dynamic MR imaging and the latter on static as well as dynamic images.

In conclusion, MRI of the upper airway is very useful in detecting the level and cause of OSA. The main advantage of MRI as compared to other imaging modalities is the ability to perform multiplanar dynamic imaging in the absence of radiation exposure. Although our study results are promising an important limitation of our study is the small sample size which limited statistical power. It is imperative to follow a larger number of cases before asserting that a 100% success that can be achieved in patients selected for UPPP based on MRI evaluation of the airway, however even though the sample size is small, the definition of test expectation will greatly effect future evaluation and implementation. Evidence based outcome analyses can then provide a framework for implementing efficient study designs and help cost-benefit considerations.

References

1. Young TB et al (1993) The occurrence of sleep disordered breathing in middle-aged adults. *New Eng J Med* 328:1230
2. Redline S, Kump K, and Browner I et al (1991) Gender differences in sleep disordered in community based sample. *Am J Resp Crit Care Med* 149:722
3. Coy TV, Dimesdale et al (1996) The role of sleep disordered breathing in essential hypertension. *Chest* 109:890
4. Stoohs R, Kim YD, Mineault CG et al (1994) Upper airway sleep disordered breathing in women. *Ann Intern Med* 122:382
5. Schwab RJ, Goldberg AN (1998) Upper airway assessment Radiographic and other imaging techniques. *Otolaryngol Clin North America* 31:931