Original Article

Role of Magnetic Resonance Imaging Cephalometry in Obstructive Sleep Apnoea

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Abstract

Background. Obstructive sleep apnoea (OSA) is one of the most common public health problems in adults. Patients with OSA are prone for excessive adipose tissue deposition in the neck, which in turn, increases the upper airway narrowing. Of the imaging modalities available for assessing the upper airway, magnetic resonance imaging (MRI) is found to be useful technique for defining soft tissue abnormalities.

Methods. We prospectively studied 50 patients presenting with OSA and 50 normal controls to evaluate the role of MRI cephalometry in the diagnosis of OSA and compared the cross-sectional area and antero-posterior diameter of the upper airway in the retro-palatal airway and retro-glossal areas by MRI cephalometry.

Results. In comparison with controls, cases had a significantly lower cross-sectional area and antero-posterior diameter of the upper airway in the retro-palatal airway and retro-glossal areas.

Conclusions. Our observations suggest that MRI cephalometry is a sensitive technique for the diagnosis of OSA.
[Indian J Chest Dis Allied Sci 2014;56:157-159]

Key words: Obstructive sleep apnoea, Magnetic resonance imaging cephalometry.

Introduction

Obstructive sleep apnoea (OSA) is a disorder characterised by prolonged partial upper airway obstruction and/or intermittent complete obstruction that disrupts normal sleep pattern and ventilation.[1] The pathogenesis of OSA includes, sleep-related collapse of upper airway at the level of pharynx because of intra-luminal negative pressure generated by diaphragm and extra-luminal tissues around airways. The morphological abnormalities contributing to the pathology includes lateral pharyngeal wall thickening, macroglossia, enlarged uvula, soft palate, tonsil and intra-nasal obstruction, others being caudal displacement of hyoid congenital craniofacial dysplasia and hypoplaisa of maxilla and mandible.

Polysomnography is "gold standard" for the diagnosis of OSA. As it is not widely available, imaging of the upper airway has been considered as an alternative investigation for the diagnosis of OSA. As magnetic resonance imaging (MRI) provides excellent soft tissue resolution and three dimensional reconstruction, we evaluated the utility of MRI cephalometry as diagnostic modality for OSA.

Material and Methods

The study was conducted in the Department of Radiodiagnosis, Gandhi Medical College and Hospital, Secunderabad between June 2011 to May 2012. We prospectively studied 50 patients who presented to the Respiratory Medicine out-patient department with clinical features of OSA, who were over 25 years of age, had a body masss index (BMI, kg/m^2) greater than 25, who had undergone polysomnography (PSG) and had an apnoea-hypopnoea index (AHI) more than 15 (Cases). We also studied 50 age-matched normal control subjects. The study was approved by the Institutional Ethical Committee. Written informed consent was obtained from all participants and the electronic data were secured safely.

All the cases and controls were subjected to MRI examination of pharynx using 1.5 Tesla Magnetom® Avanto MRI scanner (Siemens Limited; Germany) using standard protocol for neck imaging that included T1 sagittal, T1 axial and fatsat sagittal. The cross-sectional area and antero-posterior diameter of the upper airway was measured at retro-palatal and retro-glossal levels.

Statistical Analysis

Data were recorded in a structured format and entered in Microsoft Excel sheet. Statistical analysis was carried out applying Student's t-test by using Epi-info 7 statistical software.

Results

We observed significantly lower cross-sectional area and antero-posterior diameters of the upper airways at

[Received: August 7, 2012; accepted after revision: March 6, 2014]

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retro-palatal (Figures 1 and 2) and retro-glossal levels (Figures 3 and 4) in patients with OSA.

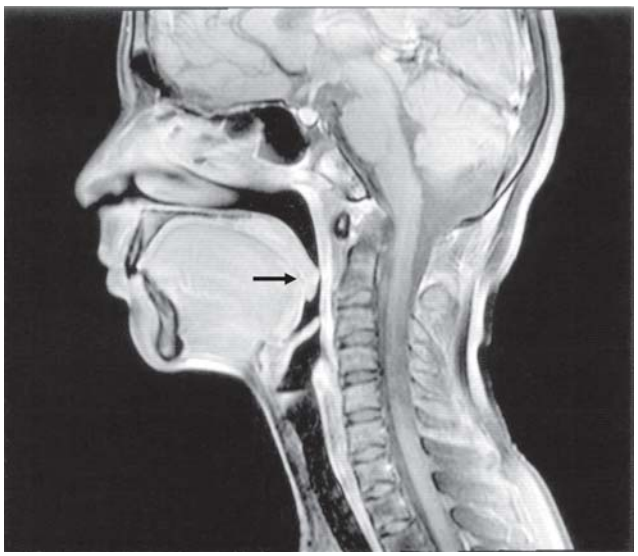

Figure 1. Sagittal T1-weighted MRI showing reduced antero-posterior diameter at retro-palatal level.

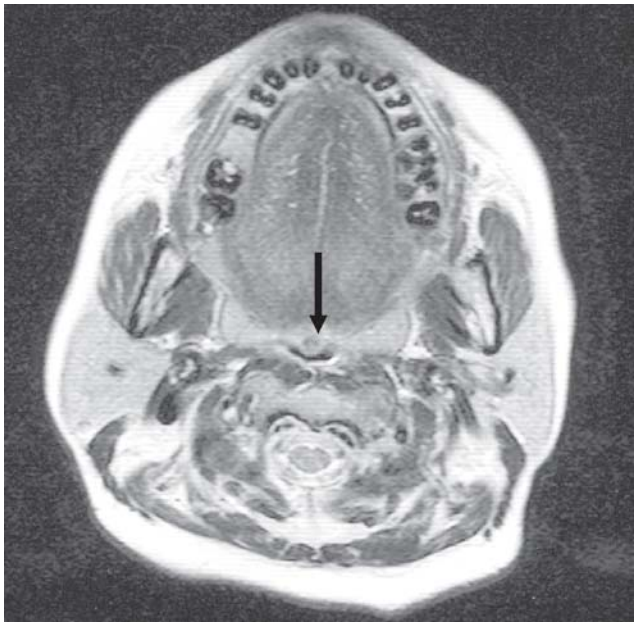

Figure 2. Axial T1-weighted MRI showing reduced cross-sectional area at retro-palatal level.

Comparison of MRI cephalometry measurements between cases and controls is shown in the table. In comparison with controls, cases had a significantly lower cross-sectional area and antero-posterior diameter of the upper airway in the retro-palatal airway and retro-glossal areas.

Discussion

In patients with OSA, the upper airways were found to be narrowed at retro-palatal and retro-glossal levels in these patients on previous studies on cephalograms

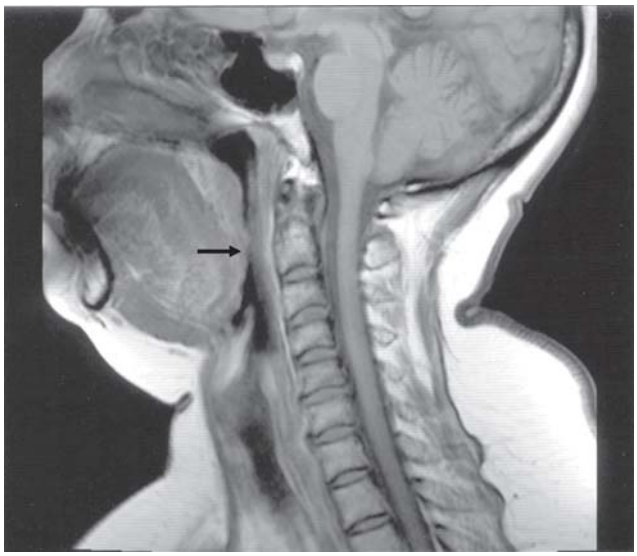

Figure 3. Sagittal T1-weighted MRI showing reduced antero-posterior diameter at retro-glossal level.

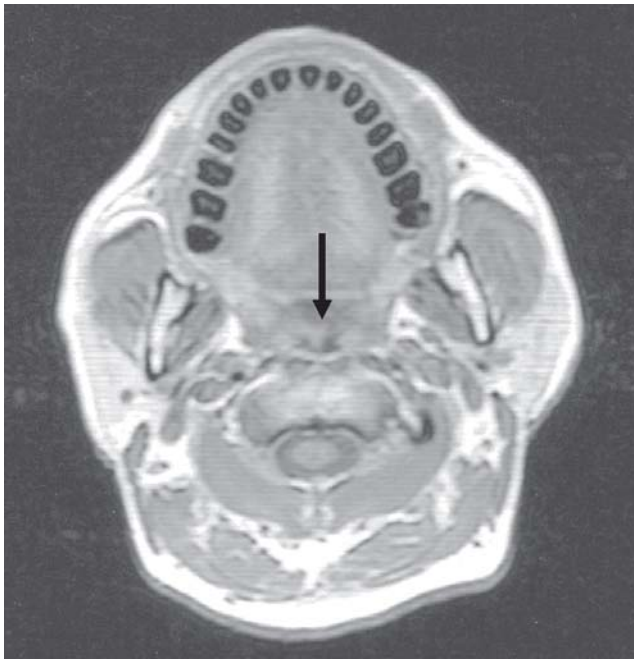

Figure 4. Sagittal T1-weighted MRI showing reduced cross-sectional area at retro-glossal level.

and computed tomography (CT). In the present study, a detailed analysis of the antero-posterior and cross-sectional areas were evaluated at these sites by MRI. The study shows reduction in the antero-posterior diameter and cross-sectional area measurements in cases in comparison with controls, which is statistically significant. Retro-palatal area measurement is a superior indicator of narrowing than retro-glossal area measurement.

Galvin *et al*[1] has found significant reduction in the cross-sectional area in obstructive sleep apnoea syndrome (OSAS) group on ultra-fast CT. Ikeda *et al*[2]

Table. Comparison of cross-sectional area and antero-posterior diameter of the upper airway in the retro-palatal airway and retro-glossal areas by MRI cephalometry between cases and controls

Variable	Cases (n=50)	Controls (n=50)	p-value
Retro-palatal airway			
AP diameter (cm)	0.44±0.17	1.13±1.21	0.048
Cross-sectional area (cm)	0.38±0.21	0.92±0.35	0.02
Retro-glossal airway			
AP diameter (cm)	0.75±0.37	1.1±0.22	0.005
Cross-sectional area (cm)	0.68±0.36	1.2±0.44	0.015

Data are presented as mean ± standard deviation
MRI=Magnetic resonance imaging; AP=Antero-posterior

measured the cross-sectional area of airways in OSAS by dynamic MRI. They observed that spontaneous sleep caused significant obstruction and narrowing of various sites of the pharyngeal airway in the OSAS patients, but not in the non-OSAS subjects. In other study[3] the authors investigated the relationship between dentofacial characteristics of patients with the obstructive sites in OSAS. Volumetric analysis techniques with MRI was sued in another study[4] to identify the upper airway anatomic risk factors for OSA in 48 patients. They reported that after covariate adjustments the volume of the lateral pharyngeal walls ($p<0.0001$), tongue ($p<0.0001$), and total soft tissue ($p < 0.0001$) was significantly larger in subjects with OSA than in normal subjects.

In one study,[5] the authors compared the ratio between volume of tongue and oral cavity OSA symptomatic and normal adults using MRI. They observed that the tongue volume/oral cavity volume ratio in OSAS patients was significantly higher than in normal control subjects ($p<0.01$). In another case report,[6] the authors evaluated the lateral pharyngeal wall by MRI both in awake and sleep after sedation and reported narrowing of the lumen to the extent of 70% as compared to dimensions in the wakeful state.

Though nasal continuous airway pressure (nCPAP) continues to be the standard therapy for OSA, the disappointing long-term compliance rates of 40% to 60% among continuous positive airway pressure (CPAP) users have to be regarded as a major challenge warranting more aggressive exploration of both surgical and non-surgical alternatives for OSA therapy. The role of surgery in the treatment of OSA has been controversial and effective surgical management depends upon precisely determining obstruction at different levels.[7] Hence, MRI cephalometry has been exploited to assess the various sites of obstruction in OSA so as to guide the surgeon to choose the best surgical and curative option. There are several types of surgeries like nasal reconstruction, uvulopalato-pharyngoplasty (UPPP), advancement genioplasty, mandibular osteotomy, with genioglossus advancement, hyoid myotomy and suspension, maxilomandibular advancement with advancement genioplasty, etc., that can be carried out. Presently, surgical success is defined as achieving a greater than 50% reduction of the AHI and /or AHI of less than 20 events per hour.[8]

Our observations suggest that patients with OSA have narrow retro-palatal and retro-glossal area. We feel that MRI cephalometry may be helful in identifying the subset of OSA patients who will be benefited by curative surgical intervention. There is a need for further research to develop normative data for these parameters in the community.

Acknowledgements

The authors wish to thank Dr KVS Murthy, Professor, Department of Community Medicine, Gandhi Medical College, Secunderabad, for providing help with statistical analysis.

References

1. Galvin JR, Rooholamini SA, Stanford W. Obstructive sleep apnea: diagnosis with ultrafast CT. *Radiology* 1989;171: 775-8.
2. Ikeda K, Ogura M, Oshima T, Suzuki H, Higano S, Takahashi S, *et al*. Quantitative assessment of the pharyngeal airway by dynamic magnetic resonance imaging in obstructive sleep apnea syndrome. *Ann Otol Rhinol Laryngol* 2001;110:183-9.
3. Baik UB, Suzuki M, Ikeda K, Sugawara J, Mitani H. Relationship between cephalometric characteristics and obstructive sites in obstructive sleep apnea syndrome. *Angle Orthod* 2002;72:124-34.
4. Schwab RJ, Pasirstein M, Pierson R, Mackley A, Hachadoorian R, Arens R, *et al*. Identification of upper airway anatomic risk factors for obstructive sleep apnea with volumetric magnetic resonance imaging. *Am J Respir Crit Care Med* 2003;168:522-30.
5. Iida-Kondo C, Yoshino N, Kurabayashi T, Mataki S, Hasagawa M, Kurosaki N. Comparison of tongue volume/ oral cavity volume ratio between obstructive sleep apnea syndrome patients and normal adults using magnetic resonance imaging. *J Med Dent Sci* 2006;53:119-26.
6. Maheshwari PR, Nagar AM, Shah JR, Patkar DP. MRI in sleep apnoea. *J Postgrad Med* 2003;49:177-8.
7. Grote L, Hedner J, Grunstein R, Kraiczi H. Therapy with nCPAP: incomplete elimination of sleep related breathing disorder. *Eur Respir J* 2000;16:921-7.
8. Ephros HD, Madani M, Yalamanchili SC. Surgical treatment of snoring and obstructive sleep apnoea. *Indian J Med Res* 2010;131:267-76.