Original Article

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Radiology Section

Prevalence and Clinical Relevance of Schmorl's Nodes on Magnetic Resonance Imaging in a Tertiary Hospital in Southern India

DEVIMEENAL JAGANNATHAN[1], VENKATRAMAN INDIRAN[2], FOUZAL HITHAYA[3]

ABSTRACT

Introduction: Schmorl's Nodes (SN), which appear as defects in superior and inferior endplates of vertebrae, are commonly seen around the thoracolumbar junction. They may be asymptomatic or symptomatic. Their prevalence varies with respect to age, gender, regions involved and other associated disc or vertebral findings.

Aim: SN is quite a common finding on the Magnetic Resonance Imaging (MRI) of the spine. The purpose of the study was to evaluate the prevalence of SN in the patients who underwent MRI whole spine in the radiology department, ascertain its clinical relevance and to compare the prevalence of SN in the study population with the prevalence in rest of the Indian and global population described already in the literature.

Materials and Methods: Clinical history and MRI images of the patients who underwent whole spine MRI study in the Radiology Department during the period of 6 months from June to December 2015 were retrospectively reviewed. The prevalence of SN, their location and associated imaging findings were studied.

Results: Of the 509 patients in the study, 47 had SN at one or more levels with prevalence of 9.2%. Maximum cases were seen in the 4th decade with least cases in the extremes of age. Twenty five patients had SN at thoracic levels. Twenty five patients had SN at lumbar levels. Twenty eight patients had SN at one intervertebral disc level. Other 19 patients had SN at multiple levels. Of the total 103 SN found, 57 were seen in the superior endplates and 46 in the inferior endplates. All SNs were in central position, except for one. Twelve of the 47 patients had disc degeneration at the same level as SN. Forty two of the 47 patients (89%) with Schmorl's nodes had associated spinal disc degenerative disease at the same or different levels. Modic type II endplate changes were demonstrated at the same level in 10 of the 47 patients with SN. Thirty eight of the 47 patients presented with history of backache. Only 9 of these patients had come with history of trauma; of these only four had wedge compression fracture at the level of SN.

Conclusion: Schmorl's nodes in the studied South Indian population appear to show one of the lowest prevalence described on MRI, so far. Maximum number of SN occurred in the lower thoracic spine followed by the proximal lumbar spine. Schmorl's nodes are commonly associated with degenerative disc disease of the spine, though not at the same level.

Keywords: Backache, Herniation, India, Intervertebral disc, MRI

INTRODUCTION

Schmorl's Nodes (SN), first described in 1927, denote herniation of part of intervertebral disc (nucleus pulposus) through the vertebral endplate into adjacent vertebral body [1]. They appear as defects in superior and inferior endplates of vertebrae. Classically, their maximum prevalence is described around the thoracolumbar junction, probably related to the higher axial load on these vertebrae. SN may be asymptomatic or present with pain. The diagnosis of SN as cause of pain is made by ruling out other causes. They may occur in normal vertebrae or in vertebrae with weakened endplate or subchondral bone. SN is visualized on the following imaging modalities- plain radiographs, computed tomography, and magnetic resonance imaging. Prevalence of SN in spine ranges widely from 5-76% in different studies [1-4]. SN were observed in 19% of 400 Japanese patients studied by Haminishi et al., [2]. Wang et al., in their study involving Chinese patients found the prevalence to be around 28% [5]. The prevalence of SNs in the North Indian population was about 18% [6]. This study retrospectively analysed the prevalence, age and gender distribution, locations, associated findings like disc degeneration and vertebral changes on the spinal MRI in the south Indian population. This study was done, as there have been no specific studies in the south Indian population and to see if there is any difference in South Indian population due to anthropological difference from the rest. This study also sought to determine how closely SN was associated with disc degeneration and modic degenerative endplate changes.

MATERIALS AND METHODS

The MRI images and clinical history of patients who presented to the Radiology Department during the period of 6 months from June to December 2015 were retrospectively reviewed and analysed. The prevalence, age and gender distribution, locations, associated findings like disc degeneration and vertebral changes on the spinal MRI in this south Indian population were studied. All South Indian patients who presented to the Department of Radiodiagnosis in our institution and underwent whole spine MRI were included in the study, irrespective of the complaints. Only those patients with orthopedic hardware implants in the spine and those who did not undergo imaging of whole spine were excluded from the study. The study was carried out on 1.5 Tesla MRI scanner (Signa 1.5 HDXT,GE corporation, US). Whole spine T2 sagittal image was acquired for all the patients with additional sagittal T1, STIR and axial T2 weighted images for the region of clinical interest. The ethics committee of our institute approved this study and an informed consent for the MRI scan was taken from all patients included in it. No financial burden was placed on the patients. The data was analysed using Excel software.

RESULTS

Total of 509 patients were included in the study. Eighteen patients were excluded as they had either previous spinal surgery or fusion segmentation anomalies. Age of the patients ranged from 14 to 86 years with mean of 50 years and male: female ratio of about 1:1.

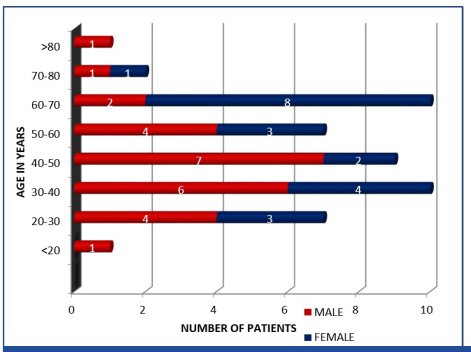
Of these patients, 47 had SN at one or more levels. Age of these patients ranged from 18 to 86 years with mean of 52 years and male: female ratio of 1.1: 1. Maximum cases were seen in the 4th and 7th decades with least cases in the extremes of age (1st, 2nd, 8th and 9th decades) [Table/Fig-1].

38 of the 47 patients presented with history of backache. Only 9 of these patients had come with history of trauma; of these only four had wedge compression fracture at the level of SN [Table/Fig-2].

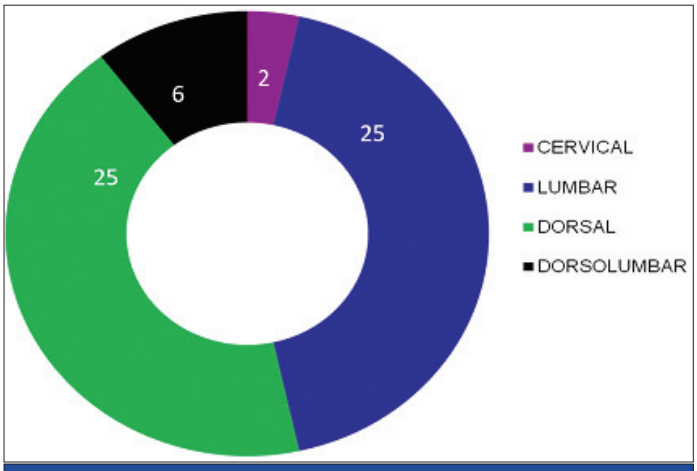
Only two patients had SN at cervical level, that too at C6-C7 level. Twenty five patients had SN at thoracic levels, with only one in the upper half of thoracic spine at D4-D5 level. Twenty five patients had SN at lumbar levels. Six patients had SN in thoracic as well as lumbar spine [Table/Fig-3]. Twenty eight patients had SN at one intervertebral disc level. Other19 patients had SN at multiple levels.

Totally 103 SN were evaluated. Two SN were seen at cervical levels with both at superior endplate. Sixty one SN were seen at the thoracic levels with 34 in the superior endplates and 27 in the inferior endplates [Table/Fig-4]. Forty SN were seen at the lumbar levels with 21 in the superior endplates and 19 in the inferior endplates. Of the 103 SN, 57 were seen in the superior endplates and 46 in the inferior endplates (55:45). Of the 103 SN, only one patient had an anterior SN at D12, L1, L2 and L5 endplates [Table/Fig-5]. Rest of the SNs was in central position.

Twelve of the 47 patients had disc degeneration at the same level as SN. Thirty patients had disc degeneration at levels, different from that of SN. Forty two of the 47 patients (89%) with Schmorl's nodes had associated spinal disc degenerative disease at the same or different levels [Table/Fig-6]. Modic type II endplate changes were demonstrated at the same level in 10 of the 47 patients with SN [Table/Fig-7]. None of the SN in this study was associated with Modic type I endplate change.



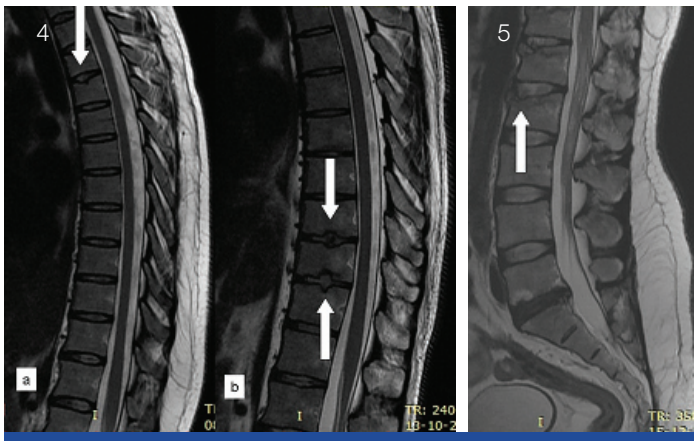
[Table/Fig-1]: Age and gender distribution of cases. **[Table/Fig-2]:** MRI sagittal T2 sequence shows Schmorl's node in the superior end plate of D12 and L1 vertebra(Arrow) and associated wedge compression of D12 , L2 & L3 vertebra.



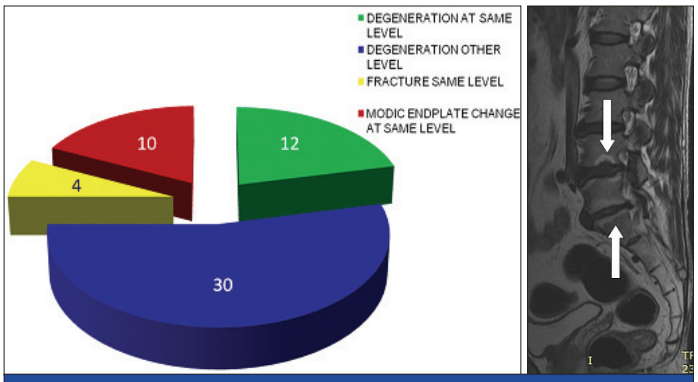
[Table/Fig-3]: Distribution of Schmorl's node in spinal levels.

DISCUSSION

Though SN is a common finding on spinal MRI, their prevalence is highly variable depending on the ethnic population. Prevalence



[Table/Fig-4]: (a) MRI sagittal T2 sequence shows central SN in superior end plate of D4 (Arrow). (b) Central SN in Adjacent end plates of D9-D10 &D10-D11 (Arrow). No associated disc degeneration. **[Table/Fig-5]:** MRI sagittal T2 sequence shows anterior SN at superior end plate of D12, L1, L2 (Arrow) and L5 vertebra. Associated superior end plate fracture seen in L1& L2. Degenerative disc at L5-S1. Modic type 2endplate changes at inferior endplate of L5adjacent to SN.



[Table/Fig-6]: Pie chart showing associated findings of disc degeneration, Modic changes and Fractures. **[Table/Fig-7]:** MRI sagittal T2 sequence shows Modic type 2endplate changes adjacent to SN at inferior endplate of L4 (Arrow) and adjacent to degenerated disc not having SN at L5-S1(Arrow). Disc degeneration also seen at L4-L5 level.

of SN in spine ranges widely from 5- 76% [Table/Fig-8] in different studies [5-11].

This variation may be due to the differences in definition of SN, imaging methods used, ethnicity of the population and the occupation of the population included in the study. Schmorl's nodes may be demonstrated on plain radiography, Computed Tomography (CT), scintigraphy, MRI and PET-CT. MRI is the best modality for identifying the SN as well as the associated spinal findings [12].

Only 47 of the 509 patients included in the study had SN at one or more levels accounting for a prevalence of only 9.2%. This happens to the one of the lowest prevalence in the MRI studies for identifying SN prevalence. Stabler et al., identified a SN prevalence of 38%, in their study of 372 patients with gadolinium enhanced MR [7]. They found that vascularized SN were larger and more frequently associated with bone marrow oedema in patients with back pain than in asymptomatic patients. Williams et al., identified a prevalence of 30 % in their study involving healthy female twin volunteers to determine the prevalence and clinical features associated with SN [8]. They found that SN is common in middle-aged females, genetically determined and associated with lumbar degenerative change. Wang et al., in their study of 1,179 individuals undergoing Magnetic Resonance Imaging (MRI) scans, found the prevalence of SN in lumbar spine to be 28.4%. They found that SN was more pronounced in males and most common in L2 and L3 vertebrae [5]. Yin et al., in their study of SN using kinematic MRI found the prevalence of SNs to be 28.4%, with higher

Study& Modality	Journal & Year	Area	Prevalence of SN
Hilton et al., [1] Post mortem pines	Ann Rheum Dis.1976	University of Manchester	76%
Hamanishi et al., [2] MRI	Spine (PhilaPa 1976). 1994	Kinki University School of Medicine, Osaka, Japan.	19%. (33 % of above only seen in Xray)
Stabler et al., [7] MRI	AJR Am J Roentgenol. 1997	Ludwig-Maximilians-University of Munich, Germany.	38 %
Pfirrmann et al., [3] Cadavers	Radiology. 2001 May	Veterans Affairs San Diego Healthcare System CA 92161, USA	58%
Williams et al., [8] MRI	Arthritis Care & Research 2007	King's College London, St. Thomas' Campus, London, UK	30%
Mok et al., [9] MRI	Spine (Phila Pa 1976). 2010	University of Hong Kong ,China	16.4%
Sonne-Holm et al., [10] XRAYS	Eur Spine J. 2013	Copenhagen University Hospital of Hvidovre. Denmark.	3.8%
Munsif et al., [6] MRI	International Journal Of Advanced Research. 2014	Era's Lucknow Medical College & Hospital. Lucknow.	18%
Wang et al., [5] MRI	Zhonghua Yi XueZaZhi. 2014	China-Japan Friendship Hospital, Jilin University, Changchun 130033,China.	28.4%
Yin et al., [11] MRI	Spine (Phila Pa 1976). 2015	China-Japan Union Hospital, Jilin University; China.	28.4%
Devimeenal et al., [current study]	JCDR. 2016	Government Kilpauk Medical college, Chennai,India.	9.2%

[Table/Fig-8]: Prevalence of schmorl's nodes in various studies.

occurrence in males. They also found that SNs occurrence was positively associated with lumbar disk degeneration [11]. Sonne-Holm et al., in their study of 4,151 standardized lateral radiographs of adult lumbar spine in Caucasian population, found that overall prevalence was 3.8% [10]. In our study, maximum cases were in the 4th and 7th decade with least cases in the extremes of age (1st, 2nd, 8th and 9th decades). This is in concurrence to the maximum prevalence of 58% in the 7th decade in the study by Pfirrmann et al., and contrast to maximum prevalence of 57% in the 2nd decade in the study by Hamanishi et al., [2,3].

SN in our study was nearly equally distributed between the superior and inferior endplates in thoracic as well as lumbar vertebrae. Of the 103 SN, 57 were seen in the superior endplates and 46 in the inferior endplates. Dar et al., found that SNs were more commonly found on the inferior surface of the vertebra in the thoracic region and on the superior surface of the vertebra in the lumbar region [4]. They also found that SNs were more commonly seen in the middle portion of the vertebral body (63.7%), followed by 33.7% in the posterior part and only 2.6% in the anterior part. However in our study, only one patient had an anterior SN with rest of the SNs in central position.

Various mechanisms for SN formation include axial load during trauma, disc degeneration, embryogenesis, various pathological processes involving the spine and autoimmune involvement [13]. Higher incidence of SNs in elite gymnasts (71%) compared to non-athletes (44 %) in a study by Sward et al., alludes to the possibility that axial loading may have an important role in the development of SNs [14]. Some say that SNs can occur when disc material herniate into a gap in the developing vertebrae occurring as a result of developmental insult [15]. Pathological processes like osteomalacia, osteoporosis, hyperparathyroidism, Paget's disease, infections, neoplasm, trauma or mechanical overuse and Scheuermann's disease can weaken the subchondral bone and predispose to SN [16]. It is also postulated that SN may occur due to subchondral ischemic necrosis beneath the cartilaginous endplate with disk herniation into vertebra being a secondary finding [17].

Maximum number of SN (60/103) occurred in the lower thoracic spine (D6-D12) followed by (31/103) proximal lumbar spine (L1 –L3), in our study, as has been described in the previous studies by Pfirrmann et al., Dar et al., and Munsif et al., [3,4,6]. Higher prevalence of SN in lower thoracic spine could be due to the increased axial loading stress apart from the increased rotational movements at that site. Other causes could be smaller size and thinner cortices of thoracic vertebrae compared to the lumbar vertebrae. However, Mok et al., in their large cross-sectional population-based MRI study, found highest prevalence of SN at L2-3 level [9].

In our study, only 12 of the 47 patients with SN had disc degeneration at the same level as SN, implying an association in less than 25% of the patients. Modic type II endplate changes were demonstrated at the same level in 10 of the 47 patients with SN with none of the SN being associated with Modic type I endplate change. This would imply that none of the SN in our study was acute, contrary to some acute SN described so far [18].

LIMITATION

The limitation of our study is the lack of inclusion of normal subjects who did not have spinal complaints. The study included only those who presented for MRI with backache or other complaints. Hence the data would reveal the prevalence of SN in those presenting with one or other complaints, rather than that in the general population.

CONCLUSION

SN in the studied South Indian population appear to show one of the lowest prevalence described on MRI, so far. Maximum number of SN occurred in the lower thoracic spine followed by the proximal lumbar spine. SN are commonly associated with degenerative disc disease of the spine, though not at the same level. Degenerative changes may be seen in adjacent endplates or distant endplates. None of the SN in the study was associated with marrow oedema, implying that none of them is of acute onset and unlikely to cause spinal pain. Further studies would be necessary to identify the reasons for the lower prevalence of SN in the South Indian population.

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PARTICULARS OF CONTRIBUTORS:
1. Professor and Head, Department of Radiodiagnosis, Government Kilpauk Medical College, Chennai, Tamilnadu, India.
2. Professor, Department of Radiodiagnosis, Sree Balaji Medical College and Hospital, Chennai, India.
3. Post Graduate MD Student, Department of Radiodiagnosis, Government Kilpauk Medical College, Chennai, Tamilnadu, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Devimeenal Jagannathan,
Professor and Head, Department of Radiodiagnosis, Government Kilpauk Medical College,
Chennai, Tamil Nadu-600 010, India.
E-mail: kmcacademicradiology@gmail.com

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