Available online at www.journalijmrr.com

INTERNATIONAL JOURNAL OF MODERN RESEARCH AND REVIEWS

ISSN: 2347-8314

Int. J. Modn. Res. Revs.
Volume 4, Issue 10, pp 1292-1296,October, 2016

ORIGINAL ARTICLE

BMI AND LIFE STYLE OF A PERSON DOES INDUCE FORMATION OF SCHMORL'S NODES – AN INSIGHT TO PATHOGENESIS BASED ON FIRST EVER PROSPECTIVE CASE CONTROL STUDY

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Article History: *Received 7th October ,2016, Accepted 24th October ,2016, Published 25th October ,2016*

ABSTRACT

INTRODUCTION: Schmorl's nodes are herniation of nucleus pulposus material into the trabecular bone of the vertebral endplates. Some have suggested that these herniation develop through congenitally weak points in the cartilaginous disc plates left by attrition of blood vessels and small defects from notochord remnants. Schmorl's nodes are known to have bimodal distribution with one peak in younger age or teens before growth has ended and the second peak after fifth decade.[(1)] **AIM:** The aim of this is to determine distribution ofSchmorl's nodes between both sexes and among various built of an individual and to determine if there are factors influencing its presence. **MATERIALS AND METHODS:** 81 symptomatic cases with low backache and no cause identified till the patient arrived to Department of Radiodiagnosis, RMMCH were selected and asked to fill a questionnaire and were subjected MRI LS spine, to look for the presence of Schmorl's nodes. Equal number of age and sex matched asymptomatic controls with ailment other than low backache were selected and were subjected to MRI LS spine to look for the presence of Schmorl's nodes. Data analysis was done using Social Sciences (SPSS) version 21. **RESULTS AND OBSERVATIONS:** Out of the total 81 cases, 68 cases (84%) showed Schmorl's nodes in MRI. 53 (65.4%) subjects were males and 28 (34.6%) were females with male female ratio of 1.8:1. Majority of Schmorl's node were seen in the age group 40 – 49 years (28 Schmorl's nodes – 34.6%). 47.1% of patients had single Schmorl's nodes. Multiple nodes were seen in 36 cases (52.94%) with a maximum of 7 nodes seen in 4 cases. Overweight and obese subjects have 4 times greater chance of developing Schmorl's nodes than subjects with normal BMI. The odds for developing Schmorl's nodes is 3.778 times greater for persons with positive axial loading. **CONCLUSION:** Individuals with high BMI and history of axial loading have 4 times and 3.7 times greater chance for developing a Schmorl's nodes respectively. Awareness about correlation between BMI and history of axial loading to induction of formation of Schmorl's nodes can help clinicians arrive at a early diagnosis of low backache due to Schmorl's nodes and help patients with timely intervention.

Keywords: Schmorl'sNodes, BMI, Axial Loading, Pathogenesis

1.INTRODUCTION

Prevalence of Schmorl's nodes in various studies vary widely from 5 to 76%, probably due to difference in age, sex, ethnicity, genetic(Stabler et al., 1997;Coventry et al., 1945; Williams et al., 2007; Moore,1988) profile as well as due to varied lifestyle of individuals in different geographic locations. They have very high inheritability (more than 70%). A number of genes including aggrecan gene polymorphism(Kawaguchi et al., 1999), a vitamin D receptor(Jones et al., 1998)[(6)], and matrix metalloproteinase 3 gene alleles(Takahashi et al., 2001) meant for synthesis and breakdown of molecules related to the maintenances of the disc anatomic integrity were implicated which had positive implication between Schmorl's nodes and degenerative disc disease. Even then a positive correlation between and Schmorl's nodes and increasing age is lacking. Prevalence of Schmorl's nodes show a bimodal distribution with majority seen in teen age individuals(Chiakihimanishi et al., 1994) and in subjects beyond seventh decade(Chiakihimanishi et al.,

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1994). Schmorl's nodes are seen more in men than in women (Keyes and Compere,1932).

Some researchers proposed a positive association with increasing age(Vernon-Roberts et al., 2007),while others argue that age could not be a significant factor. They are more commonly seen in motor cyclists(Fahey et al.,1998), elite gymnasts(Sward et al., 1991), soccer players(Swain and Evans,2014), athletes(Aggrawal et al., 1979), weight lifters(Aggrawal et al., 1979) and elite skiers(Michael et al., 2001). A Chinese study showed that males, taller and heavier individuals had increased likelihood of SN(Samartzis et al., 2010). An European study done in 2013 with 4,151 subjects stated that Schmorl's nodes are related neither to degenerative changes nor age, sex, body weight, body mass index or occupational exposure to heavy or manual labor(Holm et al., 2013).

Even though Schmorl's Nodes can occur in any vertebra, they are seen more commonly in thoracolumbar regions especially upper end plates of lower thoracic vertebrae and lower end plates of upper lumbar vertebrae(Williams et al., 2007)
Interestingly a Schmorl's node detected in routine spine radiographs done for medical clearance in Indian military academy, Naval aviation branch and Flying duties of Air force were considered as criteria for disqualification until 2015. Common defense services (CDS) physical standards 2016 states that candidates detected with Schmorl's node at more than one level only will be a disqualified when applied for flying branches.

2.MATERIALS AND METHODS:

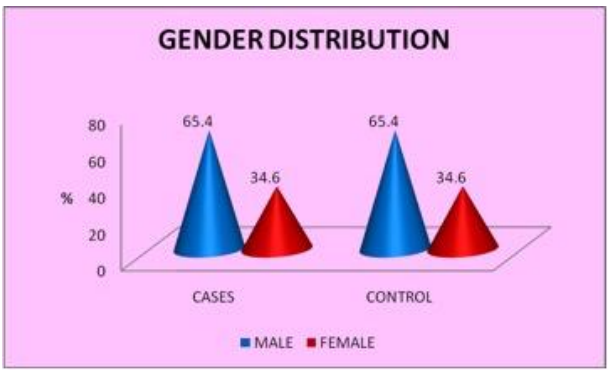
568 patients presented to our radiology department for MRI Lumbosacral spine from November 2014 till April 2016 (18 months) with complaints of low backache. 336 patients had known cause for low backache even before they were subjected to MRI of spine. Out of the remaining 232 patients, 141 were diagnosed with pathologies other than Schmorl's nodes as a direct cause for their low backache in MRI study.The rest 81 were enrolled in our present study, out of which 68 patients had Schmorl's nodes and 13 had normal study of the MRI lumbosacral region. Equal number of age and sex matched controls with no history of low backache were selected. Both the groups were enrolled in the study after informed written consent. They were subjected to questionnaire to collect information regarding socio demographic profile, history of low backache with its characterization, duration of low backache, history suggestive of trauma, numbness or weakness of limbs and axial loading. Details on relevant family history, physical examination including height, weight and body mass index and MRI spine imaging findings were included. Data analysis was done using Statistical package for social sciences (SPSS) -version 21.

3.RESULTS AND OBSERVATIONS:

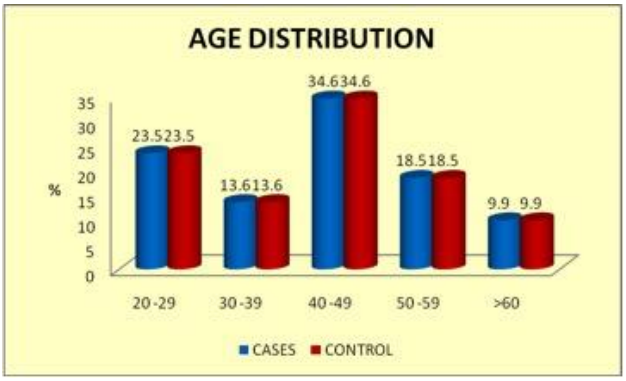
Out of the total 81 cases, 68 cases (84%) showed Schmorl's nodes in MRI and the rest 13 (16%) had normal study of the spine. A total of 156 Schmorl's nodes were observed in the 68 cases. 53 (65.4%) subjects were males and 28 (34.6%) were females with male female ratio of 1.8:1.

Gender distribution

Gender	Cases		Control		Mann-Whitney 'U' Test	
	N	**%**	**N**	**%**	**'Z' value**	**'P' value**
Male	53	65.4	53	65.4	0.000	1.000
Female	28	34.6	28	34.6		
Total	81	100	81	100		

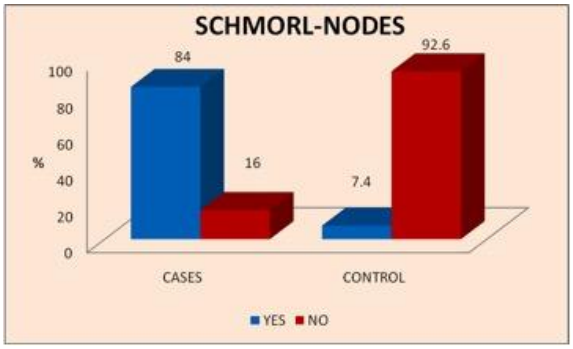


In both groups, male constitute 65.4% and female representing in 34.6%. The Man Whitney 'U' test shows (Z = 0.000, P = 1.000) there is insignificant difference in the gender between two groups. Hence gender of two groups is matching with each other.



Majority of Schmorl's nodes were seen in the age group 40 – 49 years (28 Schmorl's nodes – 34.6%) followed by the age group between 20 – 29 years (23.5%) located more frequently in the superior end plates of upper lumbar vertebrae (40 nodes).

The age ranges of two groups are completely matching with each other. Test of homogeneity is calculated to study the variance of age between groups. The obtained 'P' value is 0.973 which is greater than 0.05 and hence age range of both groups are same.



The schmorl node occurrence is very much high in cases (84%) than in controls (7.4%). The chi-square test of association χ^2 = 1.239, P = 0.266 is insignificant. Therefore, the rate of occurrence of schmorl nodes is different for cases and controls. As the occurrence is very much high in cases, it is inferred that schmorl's nodes occurrence is significantly higher in cases than in controls.

Table: Number of Schmorl's Nodes

Number	Cases		Control	
	N	%	N	%
1	32	47.1	5	83.3
2	12	17.6	1	16.7
3	12	17.6	-	-
4	6	8.8	-	-
5	-	-	-	-
6	2	2.9	-	-
7	4	5.9	-	-
Total	68	100	6	100

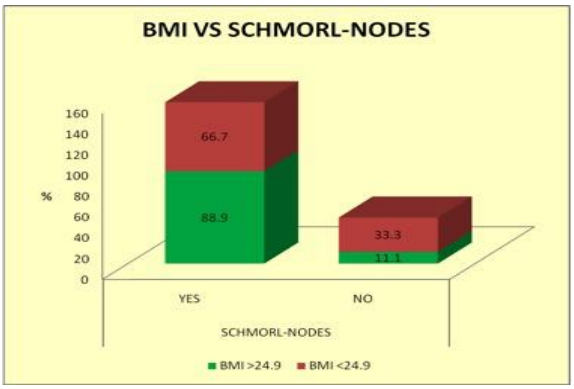
47.1% of patients had single Schmorl's nodes. Multiple nodes were seen in 36 cases (52.94%) with a maximum of 7 nodes seen in 4 cases. Most of the Schmorl's nodes were of 3mm (41.2%) in height in both cases and in controls, with the largest measuring 6 mm in our study.

BMI Vs Schmorl's Nodes

BMI	Schmorl-Nodes Yes		No		Total
	N	%	N	%	
≥ 24.9	56	88.9	7	11.1	63
< 24.9	12	66.7	6	33.3	18
Total	68	84	13	16	81

Chi square test:

	Value	'P' Value	Odds Ratio for BMI
Chi-square Value	5.13	0.023	4.000



The occurrence of Schmorl's nodes were higher in subjects with BMI ≥ 24.9 (overweight and obese) than in normal and underweight subjects. The odds ratio was 4.0 stating that overweight and obese subjects have 4 times greater chance of developing Schmorl's nodes than subjects with normal BMI.

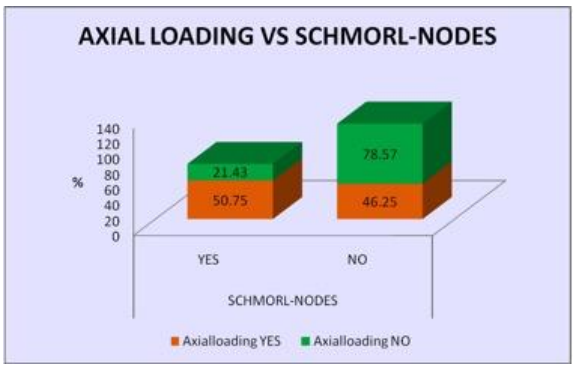
Axial Loading Vs Schmorl's Nodes

Chi-Square Test

Axial Loading	Value	'P' Value	Odds Ratio for Axis Loading
Chi-square Test	8.023	0.005	3.778

Cross Tabulation

Axial Loading	Schmorl's Nodes Yes		No		Total
	N	%	N	%	
Yes	68	50.7	66	49.3	134
No	6	21.4	22	78.6	28
Total	74	45.7	88	54.3	162



Although, most of the subjects in both case group (87.7%) and control group (77.8%) had history of axial loading, the exposure of axial loading was significantly higher in cases than in controls. The chi square test of association was insignificant rejecting the null hypothesis. The odds ratio was 3.778 stating that the odds for developing Schmorl's nodes is 3.778 times greater for persons with positive axial loading.

4.DISCUSSION:

Schmorl's nodes are not seen in Quadrupeds(Exner,1959). Studies have proved that adaptation to upright position results in structural changes in annulus fibrosus and nucleus pulposus(Ushikubo,1959; Yamada,1962). Large discs were observed post adaptation of upright position in bipedal rats(Cassidy et al., 1988)Schmorl's nodes are considered as man's penalty to his erect posture.

The twisting force during the adolescence poses considerable stress on the endplate, especially at its center. These repetitive movements can cause small micro fissures in the central part of the cartilaginous end plate, enabling fluid to travel through and reach the bony surface. These fissures then expand with the extrusion of the nucleus pulposus, which erodes into the vertebral body(Dar et al., 2010).

In a population-based cohort, 16.4% of Southern Chinese subjects had SN at 1 or more lumbar levels. Males, taller and heavier individuals had increased likelihood of SN(Samartzis et al., 2010).

Significance of Thoracolumbar transitional region in various studies:

Schmorl'snodes are more frequently seen in the thoracolumbar transition region(Munsif et al., 2014; Jagannathan et al., 2016; Christian et al., 2005); Resnick and Niwayama,1976).In our study, SNs were predominantly seen in upper lumbar vertebrae followed by lower thoracic vertebrae especially the thoracolumbar transitional region. This agrees with the North Indian study done by Munsif et al,(2014) but not in agreement with Devimeenal et al(2016), Christian et al(2001) and Resnick and Niwayama, (1978) who demonstrated the vice versa. But all are in agreement with the

fact that SNs are most predominant in the thoracolumbar transition zone.
Our study also shows that SNs nodes involves superior end plates more commonly than the inferior end plates which agrees with the south Indian study done by Devimeenal et al.,(2016)but Devimeenal et al study states that superior end plates of upper lumbar vertebrae are more commonly involved than lower thoracic vertebrae, among these two regions in agreement with Christian et al.,(2001)and Resnicket and Niwayama,(1978). But as already mentioned, all these narrow down to one point that SNs are common in lumbosacral transition region.

Further more, Torsional stress within a vertebral segment is greatest where the zygapophyseal joints are oriented close to the sagittal plane. It is possible, then, that the greater incidence of SNs reported in the thoracolumbar transitional region is significantly influenced by the unique mechanical and anatomical characteristics of this region, which demonstrates increased susceptibility to axial and torsional force(Cyron and Hutton,1980).

Dar et al.,(2010)concluded that thoracolumbar spine bears great axial stress and is relatively mobile, it may accumulate micro-traumas that can, over time, lead to the formation of SNs.

In a study by Fahey et al(1998) with 70 thoracolumbar spines from cadavers of individuals killed in motor vehicle collisions, he reported a link between acute trauma and the occurrence of SNs. He found that 10 % of their samples manifested SNs, of which 40 % were from motorcyclists. This was significant finding explaining the axial load theory given the typical axial trajectory of a motorcyclist from his/her vehicle to the ground in an accident. Cyclists often land head first in an inverted position leading to axial loading on the vertebrae. It also known that falls cause axial loading on the spine(Fahey et al., 1998).[11]

Interestingly, Sward et al., (1991) compared vertebral abnormalities in elite gymnasts versus non-athletes. They demonstrated SNs in 71 % (17 out of 24) of gymnasts Vs 44 % (7 out of 17) in non-athletes. This explains that the axial loading theory in the development of SNs, since it is well known fact that Gymnasts experience greater than average axial forces on their vertebrae.

Hilton et al., (1976)explains why lower thoracic vertebrae are more involved than lumbar vertebrae in his study with the following reasons:

1. Thoracic Vertebrae as against Lumbar Vertebrae in various studies: (dar)

2. Lumbar vertebrae are larger and hence resist stress better.

3. Lumbar vertebrae have thicker cortex than Thoracic vertebrae, with endurance against herniation of the intervertebral disc.

4. Mechanical stress in a vertebral body during axial loading is inversely proportional to the cross sectional area of the body, pointing to the fact that lumbar vertebrae are exposed to less stress in an event of axial loading than the thoracic vertebrae.

5. Torsion movement in lumbar vertebrae is lesser than that in thoracic vertebrae.

6. Vertebral fractures more commonly occur at the superior end plates of thoracolumbar region (T12-L1) in contrary to predominant occurrence of SNs in inferior end plates in his study.

He therefore concluded that distribution and location of SNs along the thoracolumbar region does not explain traumatic or disease explanation of the phenomenon. They are probably associated with pressure of nucleus pulposus on the weakest part of the end plate in conjunction with the various strains on vertebrae and IVDs during spinal (torsional) movements.

We are in full agreement with Hilton and propose that developmental pathogenesis is the root cause that weakens the vertebral end plates, on which superimposition of axial loading, trauma or degeneration accelerates the formation of Schmorl's nodes. This way we can explain the discrepancy regarding whether upper lumbar or lower thoracic regions are predominantly involved and hold a holistic view that SNs are predominantly seen in the thoracolumbar region. Also the predominance of involvement of superior end plates of lumbar region followed by involvement of inferior end plates of lower thoracic region in our study explains the proposed theory of Dar et al on accumulation of micro fracture on the superior end plates depending on the type of axial load sustained by the person.

5.CONCLUSION:

Formation of SNs is aggravated by significantly high BMI and lifestyle with heavy axial loading on a already weakened vertebral body. Overweight and obese subjects have 4 times greater chance of developing Schmorl's nodes than subjects with normal BMI. The odds for developing Schmorl's nodes is 3.778 times greater for persons with history suggestive of axial loading. Schmorl's node does cause low backache. Awareness about correlation between BMI and history of axial loading to induction of formation of Schmorl's nodes can help clinicians arrive at a early diagnosis of low backache due to Schmorl's nodes and help patients with timely intervention.

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