Indian Journal of Clinical Anatomy and Physiology 2023;10(2):113–118

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Clinical Anatomy and Physiology

Journal homepage: https://www.ijcap.org/

Original Research Article

Prevalence of cervical spinal stenosis and its association with body mass index among Uttar Pradesh population

Divya Singh[1,*], P K Sharma[1], Sonia Jaiswal[1]

[1] *Dept. of Anatomy, Era's Lucknow Medical College and Hospital, Lucknow, Uttar Pradesh, India*

ARTICLE INFO

Article history:
Received 12-05-2023
Accepted 25-05-2023
Available online 08-07-2023

Keywords:
Spondylolisthesis
BMI
Low back pain
Lumbar length and cervical length

ABSTRACT

Introduction: Spondylolisthesis occurs when one of the bones of the spine termed as vertebra slips forward on the vertebra directly below it thus causing significant pain and nerve injury. Damage to the integrity of the disc accompanied by mechanical compression or chemical damage to the nerve roots is the result of both static compressive loading and increased pressures in particular postures.
Aim: This study was done to study the effect of BMI on lumbar spinal canal diameter, to find the value of spinal canal diameter with respect to age & gender and to correlate spinal stenosis with BMI.
Materials and Methods: This was an observational, case control study conducted over 361 subjects. The studied participants suffering from spinal stenosis that underwent MRI and were aged between 30 years to 60 years visiting the outpatient department (OPD) of Department of Radiology, Era's Lucknow Medical College & Hospital were included in the study.
Result: The age distribution showed that most of the cases belong to the age group 40-44 yr. (22.7%), 30-34 yr. (21.1%) and 35-39 yr. (18.3%). The mean age was 42.46±8.31 years. Our study also observed that at anterior posterior diameter and transverse diameter, no significant difference was observed in various cervical and lumbar spinal canal diameter for various categories of BMI (p>0.05), though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2) and lumbar spinal canal diameter was shorter for higher BMI.
Conclusion: Treatment and prevention of being obese is requisite public health priority. If successful, such results may lead to the minimization of the severity and extent of spondylolisthesis, which in turn may also reduce the risk of low back pain and the subsequent need for management.

1. Introduction

Spondylolisthesis occurs when one of the bones of the spine termed as vertebra slips forward on the vertebra directly below it thus causing significant pain and nerve injury. Any pathological cascade that can cause weakening of the supports responsible for alignment of vertebral bodies can cause spondylolisthesis.[1] Present estimates for pervasiveness are 6 to 7% for isthmic spondylolisthesis up to 18 years, and approx.18% of adult patients undergo MRI of the lumbar spine. It is reported that 75% of all cases account for Grade I spondylolisthesis. It most frequently occurs at the L5-S1 level along with an anterior translation of the L5 vertebral body on the S1 vertebral body. The second most common location is L4-5 level for spondylolisthesis.[2]

Obesity has been depicted as an independent predictor of back pain and its severity,[3] and might play a prominent role in the chronicity and low back pain recurrence.[4] More precisely, it has been found to be associated with lumbar disc degeneration leading to low back pain, sciatica, and spondylolisthesis.[5] Damage to the integrity of the disc accompanied by mechanical compression or chemical

* *Corresponding author*.
E-mail address: 2117.divyasingh@gmail.com (D. Singh).

https://doi.org/10.18231/j.ijcap.2023.024

damage to the nerve roots is the result of both static compressive loading and increased pressures in particular postures.[6] Moreover, the acute response of the spine to loading may epitomize a risk for low back pain in the obese individuals. Rather, a prolonged period of recovery is required for obese individuals to resume intervertebral disc height.[7] Latest researches specify a genetic component to be the role-play in disc degeneration in the obese. Another reason can also be the systemic effects of common inflammatory mechanisms accountable for the development of disc degeneration.[8]

There still remains much controversy regarding the influence of obesity on the overall outcome of surgical treatment of spinal disease.[9] However, several recent researches also conclude that obese patients can attain similar benefits as in non-obese patients as long as the indications for surgical intervention are grounded on sound clinical judgment.[10–13]

Thus, this study was done to study the effect of BMI on lumbar spinal canal diameter, to find the value of spinal canal diameter with respect to age & gender and to correlate spinal stenosis with BMI.

2. Materials and Methods

This was an observational, case control study conducted over 361 subjects. The study was conducted in the Department of Anatomy in collaboration with Department of Radiology, Department of Orthopaedics at Era's Lucknow Medical College and Hospital, Lucknow.

2.1. *Selection of patients and grouping*

The studied participants suffering from spinal stenosis that underwent MRI and were aged between 30 years to 60 years visiting the outpatient department (OPD) of Department of Radiology, Era's Lucknow Medical College & Hospital were included in the study. All the patients were free of artifacts at the site of measurement. A written informed consent was obtained from all the participants. Normal healthy individual were included as controls. All other patients below 30 years of age, traumatic cases, critically ill patients, pregnant women were excluded from the study

2.2. *Clinical and radiographic measurements*

All the essential details which included Age, sex, address, height, body weight, Family and medical history of patients were recorded for each participant. The MR radiographs of TI & T2 images were taken for selected subjects in supine position. The spinal canal diameter was measured on DICOM software as the shortest distance from the midpoint between the vertebral body's superior and inferior endplates to the spinolaminar line. The values were tabulated after grouping for age, gender statistical analysis was performed.

3. Results

The age distribution showed that most of the cases belong to the age group 40-44 yr. (22.7%), 30-34 yr. (21.1%) and 35-39 yr. (18.3%). The mean age was 42.46±8.31 years. Further, out of 361 cases, 169 (46.8%) were males and rest 192 (53.2%) were females. The distribution according to BMI showed that maximum 50.4% belong to the BMI range 18.5-24.9 kg/m^2, followed by the 35.5% belong to the range 25.0-29.9 kg/m^2. Rest 2.5% had BMI <18.5 kg/m^2 and 11.6% had BMI >=30 kg/m^2. The mean BMI of the study cases was 24.91±4.23 kg/m^2.(Table 1)

Table 1: Distribution of Subjects according to Age, Gender & BMI

Variable	Category	No	%
Age group	30 - 34 yr	76	21.1
	35 - 39 yr	66	18.3
	40 - 44 yr	82	22.7
	45 - 49 yr	53	14.7
	50 - 54 yr	37	10.2
	55 - 60 yr	47	13.0
	Mean±SD	42.46±8.31	
Gender	Male	169	46.8
	Female	192	53.2
BMI	< 18.5	9	2.5
	18.5 - 24.9	182	50.4
	25.0 - 29.9	128	35.5
	>= 30	42	11.6
	Mean±SD	24.91±4.23	

At Anterior- posterior diameter, no significant difference was observed in various cervical and lumbar spinal canal diameter for various categories of BMI (p>0.05), though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2) and lumbar spinal canal diameter was shorter for higher BMI. (Table 2)

At Transverse diameter, no significant difference was observed in various cervical and lumbar spinal canal diameter for various categories of BMI (p>0.05) except c6 and c7, though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2). But can't draw any inference for lumbar spinal canal diameter.

However significant difference was found for C6 cervical spinal canal diameter (p=0.042) and c7 cervical spinal canal diameter (p=0.024) among various categories of BMI. The C6_cervical spinal canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI <18.5 kg/m^2. Further the C7_cervical spinal canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI >=30.0 kg/m^2.

At anterior posterior diameter, no significant difference was observed in various cervical and lumbar lengths for various categories of BMI (p>0.05), though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2) and lumbar spinal canal diameter

Table 2: Comparison of cervical spinal canal diameter between BMI Categories

Lumbar spondylolisthesis parameter		Anterior posterior diameter BMI category				Transverse diameter BMI category			
		< 18.5	18.5 - 24.9	25.0 - 29.9	>= 30	< 18.5	18.5 - 24.9	25.0 - 29.9	>= 30
C3_cervical	Mean	1.30	1.44	1.46	1.48	2.01	2.08	2.10	2.05
	SD	.12	.22	.22	.25	.35	.23	.21	.21
significance	F-value		.76				.35		
	p-value		0.516				0.787		
C4_cervical	Mean	1.20	1.32	1.29	1.35	1.76	1.99	1.97	1.90
	SD	.22	.23	.23	.26	.36	.23	.23	.24
C5_cervical	Mean	1.13	1.32	1.26	1.30	1.65	1.96	1.91	1.87
	SD	.15	.23	.21	.27	.28	.21	.27	.28
significance	F-value		1.16				2.63		
	p-value		0.326				0.052		
C6_cervical	Mean	1.14	1.29	1.21	1.19	1.61	1.90	1.80	1.63
	SD	.22	.24	.34	.44	.28	.25	.50	.62
significance	F-value		1.00				2.81		
	p-value		0.396				**0.042**		
C7_cervical	Mean	1.28	1.34	1.28	1.26	1.69	1.90	1.87	1.66
	SD	.17	.21	.26	.35	.25	.24	.36	.52
significance	F-value		.83				3.23		
	p-value		0.481				**0.024**		
L1_lumbar	Mean	1.98	1.89	1.92	1.88	1.83	1.93	1.87	1.86
	SD	.26	.26	.28	.27	.19	.29	.29	.31
significance	F-value		.40				.93		
	p-value		0.751				0.426		
L2_lumbar	Mean	2.00	1.81	1.86	1.81	1.67	1.75	1.75	1.64
	SD	.19	.31	.25	.26	.26	.30	.31	.33
significance	F/t		1.05				.84		
	p-value		0.373				0.474		
L3_lumbar	Mean	1.83	1.71	1.75	1.65	1.53	1.57	1.55	1.51
	SD	.14	.30	.30	.33	.21	.34	.32	.48
significance	F-value		.95				.20		
	p-value		0.416				0.894		
L4_lumbar	Mean	1.68	1.44	1.50	1.40	1.38	1.39	1.41	1.29
	SD	.28	.34	.40	.47	.06	.41	.40	.45
significance	F-value		1.24				.43		
	p-value		0.297				0.729		
L5_lumbar	Mean	1.30	1.31	1.38	1.28	1.20	1.45	1.50	1.52
	SD	.38	.35	.28	.29	.06	.44	.38	.50
significance	F-value		1.07				1.09		
	p-value		0.364				0.355		

was shorter for higher BMI.(Table 3)

At Transverse Site, no significant difference was observed in various cervical and lumbar spinal canal diameter for various categories of BMI (p>0.05) except c6 and c7, though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2). But can't draw any inference for lumbar spinal canal diameter.

However significant difference was found for C6 cervical spinal canal diameter (p=0.042) and c7 cervical spinal canal diameter (p=0.024) among various categories of BMI. The C6_cervical spinal canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI <18.5 kg/m^2. Further the C7_cervical spinal canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI >=30.0 kg/m^2.

The c7 cervical spinal canal diameter showed significant negative correlation with BMI for anterior posterior (r=-0.173, p=0.042) and transverse diameter(r=-0.179, p=0.035). Other cervical spinal canal diameter did not show any significant correlation with BMI.

According to linear regression analysis, the c7 cervical spinal canal diameter of a person can be estimated from BMI and spinal canal diameter using the equation. (Table 4)

C7 = 2.13 – 0.01(BMI) – 0.54(AntPost)

Where the variable ant post will take value 1 for anterior posterior diameter and 0 for transverse diameter. Further the effect of diameter found to be more than the BMI according to the effect size.

4. Discussion

Health practitioners subdivide spondylolisthesis into low grade or high grade, depending upon the degree of slippage. A high-grade slip is defined when > 50% of the fractured vertebral width slips forward onto the vertebra below it. These patients are more likely to experience substantial nerve injury and pain and require surgery to prevent further deterioration and relieve from pain.

Our observations revealed the mean age was 42.46±8.31years where females (53.2%) outnumbered males (46.8%). Our results were in line with ten results of Nadhim ASH et al in this aspect such that 86 females (86%) exceeded 14 males (14%) with mean age of (43.92±13.83).[14] However contrasting results were found by Kalichman L et al. in his study who recorded that males (104) were more in number than females (84).[15] Schuller S also found that there were 41 male and 36 female patients in his study with mean age of 65.5 years. Our study also observed that at anterior posterior diameter and transverse diameter, no significant difference was observed in various cervical and lumbar spinal canal diameter for various categories of BMI (p>0.05), though in majority of the cases cervical spinal canal diameter was longer for higher BMI (>30 kg/m^2) and lumbar spinal canal diameter was shorter for higher BMI. Similarly, in the Rotterdam Study, which is a population-based study of Dutch subjects, a cross-sectional analysis of 2,819 individuals, 55 years old who underwent radiography did not show any association between elevated BMI and disc space narrowing.[16] Conversely, Gübitz R et al observed that increasing BMI was significantly correlated with increasing degeneration and the lower discs showed more degeneration than the upper ones.[17] Our results also revealed a significant difference was found for C6 cervical spinal canal diameter(p=0.042) and c7 cervical spinal canal diameter(p=0.024) among various categories of BMI. The C6_cervical spinal canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI <18.5 kg/m^2. Further the C7_cervical spina canal diameter was maximum for BMI 18.5-24.9 kg/m^2 and minimum for BMI >=30.0 kg/m^2.

In the population-based study also known as Rotterdam Study, conducted on 2,819 Dutch who underwent radiography did not show any association between elevated BMI and spondylolisthesis.[18] A different cross-sectional study of participants (n=938), in whom 78% were recorded to have more than moderate radio graphical central spinal stenosis, also showed a positive association between radiological spondylolisthesis and BMI.[19]

Since spondylolisthesis is associated to low back pain which in turn is allied to overweight or obesity it is rational to assume that spondylolisthesis and low back pain may have upsurged body weight in common as a risk factor. However, till date, the inter-connection of body weight and disc degeneration has been a controversial matter. In a study conducted by Hangai et al[20] on 270 elderly Japanese subjects, it was observed that high BMI values were a risk factor for developing spondylolisthesis as evident on MRI. In a study of, Liuke et al[5] through his study on 129 middle-aged Finnish men showed that obesity was associated with the development of spondylolisthesis. This severity of spondylolisthesis may aid in explaining the increased occurrence of sustained and chronic low back pain in over-weighted and obese individuals debated in a recent systematic review by Shiri et al.[21]

5. Conclusion

Treatment and prevention of being obese is requisite public health priority. If successful, such results may lead to the minimization of the severity and extent of spondylolisthesis, which in turn may also reduce the risk of low back pain and the subsequent need for management. Forthcoming clinical science studies evaluating risk factors for spondylolisthesis must be cognizant of raised BMI values, precisely BMI values that specify obesity, and their effects on disease. Nevertheless, a prospective, long-term investigation of this study cohort is being done to further authenticate the findings and also to determine the effects of being obese on the severity of spondylolisthesis progression.

Table 3: Correlation of cervical & lumbar spinal canal diameter with BMI

Correlation with BMI	Anterior posterior		Transverse	
	r-value	p-value	r-value	p-value
C3_cervical	.045	.596	-.026	.762
C4_cervical	-.012	.887	-.073	.392
C5_cervical	-.070	.412	-.080	.348
C6_cervical	-.105	.217	-.146	.086
C7_cervical	-.173	**.042**	-.179	**.035**
L1_lumbar	.001	.986	-.072	.283
L2_lumbar	.022	.746	-.006	.933
L3_lumbar	-.042	.533	-.044	.509
L4_lumbar	-.007	.920	-.035	.602
L5_lumbar	.016	.808	.045	.502

Table 4: Linear regression analysis showing relationship of BMI and spinal canal diameter of c7

Parameter	B	SE	t-value	p-value	95% Confidence Interval		Effect size
					Lower Bound	Upper Bound	
Intercept	2.13	0.10	21.19	0.000	1.93	2.33	0.62
BMI	-0.01	0.00	-2.93	0.004	-0.02	0.00	0.03
Anterior posterior	-0.54	0.04	-15.21	0.000	-0.61	-0.47	0.46
Transverse	Ref						

6. Source of Funding

None.

7. Conflict of Interest

None.

References

1. Randall RM, Silverstein M, Goodwin R. Review of Pediatric Spondylolysis and Spondylolisthesis. *Sports Med Arthrosc Rev*. 2016;24(4):184–7.
2. Kreiner DS, Baisden J, Mazanec DJ, Patel RD, Bess RS, Burton D, et al. Guideline summary review: an evidence-based clinical guideline for the diagnosis and treatment of adult isthmic spondylolisthesis. *Spine J*. 2016;16(12):1478–85.
3. Webb R, Brammah T, Lunt M, Urwin M, Allison T, Symmons D, et al. Prevalence and predictors of intense, chronic, and disabling neck and back pain in the UK general population. *Spine (Phila Pa 1976)*. 2003;28(11):1195–202.
4. Leboeuf-Yde C, Kyvik KO, Bruun NH. Low back pain and lifestyle. Part II–Obesity. Information from a population-based sample of 29,424 twin subjects. *Spine (Phila Pa 1976)*. 1999;24(8):779–83.
5. Liuke M, Solovieva S, Lamminen A, Luoma K, Leino-Arjas P, Luukkonen R, et al. Disc degeneration of the lumbar spine in relation to overweight. *Int J Obes (Lond)*. 2005;29(8):903–8.
6. Flamme CH. Obesity and low back pain–biology, biomechanics and epidemiology. *Orthopade*. 2005;34(7):652–7.
7. Rodacki ALF, Fowler NE, Provensi CLG, Rodacki CLN, Dezan VH. Body mass as a factor in stature change. *Clin Biomech (Bristol, Avon)*. 2005;20(8):799–805.
8. Kauppila LI, Mcalindon T, Evans S, Wilson PW, Kiel D, Felson DT. Disc degeneration/back pain and calcification of the abdominal aorta. A 25-year follow-up study in Framingham. *Spine (Phila Pa 1976)*. 1997;22(14):1642–7.
9. Mayer T, Aceska A, Gatchel RJ. Is obesity overrated as a "risk factor" for poor outcomes in chronic occupational spinal disorders? *Spine (Phila Pa 1976)*. 2006;31(25):2967–72.
10. Vaidya R, Carp J, Bartol S, Ouellette N, Lee S, Sethi A. Lumbar spine fusion in obese and morbidly obese patients. *Spine (Phila Pa 1976)*. 2009;34(5):495–500.
11. Andreshak TG, An HS, Hall J, Stein B. Lumbar spine surgery in the obese patient. *J Spinal Disord*. 1997;10(5):376–9.
12. Djurasovic M, Bratcher KR, Glassman SD, Dimar JR, Carreon LY. The effect of obesity on clinical outcomes after lumbar fusion. *Spine (Phila Pa 1976)*. 2008;33(16):1789–92.
13. Telfeian AE, Reiter GT, Durham SR, Marcotte P. Spine surgery in morbidly obese patients. *J Neurosurg*. 2002;97(1):20–4.
14. Nadhim ASH, Mustafa NM, Hasan SO. Risk factors and conservative management of spondylolysis and spondylolisthesis grade I and II. *JSMC*. 2017;7(1):46–53.
15. Kalichman L, Kim DH, Li L, Guermazi A, Berkin V, Hunter DJ. Spondylolysis and spondylolisthesis: prevalence and association with low back pain in the adult community-based population. *Spine (Phila Pa 1976)*. 2009;34(2):199–205.
16. Schuller S, Charles YP, Steib JP. Sagittal spinopelvic alignment and body mass index in patients with degenerative spondylolisthesis. *Eur Spine J*. 2011;20(5):713–9.
17. Gübitz R, Lange T, Gosheger G, Heindel W, Allkemper T, Stehling C, et al. Influence of Age, BMI, Gender and Lumbar Level on T1ρ Magnetic Resonance Imaging of Lumbar Discs in Healthy Asymptomatic Adults. *Rofo*. 2018;190(2):144–51.
18. deSchepper EIT, Damen J, van Meurs J, Ginai AZ, Popham M, Hofman A, et al. The association between lumbar disc degeneration and low back pain: the influence of age, gender, and individual radiographic features. *Spine (Phila Pa 1976)*. 2010;35(5):531–6.
19. Kalichman L, Guermazi A, Li L, Hunter DJ. Association between age, sex, BMI and CT-evaluated spinal degeneration features. *J Back Musculoskelet Rehabil*. 2009;22(4):189–95.
20. Hangai M, Kaneoka K, Kuno S, Hinotsu S, Sakane M, Mamizuka N, et al. Factors associated with lumbar intervertebral disc degeneration in the elderly. *Spine J*. 2008;8(5):732–40.
21. Shiri R, Karppinen J, Leino-Arjas P, Solovieva S, Viikari-Juntura E. The association between obesity and low back pain: a metaanalysis. *Am J Epidemiol*. 2010;171(2):135–54.

Author biography

Divya Singh, PhD Scholar

P K Sharma, Professor

Sonia Jaiswal, Associate Professor

Cite this article: Singh D, Sharma PK, Jaiswal S. Prevalence of cervical spinal stenosis and its association with body mass index among Uttar Pradesh population. *Indian J Clin Anat Physiol* 2023;10(2):113-118.