Journal of the Anatomical Society of India 67S (2018) S25–S28

Contents lists available at ScienceDirect

Journal of the Anatomical Society of India

journal homepage: www.elsevier.com/locate/jasi

Original Article

Spinal canal diameter in degenerative lumbar spinal stenosis

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ARTICLE INFO

Article history:
Received 24 January 2018
Accepted 23 July 2018
Available online 24 July 2018

Keywords:
Lumbar spine
Stenosis
Age
Diameter
Low back pain
Morphometry

ABSTRACT

Introduction: Lumbar spinal stenosis (LSS) is defined as reduced spinal canal diameter either due to osseous changes in the bony components of a vertebra or due to changes in the associated soft tissue structures. The purpose of the study was to determine changes in vertebral body morphometry and diameters of osseous lumbar spinal canal with age to categorize it as degenerative spinal stenosis.
Materials and methods: A pre-defined low back pain questionnaire, clinical signs and symptoms were used to select individuals within age range of 20–80 years. The selected individuals were grouped into two categories of Asymptomatic (Group I) and Symptomatic (Group II) and taken up for MRI scan of lumbar spine. Group I included 57 healthy subjects with no degenerative findings of lumbar spine and Group II had 43 patients with positive evidences of degeneration at lower lumbar levels. Each group was further subdivided into young (20–39yrs), middle (40–59yrs) and old (60–80yrs) age subgroups. Vertebral canal diameters and vertebral body morphometry were compared within and between the groups. Relationship of observed parameters with age was analysed using SPSS analysis tool.
Results: The spinal canal diameters and vertebral body height (except at L3) were significantly lower in Group II at observed vertebral levels. The antero-posterior diameter, which is categorically used to define LSS, was not associated with age in both the groups.
Discussion: Degenerative spinal stenosis suggests changes should occur with advancing age but no significant association of spinal canal diameters with age was evident in our study.

1. Introduction

With increase in life expectancy, there has been an increase in the incidence of degenerative conditions, especially affecting the weight bearing structure of the human body, the spine.[1] Among the various problems associated with aging spine, lumbar spinal stenosis (LSS) has been cited as the most common indicator of spinal surgery in people over 60 years of age.[2,3] Earlier studies on degenerative spine have focussed on (i) degenerative changes at the disc, called as disc degeneration (DDD), and (ii) degenerative changes at the only synovial joints of the spine, the facet joints, referred to as facet joint arthrosis (FJA).[4–7] These two components being more elastic and more movable structures of the spine are further prone for early degeneration.[8–10] With the occurrence and advancement of degenerative changes at these better mobile components there occurs indirect compression on the spinal nerve roots or the dural sac of the spinal cord mimicking symptoms and signs of lumbar spinal stenosis (LSS). This type of stenosis, referred to as degenerative lumbar spinal stenosis (DLSS), is associated with age related changes at the fibro-cartilaginous disc, synovial facet joints and/or other soft tissues structures associated with that respective motion segment.[11] However there has been little mention of actual gross morphological changes in the bony components of the spine which include the vertebral height and the osseous spinal canal diameters.

Many studies have attempted to define and describe various changes associated with degenerative spine but very few studies have attempted to study gross morphological changes of the vertebral body height and bony spinal canal diameters of the spine with respect to age of an individual.[4–7,11] Even in studies conducted it appeared impossible to determine if the narrow spinal canal in DLSS is a degenerative change due to age or some genetic components are involved which otherwise play a significant role in DDD and FJA.[12,13]

The hypothesis formed after extensive review search was that if there is decrease in bony spinal canal diameter that is age dependent, then only it should be categorized as DLSS otherwise it is a simple spondylosis which indirectly is producing signs and symptoms of LSS. To affirm the hypothesis the aim of the study was defined as to determine changes in vertebral body morphometry

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https://doi.org/10.1016/j.jasi.2018.07.005
0003-2778/

and diameters of osseous lumbar spinal canal with age in both healthy subjects and in patients with signs and symptoms of LSS.

2. Materials & methods

The study was conducted on subjects, within age range of 20–80 years, from orthopaedics and radiodiagnosis & imaging departments of Santosh Medical College Ghaziabad & VMMC and Safdarjung Hospital New Delhi. A modified Nordic low back pain questionnaire was given to patients to categorize them into asymptomatic (Group I) and symptomatic groups (Group II).[14] Individuals were taken up for MRI scanning on Philips Achieva 1.5 T machine after obtaining a written informed consent. For group I, 57 individuals were selected who had no positive imaging results for degeneration of lumbar spine while 43 patients were selected for group II, where positive findings of either disc degeneration and/or facet joint arthrosis were seen. Individuals in both the groups were sub-divided as per the age into young (20–39yrs), middle (40–59yrs) and old (60–80yrs) age groups. The whole project was started only after approval by the institutional ethics committee.

The various parameters assessed included (i) Anterior and posterior vertebral body heights (AVBH & PVBH) measured as the distance between most anterior and posterior points on upper and lower borders of the vertebra respectively[11] (ii) Mid vertebral body height (MVBH) measured as the distance between midpoints on the superior and inferior surfaces of the vertebra[15] (iii) Antero-posterior diameter of the vertebral canal (APV_c) also called as mid-sagittal diameter of the spinal canal measured as the distance between the middle of the posterior edge of the vertebral body and the lamina posteriorly in the midline[16] (iv) antero-posterior diameter of the vertebral body (APV_b) measured as the distance between midpoint of anterior and posterior border of the superior surface of vertebral body and (v) transverse diameter of vertebral body (TBV_b) defined as the distance between most constricted part of the anterior and posterior surfaces of the vertebral body.[17]

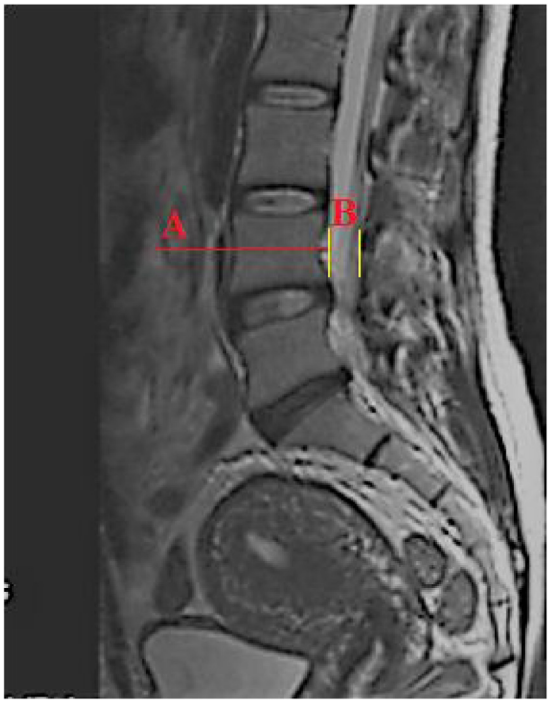

Fig. 1. Measurement of spinal canal diameter at mid vertebral level.

The APV_c was measured at mid vertebral body level as that would give the precise alterations of the spinal canal diameters due to change in osseous components of the vertebra as shown in Fig. 1.

All measurements taken were tabulated as per the groups defined by symptoms and age. Within- and between-group comparisons were made by SPSS 19 to evaluate changes by age. Student *t*-tests were used to compare data between groups and between 20–39 year olds and over 60 year olds. Pearson's correlation was used to determine correlations with age. P-values <0.05 were considered statistically significant.

3. Results

The distribution of participants for both the groups, as per pre-defined age groups is shown in Table 1. The difference of mean age between the two groups was found to be statistically non-significant at $p < 0.05$, CI 95%.

The value of all the observed parameters for both the groups, measured in millimetres, is shown in Table 2.

Degenerative changes in the disc due to aging are manifested by the changes in the mid vertebral body height, thus MVBH and APV_c dimensions were plotted at all three vertebral levels as per the age groups in both group I and II, as shown in Figs. 2 and 3 respectively.

The disc degeneration, manifested as reduced MVBH, was significantly associated with age in symptomatic subjects however there was no significant association of spinal canal diameter with age in both symptomatic and asymptomatic groups.

4. Discussion

Anatomically, LSS is caused by reduced space available for neural elements as a result of changes in the osseous as well as soft tissue elements surrounding the spinal column. Kirkaldy Willis et al in their work to define the pathology and pathogenesis of lumbar spondylosis and stenosis had proposed that degenerative LSS is initiated due to degenerative changes of the disc which further alter the load bearing mechanics of spine causing facet joint arthrosis, ligamentum flavum hypetrophy, osteophyte formation, finally presenting with symptoms of nerve entrapment.[8] It was also stated that with changes in the soft tissue structures there occurred changes in the bony lumbar vertebrae also which are evident as decrease in height or broadening of vertebrae with posterior wedging.[18] Similar results were obtained in the present study, where in group II patients of disc degeneration significant changes in morphology of vertebra with respect to AVBH, MVBH and APV_c were obtained especially at L4, L5 levels (AVBH,MVBH & APV_c was lower for symptomatic group). The observation of smaller vertebral heights and decreased antero-posterior diameter for symptomatic group was similar to that as concluded by Abbas, et al in their work on degenerative lumbar spinal stenosis.[11] Twomey and Taylor also stated that though soft tissue changes may be the prime contributors in degeneration but there are also alterations in the normal anatomy of the bony

Table 1
Age-wise distribution between the groups (SD = standard deviation).

Total (100)	Age (in yrs)	Number of cases	Mean age ± SD
Group I	Total	57	44.23 ± 14.4
	20-39	22	29.5 ± 5.73
	40-59	25	48.44 ± 5.84
	60-80	10	66.1 ± 3.81
Group II	Total	43	43.42 ± 13.77
	20-39	20	31.4 ± 5.49
	40-59	15	48.27 ± 6.33
	60-80	8	64.38 ± 3.42

Table 2
Vertebral body and spinal canal dimensions in both the groups.

Parameter	Vertebral level	GROUP I	GROUP II	p value	Result
AVBH	L3	25.27	24.35	0.107	NS
	L4	26.1	24.48	0.026	*S
	L5	26.82	24.97	0.008	*S
MVBH	L3	23.89	23.28	0.45	NS
	L4	24.83	22.73	0.012	*S
	L5	24.58	22.51	0.011	*S
PVBH	L3	26.12	25.9	0.18	NS
	L4	26.34	26.12	0.23	NS
	L5	26.9	27.1	0.24	NS
APV_b	L3	31.1	24.35	0.17	NS
	L4	32.16	24.48	0.138	NS
	L5	32.74	24.97	0.06	NS
TDV_b	L3	39.48	38.35	0.238	NS
	L4	40.64	39.64	0.319	NS
	L5	42.16	42.23	0.958	NS
APV_c	L3	14.02	9.52	<0.0001	*S
	L4	14.48	8.94	<0.0001	*S
	L5	14.56	8.44	<0.0001	*S

S = significant, NS = non-significant.

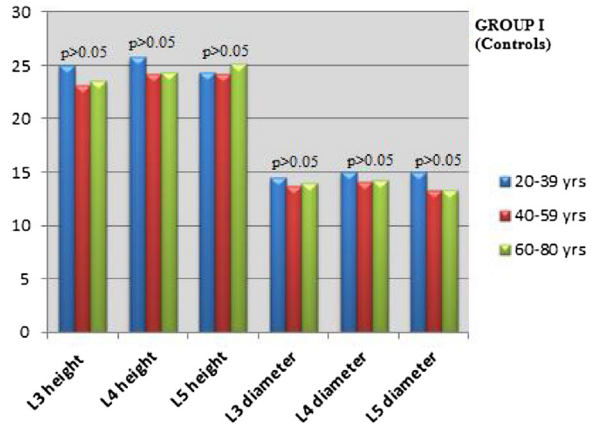

Fig. 2. MVBH & APV_c in Group I (controls).

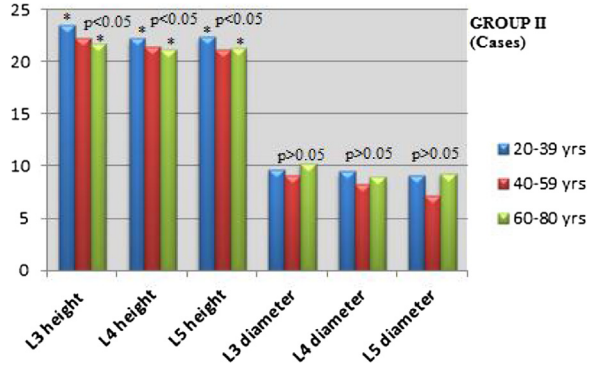

Fig. 3. MVBH & APV_c in Group II (patients).

components of the spine.[19] All these findings from earlier and present research point to the fact that bony changes accompany soft tissue changes in an aging spine. However, as observed in the present study, these changes are usually restricted to the vertebral height and transverse diameter of the vertebrae without much alteration in the anteroposterior diameter of the canal with respect to increasing age. This probably questions the use of the term degenerative lumbar spinal stenosis, as there is no actual reduction in the bony canal diameter. The APV_c decreases in symptomatic group but the decrease is not statistically associated with age and similar results were also obtained by Masharawi et al.[20]

Various genetic concepts have been proposed in the development of DDD and FJA and since disc degeneration has been considered as a prime contributor and initiator of degenerative cascade of spine, would it not be correct to state that spinal stenosis (actual bony reduction of canal) is also a genetically dependent phenomenon.[21–23,12,13] The manifestation of signs & symptoms of LSS in patients with degenerative spine is actually due to pathologic narrowing of the either nerve root canal or compression on spinal dura and not due to direct reduction of osseous canal diameter, for it to be referred to as DLSS.

5. Conclusion

The present study reveals that the degenerative lumbar spinal stenosis occurs due to advancing age but there is no significant association of spinal canal diameter with the age. Thus it is not certain whether the reduced canal diameter is actually a degenerative process or some genetic components are involved to manifest it.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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