Higher lumbar bone mineral density is associated with narrowed intervertebral disc space, but not higher hip bone mineral density: a study in 359 elderly subjects using an 8-level MRI based disc degeneration grading system.

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Introduction: Osteoporosis and disc degeneration of the spine are common conditions that primarily affect the elderly. The correlation between osteoporosis and intervertebral disc degeneration in the spine is not fully understood. Recently Griffith *et al.* (1) proposed an MRI based 8-level grading system for disc degeneration, wherein each grade represents a stepwise progression from normal disc to severe disc degeneration. With this grading system, Grade 1 corresponds to no disc degeneration, Grade 2 corresponds to mild disc degeneration, Grade >= 6 indicate an existence of disc space narrowing, while Grade 8 corresponds to end-stage degeneration. In this study the relationship between bone mineral density (BMD) and lumbar intervertebral disc space narrowing was investigated using this 8-level grading system.

Materials and methods: The study was approved by our institution ethics committee. The study subjects were recruited voluntarily by advertising in local community centers. Subjects with lumbar vertebra fracture were excluded. Back pain was not a specific inclusion or exclusion criterion. There were 359 healthy elderly subjects, comprised of 163 males (73.5 ± 4.3 years) and 196 females (73.2 ± 4.1 years) with no age difference between the two gender groups ($p>0.05$). For all the subjects, hip BMD and anteroposterior lumbar BMD were measured at L1–L4 by dual X-ray densitometry (DXA). 48 randomly selected male subjects also underwent additional quantitative CT (QCT) densitometry of the first and second lumbar vertebrae. As commonly used by other authors (2), average mid-vertebral trabecular BMD of L1 and L2 was used as lumbar spine BMD of the subjects. MRI was performed on the same day as DXA/QCT, acquired at a 1.5-T MR scanner (Intera NT; Philips Healthcare). Standard T2-weighted (TR=3500 ms, TE =120 ms) TSE sagittal images of lumbar spine were obtained for analysis. Two trained readers, one radiologist and one medical physicist, independently graded each of the 1795 lumbar intervertebral discs using the 8-level grading system. Consensus was reached when the initial reading differs.

Results: The relationship between BMD and disc space narrowing are shown in table 1 for 359 subjects and table 2 for 48 male subjects. There was no significant relationship between hip BMD and intervertebral disc space narrowing (Table 1). However, with the 48 male subjects who had both DXA and QCT, the results showed except disc L1/L2, lumbar disc were more likely to have a narrowed space when lumbar BMD was higher (table 2). This trend was stronger when DXA was used than QCT was used (table 2).

Table 1		Male			Female		
disc	Disc degeneration grade	No. of disc	BMD (Mean ± SD)	P value	No. of disc	BMD (Mean ± SD)	P value
L1/L2	< 6	130	0.86±0.13	0.028	143	0.72±0.12	0.978
	=/> 6	33	0.80±0.15		49	0.72±0.10	
L2/L3	< 6	111	0.84±0.14	0.902	119	0.71±0.11	0.456
	=/> 6	52	0.85±0.12		73	0.72±0.12	
L3/L4	< 6	115	0.83±0.13	0.075	113	0.71±0.12	0.297
	=/> 6	48	0.87±0.14		79	0.73±0.10	
L4/L5	< 6	108	0.84±0.13	0.749	99	0.72±0.12	0.985
	=/> 6	55	0.85±0.14		93	0.72±0.11	
L5/S1	< 6	119	0.83±0.13	0.080	121	0.72±0.12	0.492
	=/> 6	44	0.88±0.15		71	0.71±0.10	

Table 1: Relationship between total hip BMD and intervertebral disc space narrowing. There is no significant relation between hip BMD and intervertebral disc space narrowing ($P>0.05$, one-way ANOVA).

Table 2 disc	Disc degeneration grade	No. of disc	BMD (Mean ± SD)	P value
L1/L2	< 6	37	0.10 ±0.03**	0.49
	=/> 6	11	0.11 ±0.03**	
	< 6	37	0.92 ±0.20§	0.2
	=/> 6	11	1.02 ±0.27§	
L2/L3	< 6	30	0.10 ±0.03**	0.04*
	=/> 6	18	0.11 ±0.03**	
	< 6	30	0.89 ±0.20§	0.037*
	=/> 6	18	1.02 ±0.23§	
L3/L4	< 6	33	0.10 ±0.03**	0.009*
	=/> 6	15	0.12 ±0.04**	
	< 6	33	0.88 ±0.17§	0.002*
	=/> 6	15	1.11 ±0.25§	
L4/L5	< 6	34	0.10 ±0.03**	0.037*
	=/> 6	14	0.12 ±0.04**	
	< 6	34	0.88±0.17§	0.002*
	=/> 6	14	1.11 ±0.25§	
L5/S1	< 6	36	0.10 ±0.03**	0.009*
	=/> 6	12	0.12 ±0.03**	
	< 6	36	0.89 ±0.18§	0.002*
	=/> 6	12	1.11 ±0.25§	

Table2: Relationship between lumber spine BMD and intervertebral disc space narrowing. * denotes statistical significance ($p<0.05$, one-way ANOVA). ** denotes trabecular BMD value measured with QCT (in gram/cm^3), § denotes BMD value measured with DXA (in gram/cm^2). Lumbar discs are more likely to have a narrowed space when BMD is higher. This correlation is more significant with DXA measured BMD than QCT measured BMD.

Discussion: Using an 8-level MRI based disc degeneration grading system, this study showed there was no significant relation between hip BMD and lumbar disc space narrowing. However, higher lumbar spine BMD was associated disc space narrowing. It is known that hip BMD better represent systemic BMD. Therefore this association could be lumbar spine BMD specific. It is possible that the lumbar BMD change associated biomechanical alterations might contribute to the disc degeneration and disc space narrowing. Stronger more dense bones predisposing to disc degeneration. Reduced BMD leads to endplate weakening and loss of vertebral body height, a process that allows the disc to push into the endplates and expand. This possibly facilitates dissipation of forces applied to the disc and thus helps reduce disc damage. The increased contact surface area may also decrease pressure. Other factors may also account for this finding such as disc space narrowing being associated with more severe marginal osteophytosis, osteosclerosis and facet joint arthrosis. It is noted that the significance of this relation was stronger when DXA measured BMD was used than QCT was used (table 2). Intervertebral disc degeneration and facet arthrosis increase in prevalence with aging, such that by 60 years of age, 60–80% of people have radiographic evidence of osteophytosis, disc narrowing, and/or facet joint arthrosis (3). Degenerative change may lead to spuriously high lumbar BMD readings due to marginal osteophytosis, trabecular thickening, subchondral sclerosis and facet joint arthrosis (4, 5). QCT allows a more accurate evaluation of vertebral BMD free from these errors introduced by reactive new bone. QCT, however, suffers from higher radiation dosage than DXA. Further analysis with aims of removing or adjusting complicating factors is under way in our institute.

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