THORACOLUMBAR VERTEBRAL HEIGHT RATIO : NORMAL VALUE IN THAI POPULATION AND SIGNIFICANCE

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ABSTRACT

The vertebral height (anterior height, central height and posterior height) of thoracolumbar spine, Th12 to L4, were measured in 398 normal subjects by standard lateral radiographs, and the vertebral height ratios were calculated in both females and males to evaluate normal value in Thai population. A fracture was considered to be present if the anterior or central height was decreased by 20% comparing to the posterior height.

INTRODUCTION

Osteoporosis is nowadays observed to be an increasing problem in the Far East. It is characterized by decrease in amount of bone, leading to increased risk of fracture after minimal trauma (1). In primary osteoporosis, it relates to aging and also estrogen deprivation in postmenopausal women in the absence of other recognizable causes of bone loss such as renal disease, metabolic bone disease or some medications known to affect bone.

It has been hypothesized that loss of vertebral height in the elderly patient with osteoporosis is the result of compression fractures (2-4), nonskeletal factors such as muscle tone (5) or both (6). Of skeletal cause, some authors graded fracture ratios in osteoporotic women as quantitated with spinal DPA,* however, mild anterior wedging at lower thoracic levels are considered within normal limits.

Vertebral bodies of the spine is the early site of osteoporosis. It is composed of predominantly trabecular bone which is susceptible to metabolic stimuli and presenting early bone loss. Lateral spinal radiograph is the first method to be used for semiquantitative assessment of the osteoporotic spine and its associated fracture.

In the present study we calculate anterior wedging ratio and central compression ratio at thoracolumbar junction (Th12) and lumber levels (L1-L4) in healthy Thai subjects of different age and gender.

MATERIAL AND METHODS

The studied population consisted of 398 healthy volunteers (245 women, 153 men), 20-80 years old. We confirmed that no of volunteer had a history of metabolic bone disease, trauma or arthritis. Standard lateral radiographs of thoracolumbar spine were obtained, with the patient in left lateral decubitus position. The focal film distance was 40 inches. We used a measurement technique [11] to determine anterior height, central height, and posterior height (Fig. 1) of the thoracolumbar spine ; from Th12 to L4. We also calculate anterior wedging ratio and central compression ratio in each vertebra. All of the radiographic measurements were entered into the personal computer for tabulation and statistical analysis, using Anova technique.

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*DPA = Dual-photon-absorptiometry

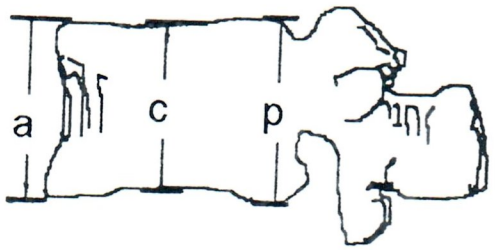

FIG. 1 : Diagram illustrates method for quantitation of vertebral height [8] Anterior wedging ratio (a/p) = anterior height (a) / posterior height (p) Central compression ratio (c/p) = central height (c) / posterior height (p)

RESULT

The results of female anterior wedging ratio (a/p) and central compression ratio (c/p) are shown in Table 1 and 2, and the results of male in Table 3 and 4 respectively, as well as their corresponding line graphs. The average values of the ratios for each vertebral body level are shown in Table 5 and 6.

DISCUSSION

Conventional radiography continues to be the mainstay of any diagnostic investigation of thoracolumbar spine. It should precede any complex imaging procedure. Usually antero-posterior and lateral radiographs are required and the latter is helpful in assessing vertebral height. Because of its availability, the mentioned measurements are usually obtained.

The studied population should represent norm, since osteoporosis was excluded clinically, through laboratory investigation and DXA* measurements of the vertebra and femoral neck. This study shows that the lower limit (average value) of the anterior wedging ratio (a/p) is 0.89 in females and 0.86 in males, and that of the central compression ratio (c/p) is 0.88 in females and 0.89 in males (Table 5 and 6). This lower limit was observed at levels of Th12 and L1, suggesting that Th12 and L1 usually have the normal more anterior wedging than the lower vertebral levels. Our findings of Th12 anterior wedging ratio (0.89 in females and 0.86 in males) are also in accordance with the data obtained by Fletcher et al.(7), who found that wedging ratios of 0.87 in females and 0.8 in males at the Th8 to Th12 levels are within normal limits.

The mechanical testing has shown that vertebral resistance to collapse is highest on the lumbar spine [12]. The lumbar vertebral cortex which is thicker than that of thoracic levels and the normal lumbar lordosis may relatively protects the lumbar vertebrae from anterior wedging forces. As a result, in osteoporotic patient, the loss of trabecular bone results instead in central compression (8).

At the level of L4 in all age groups, especially in female subjects (Table 1), we have observed that the anterior wedging ratios are near or above 1.0. This probably be due to the normal lordotic curve of lumbar spine causing the posterior aspect of the vertebrae to be more compressed than the anterior aspect, and partly due to the more lordosis in pregnant period causing the more posterior compression.

The metabolic turnover rate of trabecular bone is 6 to 8 times higher than that of cortical bone (9). Osteoporosis is characterized by a process removing entire trabeculae,lacing ones that remian more widely separated but only slightly reduced in thickness, as by Parfitt et.al (10). As a result, incomplete fracture of vertebrae are late manifestation of illness and the fracture ratios are relatively insensitive measurement.

In conclusion, we established anterior wedging ratio (a/p) and central compression ratio (c/p) in healthy Thai population. If the value is less than this measurement, particularly decreasing by 20% comparing to the posterior height, compression fracture is suggested although it is the late manifestation of osteoporosis.

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* DXA = Dual-X-ray-absorptiometry

TABLE 1 : FEMALE ANTERIOR WEDGING RATIO
(ANTERIOR/POSTERIOR VERTEBRAL HEIGHT)

AGE (YEARS)	NUMBER OF CASES	T12	L1	L2	L3	L4
20-29	30	0.8906	0.9043	0.9272	1.0260	1.0130
30-39	31	0.9001	0.9003	0.9389	0.9763	1.0200
40-49	57	0.8923	0.9014	0.9367	0.9784	1.0160
50-59	49	0.8901	0.8867	0.9411	0.9735	1.0130
60-69	52	0.8829	0.8937	0.9403	0.9831	1.0320
70-80	26	0.8988	0.8731	0.9091	0.9356	1.0041

FIG 2 : LINE GRAPH OF FEMALE ANTERIOR WEDGING RATIO
(Corresponding to Table 1)

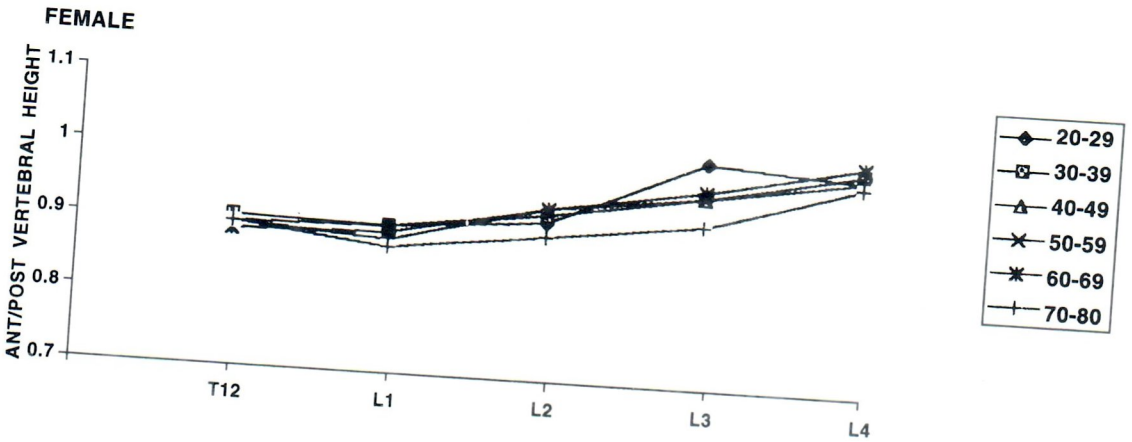

TABLE 2 : FEMALE CENTRAL COMPRESSION RATIO

(CENTRAL/POSTERIOR VERTEBRAL HEIGHT)

AGE (YEARS)	NUMBER OF CASES	T12	L1	L2	L3	L4
20-29	30	0.8584	0.8545	0.8501	0.9331	0.9032
30-39	30	0.8429	0.8693	0.8741	0.8786	0.9137
40-49	57	0.8656	0.8952	0.9096	0.9309	0.9558
50-59	48	0.9185	0.9217	0.9524	0.9590	1.0065
60-69	52	0.8976	0.6069	0.9126	0.9351	0.9762
70-80	26	0.9348	0.9239	0.9343	0.9481	0.9790

FIG 3 : LINE GRAPH OF FEMALE CENTRAL COMPRESSION RATIO

(Corresponding to Table 2)

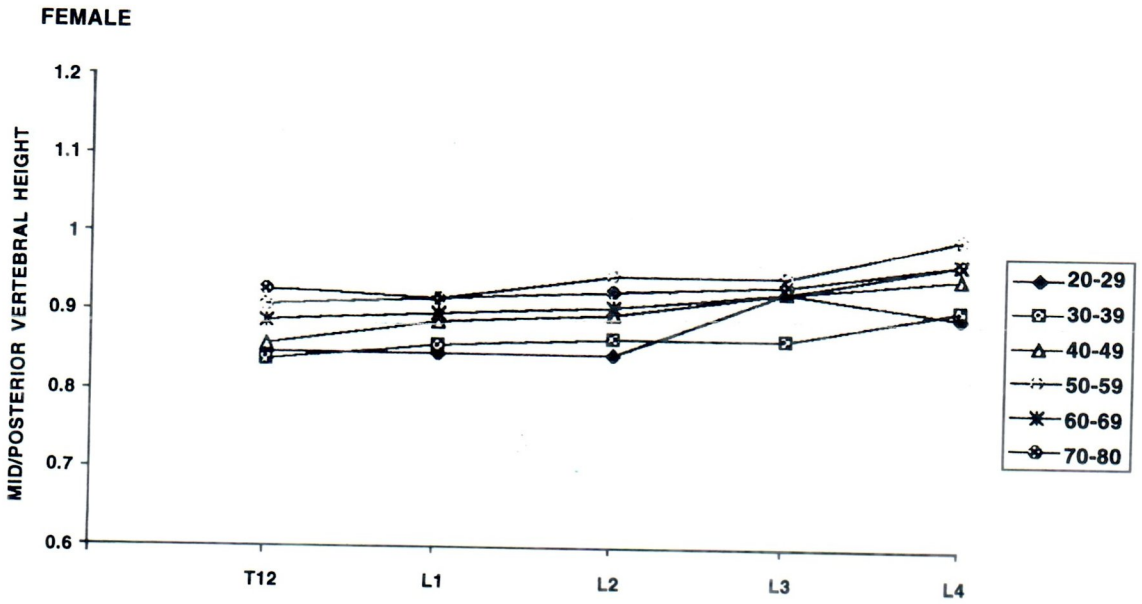

TABLE 3 : MALE ANTERIOR WEDGING RATIO
(ANTERIOR/POSTERIOR VERTEBRAL HEIGHT)

AGE (YEARS)	NUMBER OF CASES	T12	L1	L2	L3	L4
20-29	24	0.8739	0.8520	0.8910	0.9406	0.9916
30-39	25	0.8558	0.8742	0.8876	0.9399	0.9920
40-49	24	0.8636	0.8509	0.8858	0.9393	0.9698
50-59	25	0.8713	0.8582	0.9238	0.9436	0.9830
60-69	24	0.8445	0.8659	0.9190	0.9492	0.9886
70-80	26	0.8681	0.8429	0.8799	0.9379	0.9735

FIG 4 : LINE GRAPH OF MALE ANTERIOR WEDGING RATIO
(Corresponding to Table 3)

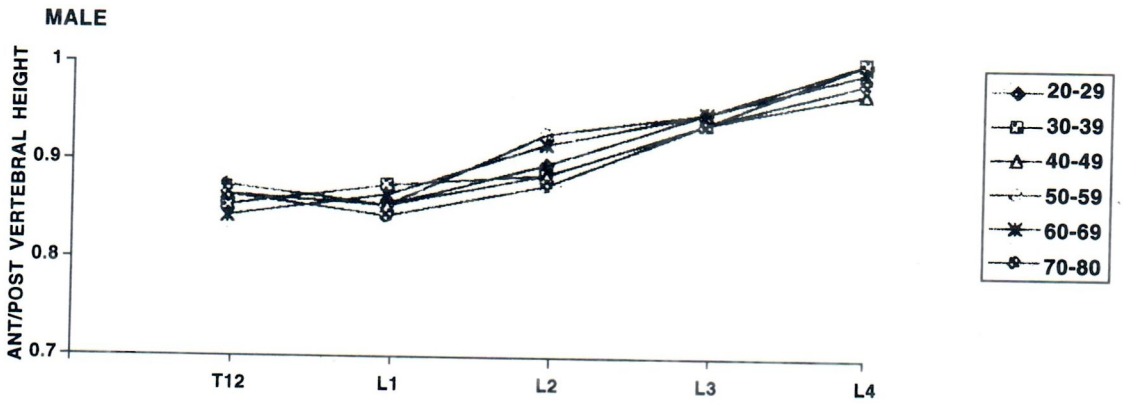

TABLE 4 : MALE CENTRAL COMPRESSION RATIO

(CENTRAL/POSTERIOR VERTEBRAL HEIGHT)

AGE (YEARS)	NUMBER OF CASES	T12	L1	L2	L3	L4
20-29	24	0.9163	0.9086	0.9306	0.9673	0.9828
30-39	25	0.8854	0.9141	0.9079	0.9072	0.9469
40-49	24	0.8954	0.9067	0.9194	0.9444	0.9612
50-59	25	0.9058	0.9046	0.9338	0.9561	0.9951
60-69	24	0.8957	0.9030	0.9217	0.9407	0.9752
70-80	25	0.8968	0.8920	0.9142	0.9453	0.9794

FIG 5 : LINE GRAPH OF MALE CENTRAL COMPRESSION RATIO

(Corresponding to Table 4)

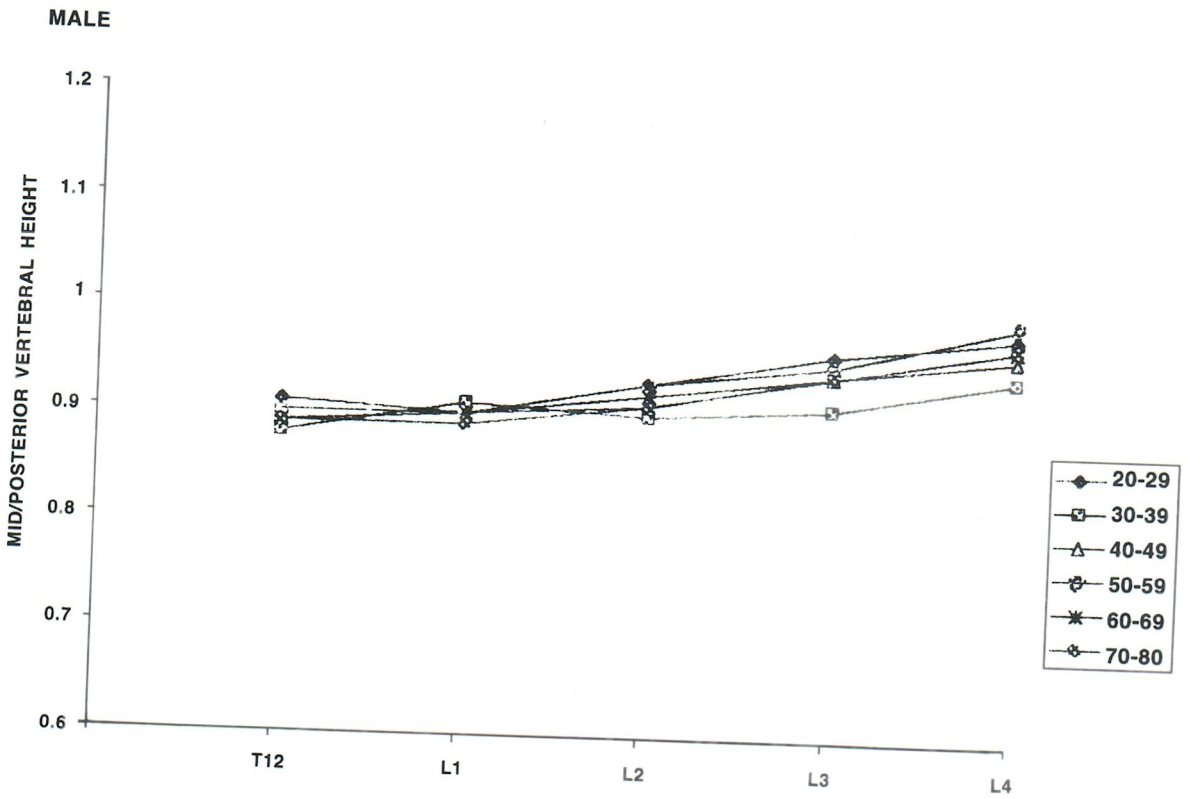

TABLE 5 : AVERAGE VALUES OF THE RATIOS FOR EACH VERTEBRAL LEVEL IN FEMALE

	Th12	L1	L2	L3	L4
a/p	0.8913	0.8940	0.9345	0.9876	1.0176
c/p	0.8866	0.8978	0.9096	0.9330	0.9609

TABLE 6 : AVERAGE VALUES OF THE RATIOS FOR EACH VERTEBRAL LEVEL IN MALE

	Th12	L1	L2	L3	L4
a/p	0.8629	0.8625	0.8977	0.9417	0.9862
c/p	0.8992	0.9048	0.9212	0.9461	0.9734

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