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Research Article

A STUDY ON THE PREVALENCE AND RISK FACTORS OF T-SCORE DISCORDANCE BETWEEN THE TWO SKELETAL SITES

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ABSTRACT

A statistical tool known as the T-score was chosen to depict the relative position of a patient in this continuum of fracture risk. The T-score is calculated by comparing patient's measured BMD with mean BMD of healthy young adults, matched for gender and ethnic group, and expressing the difference in terms of standard deviation (SD).The present study was conducted in the department of Radio diagnosis and included 269 subjects referred by clinicians for DEXA scan. The participants were recruited in the study upon informed consent. The patient underwent bone mineral density at lumbar spine (L1 to L4) and total hip. In this study, among 269 patients, a total of 135 (50.1%) patients had discordance in their T score classification at hip and spine. Minor discordance was observed in 120 (44.6%) participants and major discordance was observed in 15 (5.6%) participants. In other 134 (49.8%) participants, T-score categories at two skeletal sites were not different.

Key words:- T-score, DEXA scan, lumbar spine.

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INTRODUCTION

India houses the second largest population in the world, thus it is also home to a very large population of osteoporotic patients. Being a developing nation, in terms of economic reforms and development, there is also a steady increase in life expectancy resulting in an increasing aging population who are at risk of osteoporosis. The population above age 50 years is estimated to constitute 22% in 2025 and 33 % of the total population in 2050 respectively. Life expectancy is 67 years (2013) and is expected to increase to 71 years by 2025 and to 77 years by 2050 [1].

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State of osteoporosis/osteopenia

As per the 2009 International osteoporosis Foundation [IOF] Asian Audit, it is estimated that approximately 26 million patients suffer from osteoporosis in India in 2003, which is expected to increase to 36 million by 2013 [2]. In 2013, sources estimated that 50 million people in India are either osteoporotic or osteopenic [3]. High rate osteoporosis parallels with high rate of vitamin D deficiency prevalent in India. A recent report on the global status of Vitamin D nutrition highlights India as one of the most deficient regions [4]. High rate of vitamin D deficiency may also be due to several other factors like pigmented skin, low sun exposure, low dietary intake, lack of food fortification, environmental pollution etc. Urbanization also appears to influence the prevalence of osteoporosis

due to lifestyle changes, lower physical activity, increased indoor living, and low sun exposure.

Level of Awareness

Awareness about osteoporosis is low among Indian population. Number of small scale surveys indicate that only 10-15% of the population were familiar with the disease entity [5]. Nevertheless level of awareness varies with the level of education and those with family history of osteoporosis. Most find the information about the osteoporosis through television and radio than doctors, newspapers or peers. Information through media may not be as accurate and there is need for increased involvement of doctors in educating people about osteoporosis.

Fracture rates

In a large questionnaire-based study involving 14,271 subjects, population incidence of low trauma fractures at hip, spine and wrist was 34.3/100,000 per year [6]. A recent study from Rohtak district in North India shows an annual incidence rate of 163 and 121 per 100,000 per year in women and men respectively above the age of 55 years [7]. However, with rapid increase in the ageing population, an exponential rise is expected in the absolute numbers of fractures in the next decade.

15–20% of older urban adults aged over 50 years show evidence of at least one vertebral fracture. The prevalence of radiographic vertebral fractures in older adults in Delhi has been recently reported to be 17.9% (18.8% male and 17.1% female); indicating that vertebral fracture prevalence in India is similar to Western populations [8].

Diagnostics

There are approximately 250 DXA machines available in the country (about 0.2 DXA machines per million), and very few of these are based at the government hospitals, a fact which further limits access. While a large proportion of DXA machines are available in the metropolitan areas, there is an increasing need to spread to middle sized towns all over the country. A statistical tool known as the T-score was chosen to depict the relative position of a patient in this continuum of fracture risk. The T-score is calculated by comparing patient's measured BMD with mean BMD of healthy young adults, matched for gender and ethnic group, and expressing the difference in terms of standard deviation (SD). Therefore, a T-score result indicates the difference between the patient's BMD and the ideal peak bone mass achieved by a young adults (aged 20-39 yrs). A T-score of -1 indicates that the subjects BMD is one standard deviation less than the mean of reference young adult population.

$$\text{T-score} = \frac{\text{Measured BMD-Young adult normal BMD}}{\text{Young adult normal SD}}$$

The current WHO definitions of osteoporosis and osteopenia are based on T-score values. According to the WHO (The WHO Study Group 1994) the diagnostic criteria is as follows.

- **Normal:** a BMD or BMC value not less than 1 SD below the young adult mean value
- **Low bone mass (or osteopenia):** a BMD or BMC value between 1 and 2.5 SD below the young adult mean value
- **Osteoporosis:** a BMD or BMC value more than 2.5 SD below the young adult mean value
- **Severe osteoporosis (or established osteoporosis):** a BMD or BMC value more than 2.5 SD below the young adult mean value in the presence of one or more fragility fractures.

The logical corollary of this data is the need to identify individuals with low bone mass prior to the occurrence of the first fracture. In predicting fracture risk, the guiding principle is that the risk of fracture approximately doubles for each SD decline in bone density. The fracture risk does not have a discrete beginning or end. It is a continuum of risk. There is no T-score at which a patient is risk-free. Fracture risk is always there to a greater or lesser extent. Clinical factors modify the risk attributed to a specific T-score. Age is the greatest clinical risk factor which increases the risk for fracture at every T-score no matter the value. There is no substitute for clinical judgment when it comes to conveying what these numbers really mean. The medical implications of these scores, however, must always be placed in the context of every individual patient.

METHODOLOGY

Study Area

The present study was conducted in the department of Radiodiagnosis and included 269 subjects referred by clinicians for DEXA scan.

The participants were recruited in the study upon informed consent. The patient underwent bone mineral density at lumbar spine (L1 to L4) and total hip.

Sample size

269 subjects were included in the study.

Sample size calculation

The sample size was determined by calculations using the following formula.

$$n = Z^2 \times p \times q / D^2$$

Where, n = sample size

Z = constant considered as 2

P = prevalence of T score discordance

q = 100 – p

D = 15% of p

As the exact prevalence of T-score discordance in this geographical area was not known prevalence was considered as 50.

Therefore, $n = 2^2 \times 50 \times 50 / 7.5^2$

$= 177.77 \sim 180$

Hence the sample size of 180 was considered. However, during the study period 269 subjects satisfied the inclusion criteria and hence enrolled.

Exclusion criteria:

- Non-consenting patients.
- Patients who underwent bone density study at only one skeletal site.

Results:

When T-score at spine and total hip were compared among the study population, a significant proportion had discordance in their T-score classification at different skeletal sites. Discordance in diagnosis of osteoporosis is defined as presence of different categories of T scores (osteoporosis, osteopenia, and normal) in two skeletal sites of an individual patient.

This phenomenon is classified into two groups: major and minor. Minor discordance is where the different diagnostic classes are adjacent; i.e., patient is diagnosed as osteoporotic in one site and osteopenic in the other site, or, osteopenic in one site and normal in the other site. If the diagnosis is osteoporosis in one site and the other site is in the normal range, the discordance falls into the major class.

In this study, among 269 patients, a total of 135 (50.1%) patients had discordance in their T score classification at hip and spine. Minor discordance was observed in 120 (44.6%) participants and major discordance was observed in 15 (5.6%) participants. In other 134 (49.8%) participants, T-score categories at two skeletal sites were not different.

T-score discordance was more prevalent in women than men. However the association of gender with discordance was not statistically significant.

The bulk of patients who had discordant T scores were those above 50 yrs of age. Age > 50 was a significant risk factor for occurrence of discordance.

Mean age among discordant group was marginally higher than those with T score concordance.

No single BMI group showed significant predisposition for discordance.

In both major and minor discordances, lower BMD for lumbar spine was more prevalent. Of the 15 participants who had major discordance, 14 were osteoporotic at spine. Only 1 subject had osteoporosis at hip with normal bone density at spine.

Age >50, menopausal status, & osteoporosis at spine were significant risk factors for T-score discordance between hip & spine. T-score discordance was significantly less prevalent Those who had taken Hormone replacement therapy & who had low bone density at hip were less likely to show T score discordance.

Table 1. Distribution of Major Discordance

Major Discordance		Men	Women	Total
HIP	Spine			
Normal	Osteoporosis	2	12	14
Osteoporosis	Normal	-	1	1

Table 2. Distribution of Minor Discordance

Minor Discordance		Men	Women	Total
HIP	Spine			
Osteoporosis	Osteopenia	1	8	9
Osteopenia	Osteoporosis	9	41	50
Osteopenia	Normal	5	6	11
Normal	Osteopenia	12	38	50

Table 3. Prevalence of Discordance with Sex

Sex	Nil	%	Minor	%	Major	%	Total	%
Male	35	54.69	27	42.19	2	3.13	64	23.79
Female	99	48.29	93	45.37	13	6.34	205	76.21
Total	134	49.81	120	44.61	15	5.58	269	100.00
Chi-square=1.4162 P = 0.4931								

Table 4. Distribution of Discordance with Age Groups

Age groups	Nil	%	Minor	%	Major	%	Total	%
<=40yrs	18	75.00	6	25.00	0	0.00	24	8.92
41-50yrs	23	48.94	22	46.81	2	4.26	47	17.47
51-60yrs	26	36.62	37	52.11	8	11.27	71	26.39
61-70yrs	45	51.14	38	43.18	5	5.68	88	32.71

>=71yrs	22	56.41	17	43.59	0	0.00	39	14.50
Total	134	49.81	120	44.61	15	5.58	269	100.00
Chi-square=16.7688, p=0.0326*								

p<0.05

Table 5. Mean Age and SD in Patients with Discordance

Discordance	Means	SD
Normal	57.95	13.35
Minor	58.92	11.16
Major	58.33	7.20
Total	58.40	12.11
F-value	0.2016	
P-value	0.8176	

Table 6. Distribution of Discordance with BMI Groups

BMI groups	Nil	%	Minor	%	Major	%	Total	%
Under weight	6	50.00	6	50.00	0	0.00	12	4.46
Normal	49	53.85	39	42.86	3	3.30	91	33.83
Over weight	40	44.44	44	48.89	6	6.67	90	33.46
Obese	39	51.32	31	40.79	6	7.89	76	28.25
Total	134	49.81	120	44.61	15	5.58	269	100.00
Chi-square=4.0536, p=0.6695								

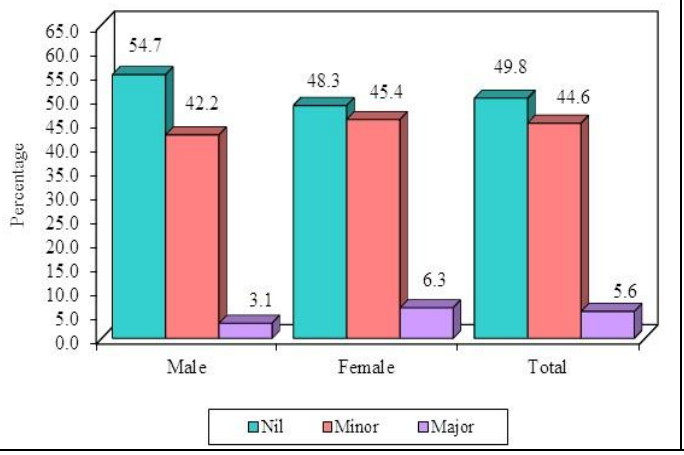
Table 7. Distribution of Osteoporosis in Patients with Major Discordance

	Osteoporosis At Spine With Normal BMD At Hip	Osteoporosis At Hip With Normal BMD At Spine	Total
Major Discordance	14	1	15

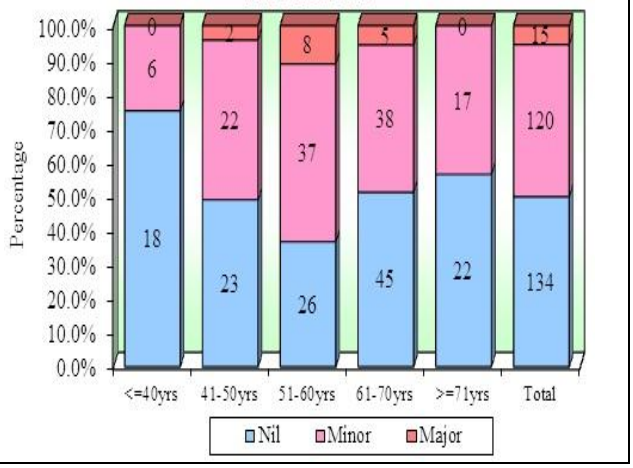
Table 8. Results of Chi-squared Test for Risk Factors of T-score Discordance

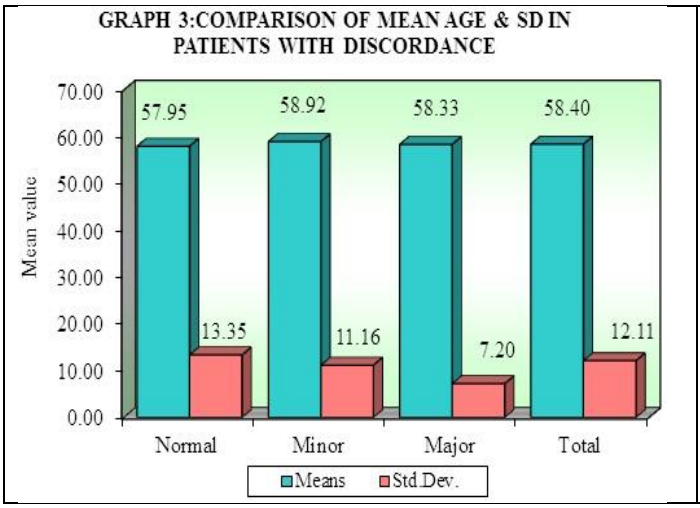
Variable	X^2	P Value
Sex	0.7978	0.3717
Age >50	82.67	0.0000*
Obesity	0.0955	0.7572
Menopausal status	4.4679	0.0345*
Steroid intake	0.5308	0.4662
HRT	6.26	0.012*
Osteoporosis at spine	17.344	<0.05*
Osteoporosis at hip	15.4	<0.05*

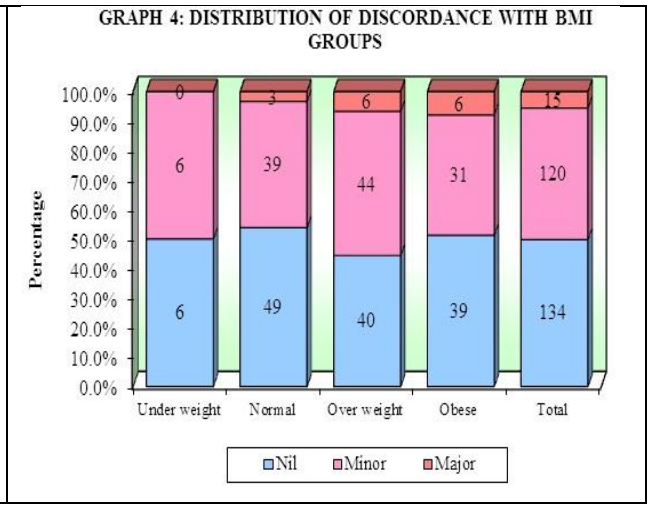
GRAPH 1: PREVALENCE OF DISCORDANCE WITH SEX



GRAPH 2: DISTRIBUTION OF DISCORDANCE WITH AGE GROUPS







DISCUSSION

Osteoporosis is a major global public health problem associated with significant morbidity, mortality, and socioeconomic burden. Osteoporosis is a condition that can be prevented and treated if diagnosed early and accurately. Unfortunately, it is often undiagnosed until a fracture occurs. Therefore, the number of people who are screened for this disease must be increased. Measuring bone mineral density (BMD) is the most important tool in the diagnosis of osteoporosis. And DEXA is the investigation of choice for measurement of bone density.

In our study, the prevalence of osteoporosis was found to be as high as 39% (n=105 out of 269). The exact prevalence and incidence of osteoporosis in India is not known. Epidemiological data is lacking, however expert groups estimated the prevalence in India to be 26 million in 2003 & 36 million by 2013 in International Osteoporosis Asian Audit 2009 [2]. Most studies on osteoporotic are done on postmenopausal women and these studies show high prevalence of postmenopausal osteoporosis in Indian women as compared to western population. Neelam Aggarwal et al, in their cross sectional study done at a tertiary referral centre in Hyderabad, reported a prevalence of 53% among postmenopausal women [9]. Similar high prevalence was also found in cross sectional study done by Paul Thomas et al in a semiurban area of southern India, with prevalence of osteoporosis of 50% among postmenopausal women [10]. In our study group, 56.4% of postmenopausal women were osteoporotic.

The reason for such high prevalence of low bone density in Indian population may include the genetic makeup, the environmental factors, personal habits, life style, high prevalence of Vitamin D deficiency etc. Several studies have shown lower mean bone density values in Indian population as compared to Caucasian population. A study done by Ranu patni et al indicated that the mean spinal BMD in Indian females in the 20–60 years age group was about 30% less than the reference American/European populations and mean hip BMD was 27% less than that in the reference American/European population. Similar results were seen in a study conducted by Nangia et al where mean spinal BMD in Indian females was 2 SD (30.52%) lower when compared to the reference American population. Since the standard DEXA machines use Caucasian reference values, naturally, greater proportion of Indian population will be classified as osteoporotic than the western counterpart. This explains higher prevalence of osteoporosis in cross sectional studies carried out in the subcontinent.

In the present study, high proportion of osteoporotic individuals were in their 6^{th} & 7^{th} decade of life. 60% of osteoporotic individuals were in their 6^{th} & 7^{th} decade of life. Senile and postmenopausal patients form the bulk of osteoporotic individuals as apparent from this study. With increasing life expectancy in India, the number of population at risk of osteoporotic fractures is also expected to increase with consequent social and economic impacts.

Age correlated negatively with bone mineral density measurements at both spine and hip bone density measurements in our study with statistically significant p values. Thus with increasing age, the bone mineral density progressively decreased irrespective of the site of measurement. Similar negative correlation of age with bone mineral density was observed in other cross sectional studies done by Neelam Aggarwal et al [9].

High prevalence of osteoporosis was found in underweight patients and least among obese patients. Accordingly on correlation study it was found that increasing BMI positively correlated with bone mineral density at both hip and spine with statistically significant p values. Higher the BMI, higher was the spinal & femoral bone mineral density. Similar positive correlation of BMI with bone parameters were shown in study done by Veena et al who studied bone status and its relationship to the nutritional status in Indian women from a low-income group [11]. This observation reinforces the contribution of these anthropometric parameters like height, weight and BMI on bone mineral

density. Better the nutritional status of an individual, better will be the bone mineral density. Other reason for this observation may be that DEXA being a projectional technique of calculating bone mineral density, three dimensional objects are analyzed in two dimension. DEXA provides areal bone mineral density, in units of grams/cm^2, the denominator being area of bone. It is not a volumetric density and depth of the bone is not accounted. Given two bones of similar volumetric bone mineral density, the smaller bone will have a lower areal BMD than the larger one since the influence of bone thickness is not factored. Obese individuals having larger size of vertebrae will have higher bone mineral density than leaner individuals. This difference may be attenuated if true volumetric measurement techniques are utilized.

Though, there may be varying degrees of correlation between bone mineral density at different anatomical sites, it is difficult to predict bone density at a skeletal site by measurement at another site. Thus discordance in bone density readings at any two skeletal sites is often observed phenomenon. T score discordance is a phenomenon where T score of a given patient differs from one key measurement site to another. Various studies have looked into prevalence of discordance in T score classification in the cross section of population and their impact on management of osteoporosis. In our study the prevalence of major discordance was 5.6% and minor discordance was seen in 44.6% of participants.

The results are in agreement with similar studies on discordance. Woodson G reported a prevalence of 5% for major discordance and 39% for minor discordance in his study [12]. In a retrospective study, El Maghraoui et al reported major discordance in 4% and minor discordance in 41% of study population in Morocco. Moayyeri et al reported a similar prevalence of discordance in a subset of Iranian population. Out of total 4188 study population, major discordance was observed in 2.7% and minor discordance was observed in 38.9% of participants. Studies on discordance are limited in Indian population. Meeta Singh et al did a study on post menopausal women undergoing bone mineral densitometry at a referral hospital in Hyderabad where they found major discordance in 16.7% of postmenopausal women and minor discordance in 34.8% [13].

CONCLUSION

T-score discordance between hip & spine is a prevalent finding among the population and physicians should expect such discordances in routine outpatient and develop appropriate strategy in approaching to these patients. Because of ease and speed of BMD measurements with modern DEXA with the consequent low radiation dose, there are no longer technical barriers to scanning both spine & hip to avoid under diagnosis of osteoporosis.

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