

Simple analysis of osteoporosis with Singh's Index – Can it help in predicting the type of fracture?

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Abstract

Introduction: Much of osteoporosis in India remains Undiagnosed. Forgetting about mortality and morbidity, proximal femur fracture can become an economic and social burden in ageing population in our country. Singh's Index can be used along with digital X-Ray in evaluation of osteoporosis in proximal femur. This can aid in predicting the type of fracture in elderly individuals.

Aim: To evaluate osteoporosis and fracture pattern with Singh's Index in proximal femur fracture.

Null hypothesis: There exists no relationship between grade of osteoporosis (Singh's Index) and type of fracture in proximal femur fractures.

Materials and Methods: A retrospective study was carried out March 2017 to July 2019 in BIRRD (T) Hospital. Patients admitted with proximal femur fractures were evaluated radiological after fulfilling inclusion and exclusion criteria. They were graded with Singh's Index for osteoporosis and fracture type in proximal femur.

Results: A total of 263 patients were included into the study. There were 161 Intertrochanteric fractures, 86 fracture neck of femur and 16 Subtrochanteric fractures in all. There were five grades of Singh's Index were found from Grade I to V, where Grade VI and VII were not found in the study.

Conclusion: Null hypothesis remains rejected.

Keywords: Osteoporosis, Singh's Index, Intertrochanteric fracture, Fracture neck of femur, Subtrochanteric fracture, Proximal femur fractures, Fracture patterns.

Introduction

Osteoporosis in India mostly remains undiagnosed, unattended.

The reasons may be many

1. Large rural population with primary health care still in developing state, which may be not even enough to cater the basic local health needs.
2. Costly investigation for diagnosing osteoporosis like DEXA scan, not available freely in general public

Osteoporosis in elderly population results in fragility fractures like hip fractures, spine fractures, and distal end radius. Of these spine and hip fractures can result in not only mortality and morbidity, but also can have enormous economical and emotional breakdown in poor families in rural India.

Studies show that relation, (or) association between osteoporosis and proximal femur fractures. But there is paucity in literature regarding severity of osteoporosis and type of fracture which one could expect. Singh's index can be used as an inexpensive tool for diagnosing osteoporosis in India. This could also help in femoral neck fracture predictor.¹ At about 25% of patients between 40-60 years will have hip fractures due to osteoporosis quantified by Singh's Index. 75% elderly people with hip Fractures had Singh's Grade III osteoporosis pattern.² Moreover, use of digital X-Rays for estimating Singh's Index can decrease inter and intra observer variations.³⁻⁵ Intra-capsular fracture are increased in patients with moderate to severe osteoporosis and extra-capsular fractures are common in Borderline and mild osteoporosis.⁴ Osteoporosis Self-Assessment Tool for Asians (OSTA) and Singh's Index (SI)

is a good too with high predictive value for assessment of fracture risk in patient with Type 2 Diabetes Miletus.⁶ Measurements of osteoporosis through Singh's Index, calcar femorale, and femoral neck index in proximal femur fracture patients are consistent with Bone Mineral Density estimation with DEXA scan.⁷

With the paucity of literature and small sample sizes in the literature, we propose a Null Hypothesis.

Null hypothesis

Severity of osteoporosis (Singh's Index) cannot be used as a tool to predict the type of proximal femur fracture.

Materials and methods

A retrospective study was carried out on evaluating patients admitted into hospital from March, 2017 to July, 2019 in BIRRD (T) Hospital, with proximal femur fractures into hospital. Patient's hospital records were accessed mainly X-rays.

Inclusion criteria

1. Patients aged above 50 years
2. Patients with proximal femur fractures
3. Patients with X-Ray Pelvis with both hips in internal rotation antero-posterior view
4. Patients with history of domestic fall

Exclusion criteria

1. Patients aged below 50 years
2. Patients with history of trauma
3. Patients with other fractures other than proximal femur fractures
4. Patients without clear X-rays other than digital x-rays

In the X-Ray we estimated osteoporosis on the opposite proximal femur. Since the study involved only X-Ray evaluation, remaining data was not used like pre-operative morbidities, history of surgical treatment, post operative mobilization, and follow-up. Since all X-rays were digital and stored into our hard-disk sources, evaluation was easier for us. To prevent inter and intra-observer variations, evaluation was done with two different surgeons at two different times. Doubtful cases were discussed with both surgeons in case of disparity.

Evaluation was done in terms of

1. Type of fracture (Intertrochanteric, Subtrochanteric and fracture neck of femur) on the same side of fracture

2. Grade of osteoporosis (on the opposite side of proximal femur)

Results were tabulated and evaluated.

Statistical analysis

To evaluate the difference between the groups Pearson correlation test, chi-square test was used.

Observation and Results

263 patients were included into the study. There were 121 males and 142 females. Average age of patients in study is 68.24 years (range 50-95 years). All the patients were having pelvis with both hips in anterior-posterior views for dealing the osteoporosis.

Table 1: Showing sex and average age of patients in the study

Sex of patients	Male	Female	Total
No of patients	121	142	263
Average age of patients	68.56 years	67.97 years	68.24 years

Table 2: Showing grade of osteoporosis and number of patients, average age of patients, in total, male and female

Grade of osteoporosis	Total number of patients	Total (Average age of patients)	Male patients(Average age of patients)	Female (Average age of patients)
Grade I	63	68.96 years	67.81 years	70.61 years
Grade II	79	68.77 years	69.32 years	68.28 years
Grade III	78	68.73 years	69.69 years	68.02 years
Grade IV	32	65.53 years	65 years	65.80 years
Grade V	11	64.81 years	69 years	63.25 years
Pearson correlation values between osteoporosis grade and age of patients	R=-0.0987 R ² =00.97 P Value=0.1128	R=-0.9045 R ² =08181 P Value=0.035	R=-0.1611 R ² =0.026 P Value=0.7958	R=-0.976 R ² =0.9534 P Value=0.04

(p value <0.05)

Pearson co-relation test showed negative correlation between the grade of osteoporosis and age of patient. It meant that severity of osteoporosis increased with age of patient in the study. Though the value of R was variable in the table but the negative co-relation was clear. In all there were 161 Intertrochanteric fractures, 86 fracture neck of femur, and 16 Subtrochanteric fractures. Average age of patients was increased in Intertrochanteric fractures when compared to Subtrochanteric and fracture neck of femur (Table 3).

Table 3: Type of fracture, number of fractures and average age of patients

Type of Fracture	No. of fractures	Average age of Patients
Intertrochanteric fracture	161	69.33 years
Subtrochanteric fracture	16	67.62 years
Fracture neck of femur	86	66.33 years

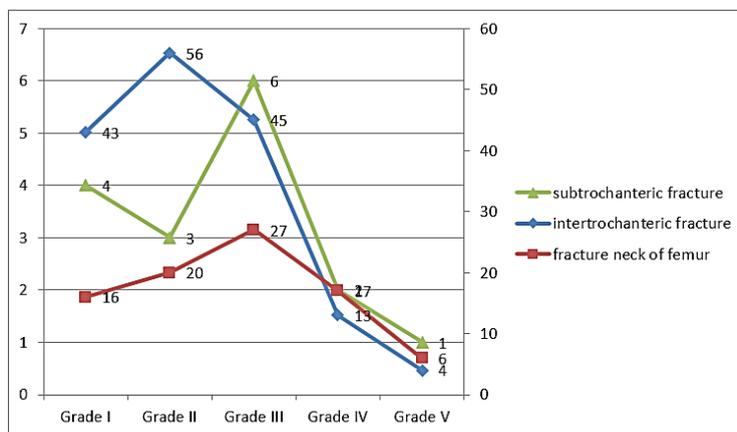


Fig. 1: Line with markers showing trend in fractures with change in Grade of osteoporosis (Singh's Index)

Chi-square test was not significant when all three fractures were evaluated separately, probably due to nominal values of Subtrochanteric fractures. But became significant when fractures were divided into Intracapsular (fracture neck of femur) and extra capsular fractures (inter and Subtrochanteric fractures).

Table 4: Showing chi-square test values between Intracapsular and extra-capsular fractures

Osteoporosis (Singh's Index) ¹³	Extra-capsular fractures	Intracapsular fractures
Grade I	47	16
Grade II	59	20
Grade III	51	27
Grade IV	15	17
Grade V	5	6

(Chi-square value – 12.0655 P Value -0.01687 p value<0.05)

We divided grades of osteoporosis into three groups by merging the grades of osteoporosis for statistical evaluation to know the significance through the chi-square test, which turned to be positive.

Table 5: Showing osteoporosis grading and no number of fractures in each group

Bone Quality	Singh' Index	Extra-capsular fractures	Intra-capsular fractures
Osteoporosis	Grade I and Grade II	106	36
Osteopaenia	Grade III and Grade IV	66	44
Near normal bone	Grade V and above	5	6

(Chi-square value-8.5328 P Value-0.014 p value<0.05)

Discussion

Osteoporosis a condition with decrease bone mass, micro architectural deterioration of bone, which leads to fragility fractures.⁸ Low Bone Mineral Density, is important risk factor of proximal femur fractures. India is a country with greater billion people, youngest population with good work force. In later years to come it will be osteoporosis capital in world. Forget about the costlier investigations, most of the rural population does not even have access to basic amenities at primary health care level, which is still in developing state. Diagnosing osteoporosis as per WHO requires DEXA scan which might not be available to rural population because of cost implications. Presently digital x-rays are available in B-grade towns in India which could be of good help in diagnosing osteoporosis. Though there is discrepancy in diagnosing osteoporosis through Singh's Index with normal X-Rays, but it appears to decrease in digital x-rays.³

Femur bone has two parts, cortical and cancellous. Outer layer of femur is cortical, withstands most of forces and movements. Cancellous bone is enclosed by cortical bone mainly absorbs shock energy produced in walking and running.⁹ Intracapsular fractures are seen in patients with long and narrower femoral neck.¹⁰ Indians have small head, short and broad neck of femur when compared to Western populations.^{11,12} Similarly good bone quality can result in stable extra-capsular (Intertrochanteric) fractures in patients above 60 years.¹³ Experimental research shows that Intracapsular fractures are common in femurs with low mechanical strength.¹⁴ We have more extra-capsular fractures (177) than Intracapsular fractures in our study. Based upon the above studies we do infer that short and broad neck of femur, in Indian populations might have resulted in more extra-capsular fractures than Intracapsular fractures here.

In our study 263 patients were present, with an average age of 68.24 years. Most proximal femur fractures were found in Grades II and III, with 79 and 78 patients respectively. Majority of our fractures were extra-capsular (177 out of 263). Average Singh's Index was 2.42/6 in our study, with lesser difference between male (2.2/6) and

female (2.6/6) populations. The difference between extra-capsular (2.27/6) and Intracapsular (2.73/6) was comparable.

In study with 87 patients, 46 men and 41 females, there were 45 intra-capsular and 42 extra-capsular fractures. Average age of the patients was 65.82 years in the study. Most of fractures were observed in Grade III (Singh's Index). It also shows Intracapsular fractures are common in grades I and II, while extra-capsular fractures in grade III and above.⁴

Scarlet M in his study of 284 patients had 2.6/6 as an average Singh's Index. This was male (1.6/6) and female (1.3/6) populations over the age of 90 on comparison of 3.7 and 3.2 at the 60-69 years respectively. Average age of patients was 60 years. He had 154 extra-capsular fractures and 130 intra-capsular fractures. He proposed that patients with lower Singh's index may be extra-capsular fractures (2.34/6 in extra-capsular on comparison with Intracapsular 2.55/6).¹⁵

Table 6: Showing comparison factors among three studies

Comparison factors	Our study	Supradeeptha et al ⁴ study	Scarlet M study ¹⁵
Sample size	263 patients	87 patients	284 patients
Male /female	121/142	46/41	
Extra-capsular/intra-capsular fractures	177/86	42/45	154/130
Most of proximal femur fractures in Singh's Index	Grade II/III (79/78)	Grade III	
Intracapsular fractures	Statistically in Grade III and Grade IV	Grade I and II	High Singh's Index (Osteopaenia)
Extra-capsular fractures	Grade I and II	Grade III and above	Low Singh's Index

Our study findings were similar with Scarlet M Study but contradictory with Supradeeptha et.al, study in the grade of osteoporosis and fracture type.^{4,15}

Most of other studies show relevance of osteoporosis with proximal femur fractures in total, but cannot define the type of fracture in regard to severity of osteoporosis. There are other factors that do influence fracture i.e, age of patients, severity of fall, height of fall, position of patient during the fall etc.

At the end we reject Null hypothesis and propose, that there exists a strong relationship between grade of osteoporosis and type of fracture in proximal femur. Our study findings also present osteoporosis (Singh's Grade I and II) results in extra-capsular fractures and Osteopaenia (Grade III and IV) results in Intracapsular fractures.

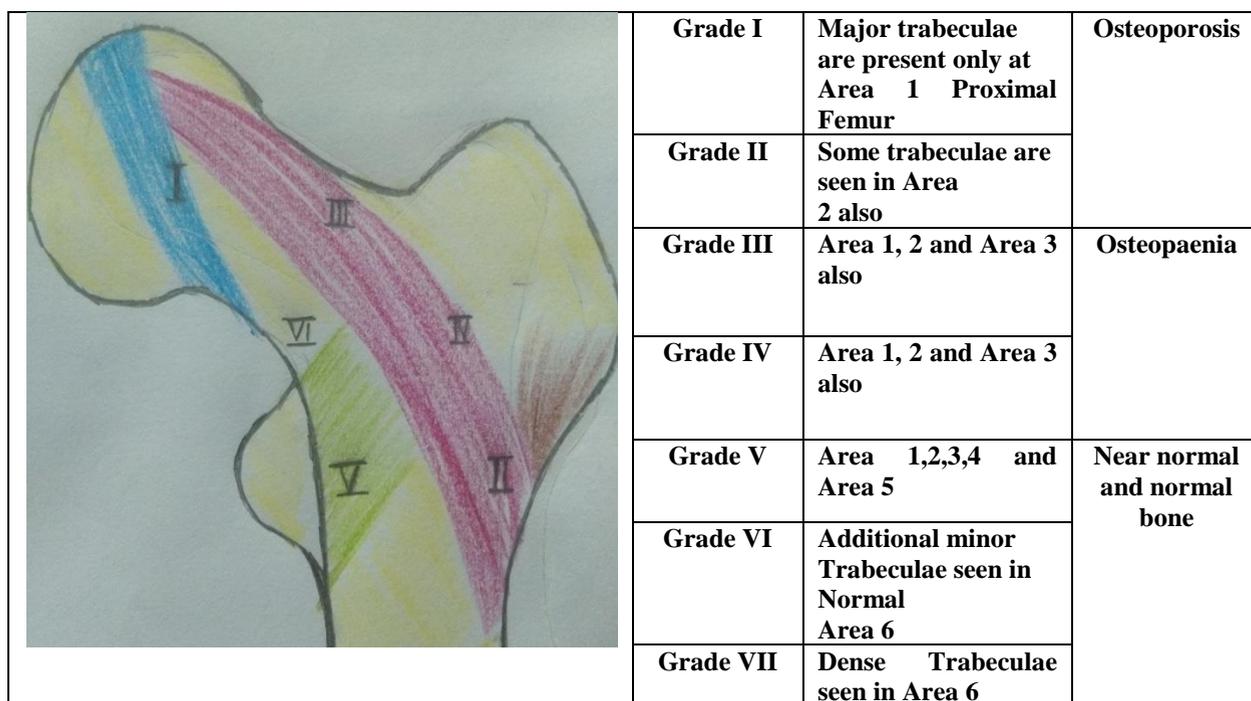


Fig. 2: Showing Singh's Index¹⁵ grading



Fig. 3



Fig. 4

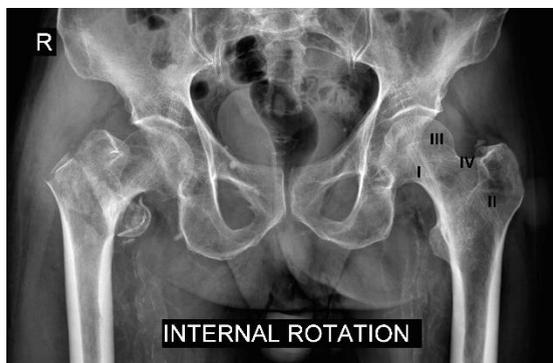


Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10

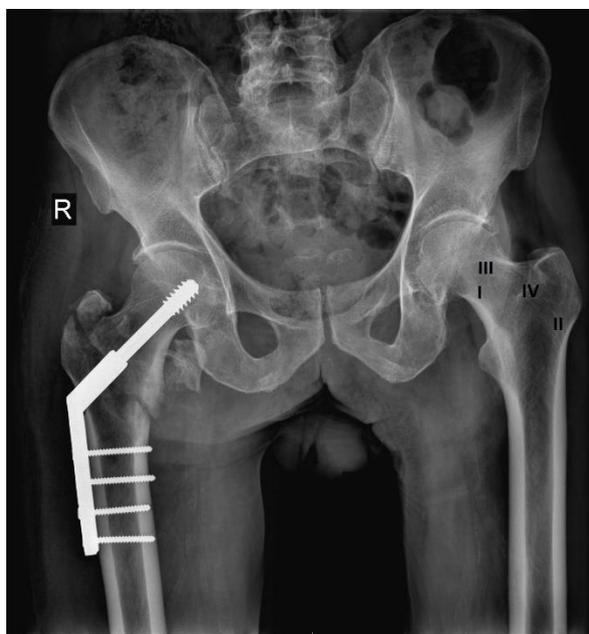


Fig. 11

Conclusion

Finally we infer that

1. Grade of osteoporosis influences the type of fracture in proximal femur (Table 4).
2. Grade osteoporosis increases with age of patients (Table 3).
3. We predict that severe osteoporosis can result in Intertrochanteric fractures to a larger extent, followed by fracture neck of femur. Osteopaenia can result in fracture neck of femur more than Intertrochanteric fractures (Table 5).

We also further see the requirement of studies with larger sample sizes to know whether this occurs by chance or natural trend.

Source of funding

None.

Conflict of interest

None.

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