

ANALYSIS OF SINGH'S INDEX FOR OSTEOPOROSIS IN PATIENTS WITH NECK OF FEMUR AND INTERTROCHANTERIC FRACTURE: AN AMBISPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

The Singh Index is a radiographic evaluation of the architecture of the proximal femur, but its role in hip fracture patients is still unclear. This study aimed to determine the Singh's Index grades and their correlation with demographic factors and fracture pattern. A total of 77 patients (40 years old or older) with low-energy fractures of the femoral neck or intertrochanteric region were recruited for an ambispective observational study. The contralateral unfractured proximal femur was compared with Singh's Index on AP pelvis X-rays. Grade distributions and associations with age, sex, comorbidities, and fracture pattern were analyzed. Grade III predominated (51.95%), followed by Grade II (28.57%), Grade IV (18.18%), and Grade V (1.30%). No patients had Grade I or VI. The number of women who participated was 57.14% and the proportion of more than 60 years was 83.12%. Intertrochanteric fractures were the most common type of fracture, representing 70.13% of injuries. In reported analyses, no association between Singh's Index grade and age, sex, comorbidity category, and fracture pattern were statistically significant. The most frequent radiographic classification was III and did not differ significantly between the subgroups studied. The Index proposed by Singh may be helpful to describe trabecular patterns observed on routine radiographs, but caution is advised when using it for diagnostic interpretation, and it needs additional densitometric validation. The small sample size and small numbers in each category further restrict inferences.

KEYWORDS: Singh's Index; Osteoporosis; Femoral Neck Fracture; Intertrochanteric Fracture; Trabecular Architecture

1. INTRODUCTION

Osteoporosis is a systemic disease of the skeleton with a decrease in bone strength and a greater risk of fragility fractures. In older persons, the impact is of particular concern as fractures of the proximal femur often led to reduced mobility, loss of independence and significant health care needs. Diagnosing osteoporosis in India is a challenge due to the limited access to specialized facilities for diagnostic purposes in health facilities. National guidelines highlight the importance of early identification of skeletal fragility and proper assessment after fracture as well as fracture prevention (Bhadada et al., 2021; Sen et al., 2025). Hip fractures are also widely acknowledged as key events that need to be assessed, treated, rehabilitated and prevented in the long term as guided by international guidance (Chandran et al., 2026).

There are two clinically important patterns of injury to the proximal femur: the femoral neck fracture and the intertrochanteric fracture. Both are common conditions that happen in older people after low-energy trauma but have differing anatomical and care characteristics. There is significant evidence of international variation in the incidence of hip fracture, the way it is managed and mortality, as is seen in population-based research, highlighting the need for evidence from other clinical settings (Sing et al., 2023). A fragility fracture should not only be treated in the acute setting but should also be evaluated for underlying skeletal health. Modern guidelines call for a systematic assessment of osteoporosis and personalised prevention rather than seeing the fracture as a standalone event (LeBoff et al., 2022; Snodgrass et al., 2022).

The measurement of bone mineral density (BMD) by dual-energy X-ray absorptiometry is a key element in the diagnosis of osteoporosis but may not be readily available as part of the routine assessment of patients admitted with acute hip fracture. In addition to bone density measurements, clinical risk factors for fracture can be added to clinical risk assessment tools. For instance, the Fracture Risk Assessment Tool (FRAT) can estimate future fracture risk and inform future testing and treatment (Schini et al., 2024). However, fracture risk is not only a single measurement, and the guidance is increasingly stressing the incorporation of clinical characteristics, previous fractures and skeletal evaluation in the plan to prevent future fractures (Morin et al., 2023; Cosman et al., 2024).

In patients with suspected proximal femoral fracture, plain pelvic radiographs are obtained routinely and can be helpful to assess trabecular architecture that is visible. Singh's Index is the traditional six-grade classification system that is based on progressive loss of characteristic trabecular groups in the proximal femur. The higher grades are relatively well-

preserved trabecular patterns, while the lower grades represent a more widespread radiographic depletion of the trabeculae. The method does not require any special bone density measurements, and this could make it desirable in locations that are not equipped for advanced bone density measurement. The radiographic appearance, however, depends on the quality of the radiographs, patient positioning, and the interpretation of the image and the use of the index should not be considered an automatic replacement for quantitative assessment of bone density.

The diagnostic utility of Singh's Index is still questionable. A systematic review identified the need to be cautious about using the index for the diagnosis of osteoporosis, since it was found to be comparable with dual-energy X-ray absorptiometry (Ghalenavi et al., 2024). Studies that compared plain radiographic features with densitometric data have also considered the need to evaluate the clinical usefulness of these in addition to inferring diagnostic equivalence (Ilyas & Ipci, 2023). There has also been renewed interest in automated classification of Singh's Index on hip radiographs, as well as emphasising the need for reproducible interpretation (Kalavakonda et al., 2024), again highlighting a focus on trabecular grading approach.

Although the Singh's Index grades have been used for some time, the distribution of the grades among patients who present with different patterns of proximal femoral fractures should be described in local clinical populations. The skeletal fragility may vary according to age and sex, and femoral neck and intertrochanteric fractures are located in different anatomical areas. These characteristics should be analyzed with radiographic grades to gain insight into the patterns observed, but not to imply that specific grades lead to specific fracture types. For this ambispective observational study, patients aged ≥ 40 years who were presented with a low-energy fracture of the femoral neck or intertrochanteric regions were recruited, with the opposite non-fractured proximal femur used for the Singh's Index measurement. This method allows for a descriptive description of the variation in radiographic trabecular patterns in the population of fractures studied and could aid in posing questions for future studies that integrate the agreement of observers and densitometric validation.

Objectives

- To outline the distribution of Singh's Index grades of patients presenting with a proximal femoral fracture.
- To investigate the correlation between the Singh's Index grades and age and sex of the patient.
- To assess associations between Singh's Index grades and fracture type and laterality.

2. MATERIALS AND METHODS

2.1. Study Design and Setting

The study was conducted as an ambispective observational study in the Department of Orthopaedics at Mahatma Gandhi Medical College and Research Institute, Pondicherry, India for a period of 5 months from December 01, 2025, to April 01, 2026. The aim of the study was to assess the distribution of Singh's Index grades in patients with femoral neck and intertrochanteric fractures and to explore the association between the grade with the demographic and fracture-related features. A single-group observational design was used and patients who satisfied the set eligibility criteria were used. The extent of trabecular changes in patients with low-energy proximal femoral fractures was estimated by the Singh's Index on radiographs of the proximal femoral trabecular architecture.

2.2. Study Population and Eligibility Criteria

Patients were selected for the study if they were aged 40 and over and presented to the Department of Orthopaedics with a clinically and radiologically confirmed femoral neck fracture or Intertrochanteric fracture. The fractures had occurred after a low-energy trauma (fall from standing height) and a good-quality AP pelvis pre-fracture radiograph was available for assessment of the fracture. Pathological fractures due to causes other than osteoporosis and patients who had previous hip surgery or hip fracture were excluded. To meet the study population eligibility criteria, a patient with a fractured proximal femur was required to have an X-ray performed within one day of the injury. These study population eligibility criteria have been applied to get an X-ray within 1 day of fracture within the proximal femur and to evaluate the association between proximal femoral trabecular pattern and fracture characteristics.

2.3. Sample Size Determination

The sample size was calculated as 27.5%, which was the proportion of fractures reported in the original study protocol. A significance level ($\alpha = 0.05$) and absolute precision ($d = 0.10$) were considered. Sample size estimation reported in the thesis indicated that a sample size of 77 participants was needed. In view of this, 77 eligible patients were enrolled in this study, and the study was terminated when the required sample size was reached.

2.4. Clinical Data Collection and Fracture Classification

After confirmation of eligibility and informed consent, the data collection form was used to collect the demographic and clinical data in a structured manner. Patient age, sex and mechanism of injury were collected. A clinical examination and radiograph confirmed the diagnosis of a proximal femur fracture. Fractures were categorized based on the anatomic site of fracture as intracapsular fractures (femoral neck fractures), and extracapsular fractures (intertrochanteric fractures). The participants' fracture classification was recorded for each patient and the distribution of Singh's Index grades was subsequently examined for each of the two categories of anatomical fracture.

2.5. Radiographic Assessment

The radiographic evaluation was made using standard AP pelvograms of both hip joints, taken preoperatively. Singh's Index grading was carried out in the contralateral (unfractured) proximal femur to evaluate trabecular architecture without the direct effect of fracture. The assessment was directed towards the visibility, continuity and structural integrity of the major trabecular groups of the proximal femur. The AP pelvic films were assessed for radiographic grade by the principal investigator. Each participant was marked according to the assigned Singh's Index grade and then compared with the various demographic parameters and fracture types.

2.6. Singh's Index Grading

The conventional six-grade radiographic classification of progressive loss of proximal femoral trabecular architecture was used to assess Singh's Index. Grade I was at the most severe stage of trabecular loss, and there were only thin primary compressive trabeculae visible. In grade II, the primary compressive trabeculae remained, and the other trabeculae were almost completely resorbed. Grade III was thinning and discontinuity of primary tensile trabeculae; Grade IV was thinning of primary tensile trabeculae but no discontinuity. Grade V had both primary tensile and compressive trabeculae visible and a prominent Ward's triangle. Grade VI refers to preservation of all the trabecular groups with normal thickness. The radiographic trabecular depletion was more evident with lower Singh's Index grades, while the relatively preserved trabecular architecture was shown with higher grades. The Index of Singh was considered as an ordinal radiographic variable and subsequently analysed statistically.

2.7. Study Variables and Outcome Measures

Study variables were age, sex, Singh's Index grade and anatomical fracture type. Age was considered a quantitative variable, while sex and fracture type were categorical variables. The Singh's Index grade was considered as an ordinal qualitative variable, indicative of the appearance of the proximal femoral trabeculae. Age, sex and Singh's Index grade were categorised as independent variables and the type of PF fracture was treated as the dependent variable in keeping with the original analytical framework. The conclusion was a correlation of Singh's Index grading with fracture type. The distribution of demographic characteristics and Singh's Index grades was also assessed for characterisation of the study population.

2.8. Statistical Analysis

The data collected were tabulated on the Microsoft Excel and analyzed with the aid of statistical software. Demographic, clinical and radiographic characteristics were summarized using descriptive statistics. The quantitative variables were presented in the form of mean and SD, and the categorical variables were presented in the form of frequency and percentage. The distribution of Singh's Index grades was analyzed in the study population and based on the anatomical classification of proximal femoral fracture. The Chi square test was used for comparing fracture type with Singh's Index grades. The p value was used and was set at < 0.05 for statistical significance. The analysis was aimed at finding statistical relationships in the observed study population.

2.9. Ethical Considerations

The study received ethical clearance from Mahatma Gandhi Medical College and Research Institute Institutional Human Ethics Committee prior to its start. Informed consent was obtained for patients with the defined eligibility criteria. The approved observational study protocol was followed to gather clinical information and to collect radiographic information. After recruiting the required 77 participants, the study was finalized.

3. RESULTS

3.1. Demographic Characteristics of the Study Population

77 patients with proximal femoral fractures were diagnosed by X-ray. The age distribution showed that most participants were in older ages (61–70 and 71–80 with 29.87 and 32.47 respectively). The age group of 81–100 years had the highest number of patients, comprising 20.78% of the population, while the age group of 41–50 years had the lowest number of patients (6.49%). Sixty-four participants (83.12%) were older than 60 years. Female patients comprised 57.14% of the patients, and male patients comprised 42.86% of the patients. Table 1 shows the demographic distribution, and the age and sex distribution is represented in Figure 1.

Table 1. Demographic characteristics of patients with proximal femoral fractures (N = 77)

Characteristic	Frequency (n)	Percentage (%)
Age group (years)		
41–50	5	6.49
51–60	8	10.39
61–70	23	29.87
71–80	25	32.47
>80	16	20.78
Sex		
Female	44	57.14

Male	33	42.86
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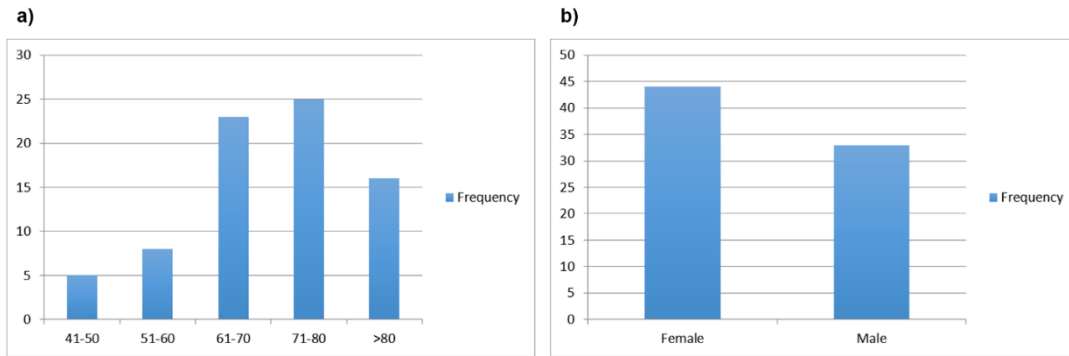


Figure 1. Demographic distribution of patients with proximal femoral fractures (N = 77). a) Age-group distribution showing the highest frequency among patients aged 71–80 years. b) Sex distribution showing a predominance of female patients

3.2. Anatomical Distribution and Laterality of Proximal Femoral Fractures

The intertrochanteric fractures occurred more frequently than the femoral neck fractures, with 54 (70.13%) and 23 (29.87%) cases, respectively. A total of 45 patients (58.44%) were found with fractures on the right side, while 32 patients (41.56%) were found with fractures on the left side. The intertrochanteric fracture type was most common (32 cases, 41.56%), with left-sided intertrochanteric fracture coming second (22 cases, 28.57%). The right side had 13 patients (16.88%) with a fracture of the femoral neck, and the left side had 10 patients (12.99%). Table 2 and Figure 2 provide an overview of the anatomical and laterality distributions.

Table 2. Distribution of proximal femoral fractures according to anatomical type and laterality

Fracture type	Right side, n (%)	Left side, n (%)	Total, n (%)
Intertrochanteric fracture	32 (41.56)	22 (28.57)	54 (70.13)
Femoral neck fracture	13 (16.88)	10 (12.99)	23 (29.87)
Total	45 (58.44)	32 (41.56)	77 (100.00)

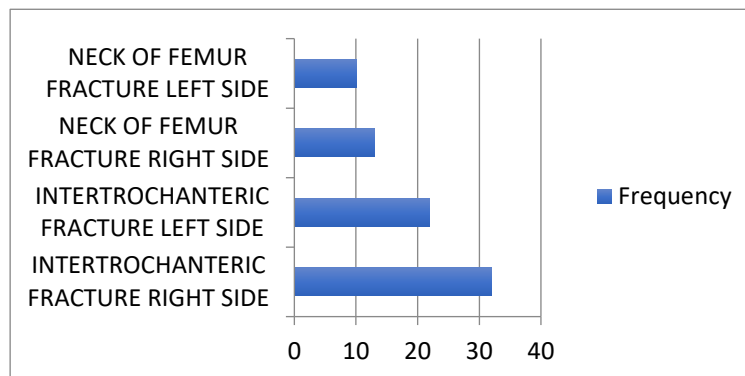


Figure 2. Distribution of femoral neck and intertrochanteric fractures by anatomical side

3.3. Distribution of Associated Comorbidities

During the clinical examination, it was found that 40.26% of patients (n=31) did not have any other documented health issues. In participants who had comorbid conditions, the most common was diabetes mellitus with hypertension (17 patients, 22.10%). Diabetes mellitus alone was reported in 13 patients (16.85%) while hypertension alone was found in 11 patients (14.29%). The other conditions that occurred much less frequently were seizure disorder, hypertension in the presence of hypothyroidism, coronary artery disease and a combination of diabetes mellitus, hypertension and coronary artery disease. Comorbidities are summarized in Table 3.

Table 3. Distribution of comorbidities among patients with proximal femoral fractures

Comorbidity	Frequency (n)	Percentage (%)
None	31	40.26
Diabetes mellitus and hypertension	17	22.08

Diabetes mellitus	13	16.88
Hypertension	11	14.29
Hypertension and hypothyroidism	1	1.30
Coronary artery disease	1	1.30
Seizure disorder	2	2.60
Diabetes mellitus, hypertension, and coronary artery disease	1	1.30
Total	77	100.00

Percentages are calculated from the reported frequencies and may differ slightly from the rounded percentages in the original tabulation.

Radiographic examination showed that Singh Grade III predominated with 40 patients (51.95%) followed by Singh Grade II with 22 patients (28.57%). Fourteen patients (18.18%) were found to have Grade IV and one patient (1.30%) Grade V. There were no participants in Grade I or Grade VI. The combined Grades II and III (62 patients, 80.52%) showed that most of the patients had only the lower grade radiographically according to the Singh classification. Table 4 and Figure 3 show the distribution of Singh's Index grades.

Table 4. Distribution of Singh's Index grades among patients with proximal femoral fractures

Singh's Index grade	Frequency (n)	Percentage (%)
Grade I	0	0.00
Grade II	22	28.57
Grade III	40	51.95
Grade IV	14	18.18
Grade V	1	1.30
Grade VI	0	0.00
Total	77	100.00

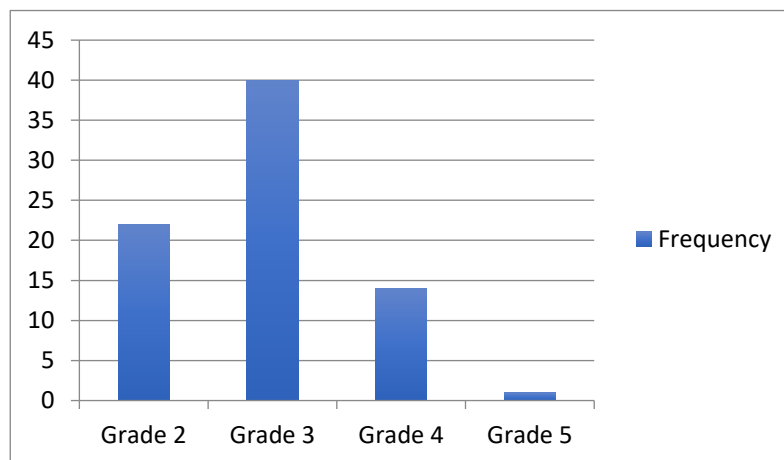


Figure 3. Frequency distribution of Singh's Index grades in the study population

3.5. Association Between Age and Singh's Index Grade

The Singh's Index grades showed a variation across age groups. The most common grade was III in patients aged 41-50 years, 51-60 years, 61-70 years and 71-80 years. There were 12 patients in the 61-70-year age group and 12 patients in the 71-80-year age group who had Grade III. Grade II was more commonly seen in the older age groups, with nine patients in the 71-80 age group and eight patients over 80 years of age. There was only one Grade V observation in 61-70 years. The reported Chi-square value was 13.833 and the p value 0.611 which shows no significant association between the age group and Singh's Index grade. The distribution of the ages is shown in Figure 4 and the frequencies in Table 5.

Table 5. Association of age group and sex with Singh's Index grade

Characteristic	Grade II	Grade III	Grade IV	Grade V	Total
Age group (years)					
41-50	0	4	1	0	5
51-60	0	5	3	0	8
61-70	5	12	5	1	23
71-80	9	12	4	0	25

>80	8	7	1	0	16
Sex					
Female	13	24	7	0	44
Male	9	16	7	1	33

Reported age-group comparison: $\chi^2 = 13.833$, $p = 0.611$. Reported sex comparison: $\chi^2 = 1.792$, $p = 0.6166$.

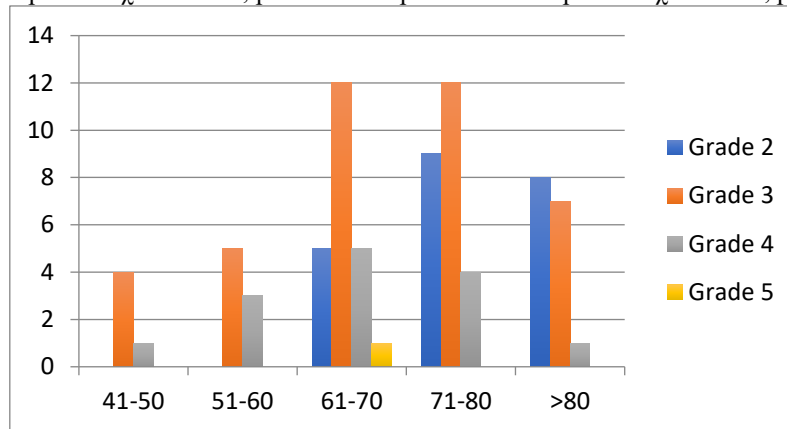


Figure 4. Distribution of Singh's Index grades across patient age groups

3.6. Association Between Sex and Singh's Index Grade

Females had the most common classification of Grade III (24/44) followed by Grade II (13/44) and Grade IV (7/44). The same distribution was seen among males in which 16 of 33 patients had Grade III, nine had Grade II and seven had Grade IV. The one Grade V observation was in a male participant. The chi-square value was reported as 1.792 and p value as 0.6166 showing no statistically significant association between sex and Singh's Index grade. The distribution of sex is reported in Table 5 and Figure 5.

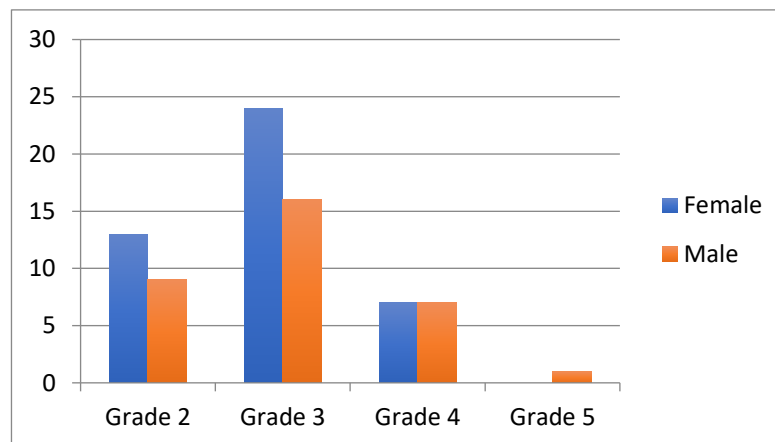


Figure 5. Distribution of Singh's Index grades according to sex among patients with proximal femoral fractures (N = 77)

3.7. Association Between Comorbidities and Singh's Index Grade

Singh's Index grades were distributed across the comorbidity categories and showed a higher prevalence of Grade III in some of these groups. Of those patients without known comorbidities, 18 were considered Grade III, eight Grade II, four Grade IV and one Grade V. Grade III was detected in 8 patients and Grade II in 7 patients with co-existent DM & HBP and Grade IV in 2 patients. In patients with diabetes mellitus alone, there were six patients with Grade III, and four and three with Grade IV and Grade II, respectively. The patients who had hypertension alone had four cases in each of Grades II, IV, and three cases of Grade III. The Chi-square reported value was 13.11 with a reported p value of 0.992, meaning that there was no statistically significant association between the categories of comorbidity and Singh's Index grade.

3.8. Association Between Fracture Pattern and Singh's Index Grade

Table 6 shows the distribution of Singh's Index grades based on fracture pattern and laterality of the fractures. Grade III was the most common, found in 11 patients of the left-sided intertrochanteric fractures, Grade II in seven patients and IV in four patients. Likewise, in right-sided intertrochanteric fractures, the majority of patients were Grade III (17 patients) with 12 patients being Grade II and three patients having Grade IV. There were five Grade III, four Grade IV, and one Grade II fracture type for left-sided femoral neck fractures. Seven cases were Grade III, three cases Grade IV, two cases

Grade II, and one case Grade V, all of which were left-sided. In general, Grade III was the most common grade in all four fracture types, and Grade V was seen in only one patient with a right femoral neck fracture. The Chi-square analysis reported showed that there was no significant association between fracture pattern and Singh's Index grade ($\chi^2 = 12.091$, $p = 0.438$). The results of the present study show that, there was no significant difference in the distribution of Singh's Index grades between fracture categories studied.

Table 6. Association between fracture pattern, laterality, and Singh's Index grade

Fracture pattern	Grade II	Grade III	Grade IV	Grade V	Total
Intertrochanteric fracture, left	7	11	4	0	22
Intertrochanteric fracture, right	12	17	3	0	32
Femoral neck fracture, left	1	5	4	0	10
Femoral neck fracture, right	2	7	3	1	13
Total	22	40	14	1	77

3.9. Representative Case Illustrations

A representative range of proximal femur trabecular patterns was presented in radiographic cases. Case 28 and Case 30 were both defined as Singh's Index Grade III (thinning & discontinuity of the primary tensile trabeculae). Further examples of Grade III were described in Cases 59 and 63, which show the radiographic features of this common category. The radiographic examples of Cases 28 and 30 are marked as Figure 6.

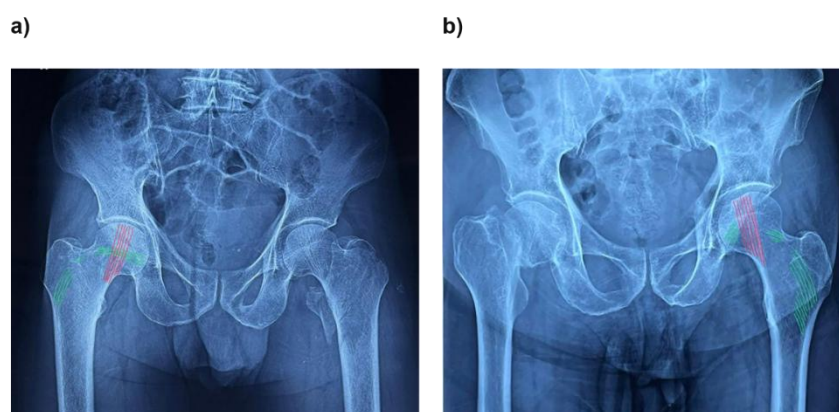


Figure 6. Representative anteroposterior pelvic radiographs demonstrating Singh's Index Grade III. a) Case 28 and b) Case 30, showing radiographic trabecular patterns classified as Grade III

The other representative cases showed variation in trabecular preservation from Singh's Index grades. Case 6 showed a Grade V with almost all primary tensile and compressive trabecular groups preserved and a prominent Ward's triangle. In case 29, the primary tensile trabeculae were thinned without experiencing any discontinuity, which was described as Grade IV. In case 52 and case 32, the primary compressive trabeculae were preserved and there was a significant decrease in the number of remaining trabecular groups (Grade II). These representative appearances are considered to be Figure 7.

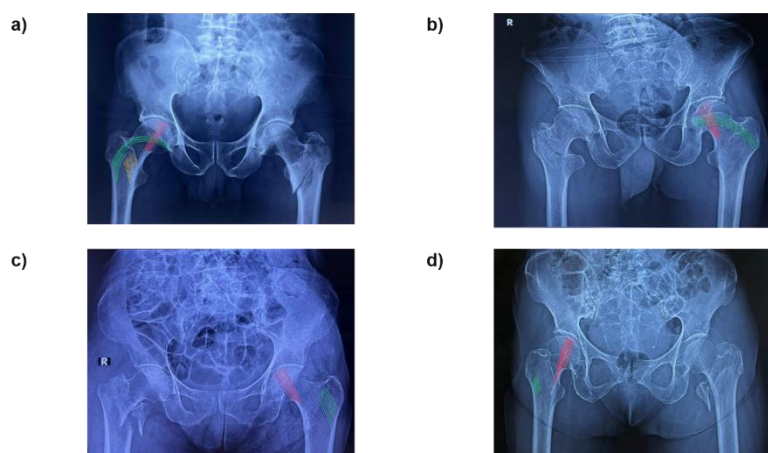


Figure 7. Representative radiographic appearances of Singh's Index Grades II, IV, and V. a) Case 6, Grade V; b) Case 29, Grade IV; c) Case 52, Grade II; and d) Case 32, Grade II

3.10. Summary of Results

This study enrolled 77 patients with low energy proximal femoral fractures, most of whom were older adults and female. Intertrochanteric fractures formed 70.13% of cases, and were more frequently on the right side than left side. Most participants (80.52%) had Singh's Index Grade III, followed by Singh's Index Grade II. The analyses of the distribution of Singh's Index grades showed no statistically significant relationship with age group, gender, comorbidity category or fracture pattern. The grade III classification was the most common classification in all of the main fracture and demographic subgroups. Overall, the results revealed the distribution of Singh's Index Grades II, III, IV, and V in patients with femoral neck and intertrochanteric fractures and showed that none of the clinical characteristics showed a statistically significant link with the grades. Representative radiographic cases showed the range of trabecular changes corresponding to Grades II, III, IV, and V of the Singh's Index.

4. DISCUSSION

In the present study, Singh's Index grading was assessed in 77 patients having femoral neck or intertrochanteric fractures. Grade III (51.95%) was most common, followed by Grade II (28.57%) and Grade IV and V were less common. The mean age was over 60 years, 57.14% of the cases were female and 70.13% of the cases were intertrochanteric fractures. No statistically significant relationship was detected between Singh's Index grade and age group, sex, comorbidity category or fracture pattern. These findings do not represent the diagnostic accuracy of Singh's Index or the likelihood of fractures occurring but rather trabecular appearances of a selected fracture population.

The proportion of older participants with fractures is in accordance with the general epidemiological significance of ageing as a risk factor for fracture. The incidence of age-related fractures has been recorded in population studies, but its distribution of incidence differs across healthcare systems and populations (Rupp et al., 2021; Núñez et al., 2025). In India, the clinical significance of proximal femoral fractures (PFFs) is also highlighted based on the demographic and prognostic factors (Mittal & David, 2025). This lack of significant age grade association however, should be interpreted as an indicator that trabecular deterioration is not related to ageing, and not as proof of the opposite. Sensitivity is reduced due to the small numbers within the younger age groups, the use of an ordinal scale and the unequal numbers of frequencies across the grades.

Although the numbers of women were majority, the Index distributions were not significantly different between sexes for Singh. This outcome is relevant to patients who already sustain fractures but does not give an estimate of fracture risk in the general population by sex. There are several factors that affect skeletal fragility, including the appearance of the bone, as well as muscle mass and other functional characteristics. Treated osteoporosis populations have reported associations between lean mass loss and fracture risk (Giangregorio et al., 2024). Dietary patterns have also been studied in relation to hip fracture risk, with some patterns not included in this investigation (Fa-Binefa et al., 2025).

The intertrochanteric fractures were more common than the femoral neck fractures and the right side was affected more. However, for all four fracture and laterality groups, Grade III was the most common rating. The nonsignificant association reported indicates that there is no clear difference between the distributions of Singh's Index by anatomical fracture pattern based on these data. Contralateral fracture research highlights the fracture risk of patients following the initial hip fracture but is not able to account for laterality in this group (Morris et al., 2025). Likewise, fracture patterns have been studied in other contexts, giving background information without substantiating these observations (Núñez et al., 2025).

The value of Singh's Index has been realised in the context of the commonly used pelvic radiographs. Its application in the decision-making process for treatment of femoral neck fractures has been recently studied (Jawale et al., 2026). However, radiographic grading is still a subjective measurement that is affected by both acquisition and interpretation of the image. When clinically warranted, bone density measurements using DEXA were shown to be important in populations at risk for femoral fractures (Ritter et al., 2024). Therefore, the results of this study should not be used to guide treatment decisions, especially when not validated with densitometry or in the absence of interobserver reliability. Radiographic classification is not the only implication in clinical aspects. There is a coordinated management of hip fractures in older adults (O'Connor & Switzer, 2022), which is emphasised in guidelines. Postoperative complications are documented in systematic reviews and quality indicators of care and mobilization are important (Goh et al., 2025; Paes et al., 2025a; Paes et al., 2025b). Limited resources can also impact pathways to services and treatment (Kiani et al., 2025). Although these outcomes were not evaluated in the present study, the findings highlight the importance of comprehensive bone health assessment and secondary fracture prevention among patients with hip fractures (Hosseinzadeh et al., 2026).

A few restrictions need to be highlighted. The data sample for the single centre was small, with only one patient in Grade V; this might lead to an underestimation of the conventional Chi square approximation. The significance tests thus reported must be confirmed by using proper exact or simulation-based tests. There was no DXA comparator or observer agreement analysis, nor were there outcomes available for prospective fractures. Furthermore, it is an observational design which does not allow causal inference. Regional and pandemic-era evidence indicates that hip fracture has a significant mortality and disability burden across settings (Harvey et al., 2024; Tripathy et al., 2021). The outcomes after non-operative treatment also show the complexity of these injuries when they occur (Winfield et al., 2025). Future multicentre studies should include standardized radiographic grading, densitometry, reliability testing, and longitudinal outcome measures in an attempt to determine if Singh's Index provides any clinically relevant information.

5. CONCLUSION

In this ambispective observational study, the relationship between Singh's Index grades and demographic features and fracture patterns was assessed in 77 patients with low-energy fractures of the femoral neck and intertrochanteric fractures.

Grade III was the most prevalent classification (51.95%), followed by Grade II (28.57%), Grade IV (18.18%), and Grade V (1.30%). A total of zero patients were graded as Grade I and VI. The majority of the participants were older than 60 years; 70.13% of them were women and 70.13% of injuries were intertrochanteric fractures. There were more fractures on the right side than on the left. No statistically significant correlation was found between Singh's Index grade and age group, sex, type of comorbidities or fracture pattern and laterality for the reported analyses. The results showed that the distribution of clinical subcategories did not show a different distribution in the radiographical grades, with the predominance of Grade III in all of the clinical subcategories analyzed. In the limited-resource setting, Singh's Index provides an objective description of proximal femoral trabecular architecture from routine hip radiographs, which offers an opportunity to assess and monitor hip structure. However, its qualitative nature, the small sample size (single centre), few grade categories and lack of densitometric validation limit the interpretation of the diagnosis. Further multicentre studies with a standardized grading system, assessment of observer reliability, dual-energy X-ray absorptiometry and statistical methods are required to determine its utility in the diagnosis of osteoporosis and fracture management.

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