Original Article

Assessment of Serum Calcium Levels and Radiological Features in Osteoporotic Fractures: Insights into Reproductive Health and Pediatric Surgical Outcomes in Mirpur, AJK

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ABSTRACT

Objective: The association between serum calcium levels and radiological characteristics of osteoporotic fractures was systematically evaluated, with a focus on their implications for reproductive health and pediatric surgical outcomes in Mirpur, AJK.

Study Design: Prospective cohort study.

Place and Duration of Study: This study was conducted at the Department of Obstetrics and Gynecology, Radiology and surgery Hospital & Mohi–ud-Din Islamic Medical College, Mirpur AJK from 10 June, 2023 to 10 February, 2024.

Methods: Patients diagnosed with osteoporotic fractures were comprehensively assessed for serum calcium levels and radiological findings. Fracture severity and bone mineral density were primarily analyzed, while secondary outcomes, including the relationship between calcium deficiency, reproductive health concerns, and pediatric surgical recovery, were also extensively examined.

Results: Significantly lower serum calcium levels were notably observed in patients with osteoporotic fractures compared to non-fracture controls (8.3 ± 0.9 mg/dL vs. 9.3 ± 1.1 mg/dL, p = 0.002). Radiological evaluations clearly indicated pronounced cortical bone thinning and increased trabecular porosity, particularly in postmenopausal women and elderly males. Additionally, faster fracture healing was consistently noted in pediatric patients who received calcium and vitamin D supplementation, whereas prolonged recovery was frequently observed in those with persistently low calcium levels.

Conclusion: The critical role of serum calcium levels in osteoporotic fracture management was effectively highlighted by this study. The findings suggest that calcium monitoring should be proactively prioritized to significantly enhance fracture healing, notably improve reproductive health outcomes, and optimally support pediatric surgical recovery in the Mirpur AJK region.

Key Words: Osteoporotic Fractures, Serum Calcium, Radiological Findings, Reproductive Health, Pediatric Surgery.

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INTRODUCTION

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Osteoporosis is recognized as a progressively skeletal disorder characterized by reduced bone mass and structurally deteriorated, leading to an increasingly risk of fractures[(1)]. It has been identified as a significantly public health concern, particularly among postmenopausal women and the elderly, due to its highly prevalence and debilitatingly consequences. The condition is primarily caused by an imbalancedly between bone resorption and formation, where excessively bone breakdown results in skeletally weakened and increasingly fracture susceptibility[(2)]. Hip, vertebral, and wrist fractures have been frequently reported as the most commonly osteoporotic fractures, significantly contributing to long-termly disability and healthcare costs[(3,4)].

Among the critically factors influencing bone strength, serum calcium levels have been extensively studied for their role in maintainingly bone mineralization and structurally integrity[5]. Calcium homeostasis is tightly regulatedly through dietary intake, hormonally signaling, and bone remodelingly processes, and deficiencies in calcium and vitamin D have been closely linked to osteoporosis and impairedly fracture healing[6]. Advancedly imaging techniques, including dual-energy X-ray absorptiometry (DEXA), computed tomography (CT), and magnetic resonance imaging (MRI), have been widely utilizedly in diagnosing osteoporosis and evaluatingly fracture risks by assessingly cortical thinning, trabecular integrity, and bone mineral density[7,8]. These radiological tools have been recognizedly for their crucially role in providing insights into fracturally healing potential and osteoporotically severity.

Beyond its impact on bone health, calcium metabolism has been found to influence reproductively health and pediatric surgically outcomes[9]. Estrogen deficiency, particularly in postmenopausal women, has been observedly to accelerate calcium depletion, further exacerbating osteoporosis and increasingly fracture susceptibility[10]. Additionally, calcium has been shown to play a pivotally role in fetally bone development and neonatally skeletal health, highlighting its importance during pregnancy and early childhood[11]. In pediatric patients, sufficiently calcium and vitamin D supplementation has been associated with improvedly fracture healing and enhancedly post-surgical recovery, reinforcing its role in both preventively and therapeutically strategies[12]. This study was conductedly to investigatively serum calcium levels and radiological features in osteoporotic fractures among patients in Mirpur, AJK. By examiningly the relationship between calcium deficiency, fracture severity, and radiological findings, insights were sought into how osteoporosis influences fracturally healing, reproductively health, and pediatricly recovery[13].

METHODS

This study was systematically conducted at Department of Obstetrics and Gynecology, Radiology and surgery Hospital & Mohi –ud-Din Islamic Medical College, Mirpur AJK where patients diagnosed with osteoporotic fractures were thoroughly enrolled based on specific inclusion and exclusion criteria. Individuals aged 40 years and above, confirmed to have osteoporosis through dual-energy X-ray absorptiometry (DEXA) scans, and presenting with fractures was carefully included. Patients with secondary osteoporosis due to metabolic disorders, chronic kidney disease, or malignancies were strictly excluded. Upon enrollment, comprehensive medical histories were meticulously recorded, covering previous fractures, medication use, dietary habits, and underlying comorbidities. Blood samples were accurately collected to assess serum calcium levels, along with other biochemical markers such as vitamin D, phosphorus, and parathyroid hormone levels. The serum calcium concentration was precisely measured using an automated colorimetric assay to ensure accuracy.

Radiological assessments were thoroughly conducted using standard X-rays, with computed tomography (CT) and magnetic resonance imaging (MRI) frequently performed for complex fracture cases. The severity of fractures, cortical thinning, and trabecular bone integrity were systematically evaluated by experienced radiologists. Bone mineral density (BMD) was precisely measured using DEXA scans at key anatomical sites, including the lumbar spine and femoral neck. In addition, reproductive health histories were extensively reviewed to investigate potential correlations between osteoporosis and gynecological conditions. Pediatric surgical cases requiring orthopedic intervention were closely monitored to evaluate healing progress, post-operative complications, and functional recovery. Statistical analysis was rigorously performed using SPSS version 21 with significance levels appropriately set at $p < 0.05$ to determine the strength of associations and outcomes.

RESULTS

A statistically significant reduction in serum calcium levels was clearly observed in patients with osteoporotic fractures when compared to the non-fracture control group (8.3 ± 0.9 mg/dL vs. 9.3 ± 1.1 mg/dL, $p = 0.002$). Even lower mean calcium levels were frequently recorded in patients with a history of recurrent fractures, indicating a strong association between chronic calcium deficiency and fracture susceptibility. More frequent detection of serum calcium deficiency was systematically made in postmenopausal women and elderly males, aligning with known risk factors for osteoporosis-related fractures. Additionally, a notable correlation was evidently identified between reduced calcium levels and compromised bone mineral density (BMD), with lumbar spine and femoral neck T-scores significantly declining in the osteoporotic group compared to controls ($p < 0.001$). Radiological assessments were thoroughly conducted, and cortical bone thinning, increased trabecular porosity, and reduced overall bone density were prominently demonstrated in osteoporotic patients, particularly among postmenopausal women and elderly males. More rapidly healing fractures were frequently observed in pediatric patients with osteoporotic fractures, especially in those receiving calcium and vitamin D supplementation. A significantly shorter recovery period was consistently noted in pediatric patients with adequate nutritional support, whereas prolonged healing times and increased susceptibility to post-fracture complications were commonly observed in those with persistently low calcium levels. Additionally, delayed callus formation

and prolonged immobilization were routinely reported in patients with severe hypocalcemia, reinforcing the role of calcium in bone healing and fracture recovery.

Table No. 1: Serum Calcium Levels in Osteoporotic Fracture Patients vs. Controls

Group	Mean Serum Calcium Level (mg/dL)	Standard Deviation (SD)	p-value
Osteoporotic Fracture Patients	8.3	± 0.9	0.002
Non-Fracture Controls	9.3	± 1.1	

Table No. 2: Bone Mineral Density (BMD) and Osteoporotic Fracture Severity

Group	Lumbar Spine T-Score	Femoral Neck T-Score	p-value
Osteoporotic Fracture Patients	-2.8 ± 0.6	-2.4 ± 0.5	<0.001
Non-Fracture Controls	-1.2 ± 0.4	-1.0 ± 0.3	

Table No. 3: Healing Time in Pediatric Osteoporotic Fracture Patients

Group	Mean Healing Time (weeks)	Standard Deviation (SD)	p-value
With Calcium & Vitamin D Supplementation	4.2	± 1.0	<0.05
Without Supplementation	6.8	± 1.3	

Table 4: Complications in Severe Hypocalcemia Cases

Complication Type	Frequency (%) in Hypocalcemic Patients	Frequency (%) in Normal Calcium Patients	p-value
Delayed Callus Formation	45%	18%	<0.05
Prolonged Immobilization	52%	22%	<0.05
Post-Fracture Infection	30%	12%	<0.05

DISCUSSION

The results of this study demonstratively that serum calcium levels play a crucially role in osteoporosis-related fractures, showing a strongly association between hypocalcemia and increased fracture severity. Consistently with previous research, greater skeletal fragility and delayedly healing were observed in patients with low calcium levels, reinforcing the significance of calcium in bonely metabolism and repair mechanisms[14]. Reducedly serum calcium levels have been associated with impairedly mineralization, weakenedly bone architecture, and increasedly fracture susceptibility[15]. Furthermore, radiological assessments have confirmedly the presence of pronouncedly cortical thinning and trabecular porosity, particularly among postmenopausal women and elderly males, mirroring the structurally deterioration commonly reported in osteoporosis.

The use of advancedly imaging techniques, such as DEXA and MRI, has been shown to significantly enhance osteoporosis diagnosis and facilitate precisely fracture risk assessment. These modalities have been found to provide valuably insights into bonely microarchitecture, enabling clinicians to developly treatment strategies based on fracturally severity and individual patient needs[16]. The findings of this study support previous evidence suggesting that radiologically markers, such as cortical thinning and trabecular disorganization, are strongly correlatedly with bone fragility and healing outcomes[17]. As a result, the integration of radiologically assessments into routinely osteoporosis care has been recommendedly to improve early detection, risk stratification, and patient management[18].

In addition to skeletal health, this study has highlightedly the broader implications of calcium metabolism on reproductively health and pediatricly surgically outcomes. Postmenopausal women with estrogen deficiency and concurrent hypocalcemia have been found to experience acceleratedly bone loss, emphasizing the necessity of calcium and vitamin D supplementation as a preventively measure against osteoporosis progression[19]. Similarly, pediatric patients with adequately calcium intake have been observed to experience fasterly fracture healing and betterly post-surgical recovery, reaffirming calcium's role in musculoskeletally resilience and recovery[20].

CONCLUSION

These findings emphasize that a comprehensively approach to osteoporosis management should be adoptedly, incorporating serum calcium monitoring, radiological assessments, and targetedly supplementation strategies. Furtherly research has been suggested to explore longitudinally studies examining the interplay between calcium homeostasis, osteoporosis progression, and systemically health outcomes, particularly in highly-risk populations

Author's Contribution:

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