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Original Article

Assessment of Disuse Osteopenia Syndrome Following Total Knee Replacement Surgery

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ABSTRACT

Background: The disuse syndrome after lower extremities disuse is very a common unintended out comes of orthopedic surgery which can be evaded with proper nursing follow up. **Aim:** to assess of the disuse osteopenia syndrome following total knee replacement surgery. **Design**: An exploratory descriptive research design was utilized in this study. **Setting**: study was conducted at orthopedic Department at Kasr El Eini. **Sample**: A convenient nonprobability sample of 19 patients was selected. **Tools of data collection: Tool**; a) Socio-demographic/ medical Data Sheet, b) Physical Functional Status Assessment Sheet. **Results: Lower Extremity Functional Scale (LEFS) Score**; This score demonstrated a statistically significant improvement at 6 months (47.7 ± 17.7) post-operatively compared to the baseline score of 30.5 (± 15.4) ($p<0.01$) and The DEXA data reveals a trend of bone loss in the ipsilateral (affected) limb particularly in the early stages following surgery. The ipsilateral Neck of Femur (NOF) BMD shows a decrease at the 3 months (0.77 ±0.11) and 6-month (0.79 ±0.11) visits. **Conclusion:** the current study which spot some light on unattended detrimental side effect for the total knee replacement therapy which could be avoided by carful physiotherapy and suitable medication by the nursing team. **Recommendation:** To follow up DEXA investigation for patient undergoing TKR surgery and to start the physiotherapy and bone restoring medication as early as possible.

Keywords: disuse osteopenia syndrome- - total knee replacement surgery

Introduction

Disuse osteopenia is defined to be a decrease in bone mineral density (BMD), and alteration of micro-architecture, due to a decrease in the mechanical loading of the skeleton. Immobility or non-weight-bearing status may cause the bone to become less dense may lead to decrease in the mechanical strength of the bone, which makes them more likely to fracture. (Rolvien & Amling, 2022).

The secondary effects of disuse osteopenia are to cause an increased risk of either re-fracturing at the original injury site or fracturing at a secondary site that has also experienced disuse-induced bone loss secondary to the reduction in weight-bearing: this may potentially include hip fracture, which is more closely

associated with BMD than fractures at other sites, and confers the greatest social and economic burden as a result of a high burden of subsequent morbidity and mortality (Sharma, Bhattachan, Bhatta, & Singh, 2024)

Total knee replacement surgery typically requires hospitalization, and 20% of patients may die within a year post-injury. 10% will die during the first year following fracture, and an additional 50% will become permanently disabled, in 2000 nearly 9 million new osteoporotic fractures were recorded worldwide and at least 20% are hip fractures but it could be present in any long or flat bone, above all as consequence of immobilization .(Salari, Ghasemi, Mohammadi, Behzadi, Rabieenia, Shohaimi & Mohammadi, 2021).

Static weight-bearing, ground reaction forces, and mechanical loading produced by muscles during movement are crucial physical factors for bone remodeling, and it is well-established that immobilization and lack of load-bearing lead to a decline in BMD, evident in the condition known as disuse osteopenia (Harithasan, & Abd Razak, 2023).

Bone loss is a condition branded by a high revenue rate, where both bone formation and resorption are heightened but out of equilibrium, with resorption exceeding formation. The primary factors influencing the onset of disuse bone loss seem to be the duration of immobilization and loss of function. The period of recovery exceeds the length of the unloading that led to the bone loss (Ferrari, & Langdahl, 2023).

Factors such as the specific modality of medical intervention, the severity of pain, and the presence of depressive symptoms that impede remobilization and the reinstatement of normative activity levels may significantly influence both the magnitude and temporal progression of recovery. Furthermore, the type of osseous tissue plays a crucial role; it has been generally observed that bone resorption is more pronounced at the epiphyseal regions (where trabecular bone is predominantly located) compared to the diaphyseal regions. This observation has fostered the hypothesis that trabecular bone experiences a greater extent of loss in comparison to cortical bone; however, contemporary research presents evidence that challenges this hypothesis, indicating that the bone loss observed in the distal tibial epiphysis following 35 days of bed rest predominantly originates from the cortical compartment. (Barak, 2024).

There are acknowledge limitation at the assessment of disuse –osteopenia syndrome therefore it is crucial to point the light to this are through the current study.

Significance of the Study

Disuse osteopenia is a secondary form of osteopenia/osteoporosis that can occur at any age and has been observed in human studies of bed-rest, stroke and conditions of micro-gravity. Desai, 2023, report that young bed-ridden patients can lose up to 30% of their bone density in only a few months and that on average there is a decrease in trabecular bone of approximately 1% per week but only a 1% per month recovery on resumption of

physical activity. Unfortunately, there is no available statistic about disuse osteopenia syndrome at Egypt although the magnitude of the problem.

One of the nursing profession core responsibility is to monitor and prevent complication of immobilization such as the disuse osteopenia which could be preventable in a lot of cases by the proper management which mainly under the nursing provision like the maintains of physiotherapy, monitor of lab investigation, supervision the nutritional management, psychological status and administration of proper medication .

Aim of The Study

the aim of this study is to assess of the disuse osteopenia syndrome following total knee replacement surgery.

Research Questions

To achieve the aim of this study, the following research questions were formulated:

Q1: is the mean score of lower extremity functional scale will differ for patients following total knee replacement surgery between first assessments and second assessment.

Q2: is the mean reading of Dexa scan for patients following total knee replacement surgery between first assessment at and second assessment will decrease.

Operational Definition

The following operational definitions were used in the current study:

Disuse osteopenia: Disuse osteopenia is a condition characterized by loss of bone mineral density (BMD) (Rolvien & Amling, 2022).

Assessment of disuse osteopenia: through lower extremity factional scale (LEFS**)** developed by Blanky, 1999, in additional to bone density scan (DXA)

Total knee replacement surgery: Patients following total knee surgery as it required more than 6 months recovery.

Research Design

An exploratory descriptive research design was utilized in this study. The combination of its characteristic summary and correlation statistics, along with its focus on specific types of research questions, methods, and outcomes is what distinguishes descriptive research from other research types. With this design three main purposes of research are to describe, explain and validate findings. Description emerges following creative exploration, and serves to organize the findings in order to fit them with explanations, and then test or validate those explanations (McCombes,2022).

Sample

A convenient nonprobability sample of 19 male/female patients with knee replacement surgery. The sample was selected based on the following inclusion and exclusion criteria according to the sample calculation equation

$$N = \frac{(r+1)(Z_{\alpha/2} + Z_{1-\beta})^2 \sigma^2}{rd^2}$$

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Inclusion criteria:

- Patients admitted for total knee surgery and aged above 18 years.
- The time of lower limb immobolization on 1st assessment not exceed 3 weeks

Execlusion criteria :

- Previously diagnosed with bone disease or Ca diffeciency .
- Previous immpbilization more than 4 weeks at past 10 years

Setting

The current study was conducted at Kasr Al Einy hospital which is located in El-Manial and it is considered one of the oldest and biggest hospital not just in Egypt but at the Middle Eastern Region. The data for the current study gathered from The Orthopedic departments.

Tools Data Collection

The following tow tools were utilized to collect data pertinent to the study, the designed and adopted three tools were reviewed by panel of three experts in the field of Medical Surgical Nursing, these tools are: a) Socio-demographic/ medical Data Sheet, and b) Physical Functional Status Assessment Sheet (Kresevic2003).

a) Socio-demographic/ medical Data Sheet: It was designed by the researcher after reviewing related literature to elicit the related data. The tool included; age, marital status, level of education, occupation, place of residence, number of family members, history of smoking, previous disease….etc. These data were collected using patient's medical chart and interviewing methods .

b) Lower extremities functional scales: `

The lower extremity functional scale (LEFS) is a valid patient-rated outcome measure (PROM) for the measurement of lower extremity function. It was first developed by Binkley et al. (1999) in a group of patients with various musculoskeletal conditions, The scale is originally developed in English language and according to western culture.

The scale consists of 4 groups with 20 questions. The questions in these group focus on activities with increasing physical demands like questions from walking between rooms to running on uneven ground. The scoring of this scale varies from 0 (extreme difficulty/unable to perform activity) to 4 (no difficulty). The total score can be obtained by summing the scores of the individual items. The maximum score of 80 indicates no functional limitations and the minimum score of 0 indicates extreme limitation.

Pilot of the Study

A pilot study was conducted on a group of 10% of the study sample with the same inclusion criteria to ensure the clarity and objectivity of the study tools as well as feasibility of the study also to determine the time required to fill out the tools, data collection procedures, as well as any possible problems in the methodological tools and data analysis approaches.

Ethical Considerations

Once official permission was granted to conduct the current study. Each potential participants were informed about the purpose, the nature and the significance of the study. Also, all of them were informed that participation in the

study is completely voluntary, and they have the right to withdraw from the study at any point without any penalty. Additionally, all potential participants were assured that anonymity and confidentiality will be considered through coding the data. Moreover, all of them were informed that the data will not be reused for any other research studies without their permission. Those who choose to participate in the study a consent was secured before starting data collection.

Procedure

The study will be conducted in two phases: preparatory and implementation phase

The preparatory phase: The researcher will conduct the literature review regarding all study variables, reviewing other studies, prepare the data collection tools and seeking expert's advice in addition to obtain the official permission to proceed with the proposed study.

Once permission was obtained to proceed with the proposed study. The eligible subjects who were scheduled for the surgery were identified from admission records with the help of orthopedic department nurses, also agreement of subjects to participate in the study was secured through informed consent.

Implementation phase

Data collection started by introducing self and explaining the purpose and the nature of the study briefly to the patients. All study participants were met individually and informed consent for participation was obtained. Data were collected from study subjects via a structured interview using firstly, socio- demographic/ medical data sheet (and it must be within the first 3 week of limb immobilization), second part is for assessment the medical condition and third part is for assessing the level of activity through lower limb functional scle. The questionnaire sheets consumed about 30-45 minutes to be fulfilled by the researcher within the first 3 weeks of immobilization. Then the patients followed up by the researchers through mobile phone call, till the time of 2nd assessment after 6 months of surgery which face to face a structured interview using firstly, socio- demographic/ medical data sheet for assessment the medical and socio demographic data then assessing the level of lower limb function through lower limb functional scale. The questionnaire sheets consumed about 30-45 minutes to be fulfilled by the researcher

Statistical Analysis

Upon completion of data collection, obtained data was tabulated, computed and analyzed using statistical package for the social sciences (SPSS) program version 20 (Mustika.2022). Descriptive as well as inferential statistics will be utilized to analyze data pertinent to the study such as frequency distribution, mean, standard deviation, Chi square, t- test and Pearson test. Level of significance will be set at $p < 0.05$.

Result

The purpose of doing the knee replacement surgery is to enable the patient to move adequately, and to improve the quality of life for those patients, unfortunately it was observed

during clinical experience that the lake of physical activity during recovery time could lead to preventable hurtful side effect, this study high light this side effect as first step to avoided it.

The result going to be represented as the following; first section will represent the demographic and medical data for the study sample and the second section represent the data of LEFS and DXA for the study sample

Table 1 represent the demographic data reveals a study sample with an average age in the mid-60s (66.1 ± 6.9),while the Total Knee Replacement (TKR) sample presents with a significantly higher Body Mass Index (BMI) (32.2 ± 7.1) at the first visit compared to the subsequent visits.

Table 2 represent the types of medication and medical condition for the study sample notable that osteoarthritis is the higher percentage by 22.2% congruent with its medication such as multivitamins 57.9 % , Fosamax 10.5 %, calcitonin 11.1%, calcium 10.5 % and Vitamin D 10.5 %.

Table 3 This table presents a longitudinal analysis of mean and standard deviation (SD) for a suite of physical and functional parameters across four distinct study visits: Visit 1 (Baseline, pre-surgery), Visit 2 (3 months post-operatively), Visit 3 (6 months post-operatively).

The parameters assessed include:

- **Lower Extremity Functional Scale (LEFS) Score**. This score demonstrated a statistically significant improvement at 6 months (47.7 ± 17.7) post-operatively compared to the baseline score of 30.5 (± 15.4) ($p<0.01$).
- **Average Pedometer Steps** (post-operative for Visit 1). There was a significant increase in average daily steps at 6 months (4361 ± 3046) compared to the baseline measure of 870 (± 1283) ($p<0.01$).

Table 4 The DEXA data reveals a trend of bone loss in the ipsilateral (affected) limb particularly in the early stages following surgery. The ipsilateral Neck of Femur (NOF) BMD shows a decrease at the 3 months (0.77 ±0.11) and 6-month (0.79 ±0.11) visits ,. This pattern is indicative of disuse osteopenia resulting from reduced weight-bearing on the affected limb. The contralateral (unaffected) limb also shows a slight decrease in BMD s (0.84 ±0.12), although to a lesser extent than the ipsilateral side. This may suggest a systemic effect or a compensatory change in loading patterns that also affects the non-injured limb. These findings emphasize the significant impact of immobilization on bone health and highlight the importance of interventions to mitigate bone loss in patients undergoing TKR or recovering from lower limb fractures.

First section

Table 1 the mean score during the 3 visits for (age, weight, height, BMI) for the study sample n (19)

Characteristic	First visit Base line	Second visit 3 months	Third vist 6 moths
Age	66.1 ± 6.9		
Weight	83.1 ± 16.1	71.0 ± 11.1	74.3 ± 15.8
Hight	1.6 ± 0.1	1.6 ± 0.1	1.6 ± 0.1
BMI	32.2 ± 7.1	26.1 ± 3.8	28.4 ± 5.5

Table 2 the percentage of medical data sheet during 3 visits for study sample n (19)

Medical Condition/Medication	**%**
Rheumatoid arthritis	15.8
Osteoarthritis	22.2
Previous Total Knee Replacement	12
Previous Total Hip Replacement	11
Steroids	10.5
Anticonvulsants	5.3
Diuretics	26.3
Fosamax	10.5
Calcitonin	11.1
Actonel	0
Multi vitamin	57.9
Calcium	10.5
Vitamin D	10.5

Second section

Table 3 Lower Extremities Functional Scale Score (mean and stander deviation) for study sample during 3 visits n (19)

Parameter	**Visit 1 (Baseline, pre-surgery) Mean (SD)**	**Visit 2 (3 months post-op) Mean (SD)**	**Visit 3 (6 months post-op) Mean (SD)**
LEFS Score	30.5 ±15.4)	34.2 ±12.7	47.7± 17.7 ††
Average pedometer steps (post-op for V1)	870 (1283)	2757 (1895)	4361 (3046) ††

Table 4 the Ipsilateral and contralateral BMD mean and stander deviation for the study sample during the 3 visits n (19).

Visit	**Ipsilateral NOF BMD (g/cm²)**	**Contralateral NOF BMD (g/cm²)**
Visit 1 (Baseline)	0.82 ±0.11	0.85 ±0.12
Visit 2 (3 months)	0.77 ±0.11	0.84 ±0.12
Visit 3 (6 months)	0.79 ±0.11	0.84 ±0.12

Discussion

The nursing team is very significant medical ward as the responsibility of patients follow up relay mainly on their shoulder, this study show that even with a successful surgery and accurate treatment still it could be harmful side effect that we could avoided by follow up and physical therapy it just need a clever nurse to detect it.

The discussion chapter will be divided to two main section the first section will answer the study first question about the LEFS and the second section will answer the second study question about the DEXA

First section

At the beginning let's present the demographic and selected medical data for the study group the result show that more than half of study sample are over sixty which is logically accepted as the type of surgery is really connected with age and it was observed that less than half of the sample are over weighted which decrease after surgery which is expected as part of treatment is to lose weight. For the medical data logically quarter of the sample are suffering from osteoarthritis and they are receiving its medication

now regarding answering the first question about LEFS This score demonstrated a statistically significant improvement at 6 months post-operatively compared to the baseline score which indicate the success of surgery and that study congruent with study done by Hudson, 2022. Early Ambulation in the post-operative orthopedic spinal patient: Does it increase functional status, this agree with clinical judgment with researcher early ambulation after orthopedic surgery increase the function capability of patient. (Hudson, 2022).

The result of current study also match with Roush, 2024 study named; Preliminary Evaluation of the Clinimetrics of a Modified Lower Extremity Functional Scale in Older Adults After Total Knee Arthroplasty and another study by Wang, et al (2021). Patient-reported outcome measures used in patients undergoing total knee arthroplasty which both emphasis the increase of LEFS score after total knee replacement therapy.

The second section

Regarding answering the second question about the DEXA score over the 3 visits period which from the researcher point of view is the core of the study it is provide by evidence that DEXA score significantly decreased over the 3 visits which highlight a major area need to be covered by research and management to grantee the quality of medical treatment, the result of the study congruent with Robertson, Pijls, Solomon, Nelissen, & Callary, 2023. Change in CT-measured acetabular bone density following total hip arthroplasty: a systematic review and meta-analysis. Although the study done on hip replacement but it represent the main concept still there is in sufficient study regarding this area, hopefully the current study will highpoint the important of more investigation and attention for that issue. (Robertson, Pijls, Solomon, Nelissen& Callary, 2023).

Summary and conclusion

Upon the result shown by the current study which spot some light on un attended detrimental side effect for the total knee replacement therapy which could be avoided by carful physiotherapy and suitable medication by the nursing team it is crucial issue to give more attention to the matter

for best result and improving the recovery and function level of patients

Recommendations

- To repeat the study on bigger sample for more accurate result
- To follow up DEXA investigation for patient undergoing TKR surgery and to start the physiotherapy and bone restoring medication as early as possible

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