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ORIGINAL ARTICLE

Impact of pathological fractures on kinesiophobia and anxiety in patients with benign and benign-aggressive lower extremity bone tumors

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ABSTRACT

Objectives: This study aims to evaluate kinesiophobia and anxiety levels in patients with benign and benign-aggressive bone tumors located in the lower extremities.

Patients and methods: Between January 2022 and June 2024, a total of 54 patients (23 males, 31 females; mean age: 35.2±14.5 years; range, 15 to 67 years) who underwent surgery for benign and benign-aggressive bone tumors in the lower extremities were retrospectively analyzed. Of the patients, 16 developed pathological fractures and 38 did not. Kinesiophobia was assessed using the Tampa Kinesiophobia Scale (TKS), and anxiety levels were measured using the State-Trait Anxiety Inventory (STAI-I and STAI-II).

Results: Pathological fractures occurred in 29.6% of cases. The most common tumor types were enchondroma (44.4%), giant cell tumor (18.5%), and aneurysmal bone cyst (11.2%). Patients with pathological fractures had significantly higher TKS, STAI-I, and STAI-II scores than those without fractures ($p<0.001$, $p=0.034$, and $p<0.001$, respectively).

Conclusion: In benign and benign-aggressive musculoskeletal lesions of the lower extremity, implementing prophylactic surgical intervention by predicting fracture risk reduces patients' levels of kinesiophobia and anxiety. Preventing pathological fractures in weight-bearing long bones allows for early mobilization, prevents fracture-related complications, and helps to preserve psychological well-being.

Keywords: Anxiety, benign bone tumors, kinesiophobia, pathological fracture.

Benign bone tumors account for approximately 40% of musculoskeletal system tumors. The total number is likely significantly higher when tumor-like lesions are taken into account. Benign bone tumors can primarily occur in any bone and at any age, although they are most commonly seen in young individuals.[1]

The management of benign bone lesions is controversial. The treatment algorithm varies depending on factors such as the age of the patient, the location of the lesion, the pathological diagnosis, the aggressive nature of the lesion or the risk of recurrence, the risk of fracture, and the experience of the surgeon.[2] The main point in treatment depends on whether the mass alters the strength of the bone and increases the risk of pathological fractures. Since these tumors predominantly occur in children and young adults with a normal life expectancy, preventing complications such as pathological fractures, growth disturbances, movement restrictions, and deformities is crucial. Although various scoring systems have been developed to predict pathological fractures, there is no consensus

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on the optimal timing of surgical intervention for specific lesions.[3]

Kinesiophobia is defined as anxiety related to activity and physical movement arising from sensitivity to painful injury and the fear of reinjury.[4,5] It is particularly common among those suffering from musculoskeletal discomfort. Due to heightened pain sensitivity, individuals may avoid certain activities, which can lead to negative physical and psychological outcomes. Therefore, it is essential to include kinesiophobia in clinical assessments, considering its psychological and physical consequences.[6] Anxiety, defined as the concern, fear, and restlessness felt by an individual, is a common psychological condition which can negatively affect individuals' daily lives and has been frequently associated with musculoskeletal pain. A review study indicates that musculoskeletal pain is linked to anxiety in various ways. Anxiety is reported to heighten pain perception, contribute to chronic pain, and is closely linked to fear, avoidance behaviors, and musculoskeletal discomfort.[7] Kinesiophobia, a feature of anxiety, depicts fear of movement with pain sensitivity. There are studies evaluating kinesiophobia following lower extremity ligament injuries and fractures.[8-10] Kinesiophobia is a significant factor affecting the return to previous activity levels in patients who undergo surgical treatment for anterior cruciate ligament injuries.[9,10] While kinesiophobia has been widely researched in orthopedic trauma patients, its occurrence in bone tumor patients is not well known. Bone tumors already have a negative psychological impact on patients.[11] Pathological fractures caused by these tumors can potentially compromise the efficacy and success of treatment. Additionally, the development of a pathological fracture can lead to fear of re-injury and anxiety, which may not only worsen the physical recovery process but also further deteriorate the patients' psychological condition.

In the present study, we hypothesized that pathological fractures would be associated with significantly higher kinesiophobia and anxiety scores. We, therefore, aimed to evaluate the levels of kinesiophobia and anxiety in patients with benign and benign-aggressive bone tumors of the lower extremities.

PATIENTS AND METHODS

This two-center, retrospective study was conducted at Dr. Abdurrahman Yurtaslan Ankara Oncology Training and Research Hospital and Gazi University Faculty of Medicine, Department of Orthopaedics and Traumatology between January 2022 and June 2024. Adolescent and adult patients (aged >15 years) who underwent surgery for benign (e.g., enchondroma, unicameral bone cyst) and benign-aggressive (e.g., giant cell tumor, aneurysmal bone cyst) bone tumors located in the long bones of the lower extremities were included in the study. The hospital database and patient follow-up files were used. Patients were excluded from the study, if they had incomplete medical records, a follow-up period of less than six months, tumor recurrence, concomitant musculoskeletal injuries, a history of previous lower extremity surgery, or benign lesions without the risk of pathological fracture (e.g., osteoid osteoma, bone island) (Figure 1).[12] Finally, a total of 54 patients (23 males, 31 females; mean age: 35.2±14.5 years; range, 15 to 67 years) were included in the study, comprising those who underwent surgery after developing a pathological fracture (n=16) and those who underwent surgery without developing a pathological fracture (n=38) (Figure 2). Written informed consent was obtained from the patients or parents and/or legal guardians of the patients. The study protocol was approved by the Gazi University Faculty of Medicine Ethics Committee (Date: 28.01.2025, No: 2025-188). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Demographic data such as age, sex, and histopathological diagnosis were evaluated. All patients were evaluated for kinesiophobia via the TAMPA Kinesiophobia Scale (TKS) and for anxiety via the State-Trait and Trait Anxiety Inventory (STAI-I and STAI-II). The results of the questionnaire measurements administered at routine outpatient clinic visits at six months postoperatively were noted. The TKS consists of 17 questions, and the participants receive a total score between 17 and 68. A high score on the scale indicates a high level of kinesiophobia. A total score above 37 is associated with kinesiophobia.[4] The test-retest reliability of this scoring system is high with an intraclass correlation coefficient of 0.806 (95% confidence interval [CI]: 0.720-0.867).[13] The STAI-I and STAI-II inventories were used to assess anxiety levels. This questionnaire consists of two separate scales, each comprising 20 items. The scores obtained from both scales theoretically range from 20 to 80, with higher scores indicating higher levels of anxiety. The STAI-I and STAI-II inventories were adapted into Turkish by Öner and Le Compte,[14] and their validity and reliability were studied. The Kuder-Richardson (Alpha) reliability of the scale

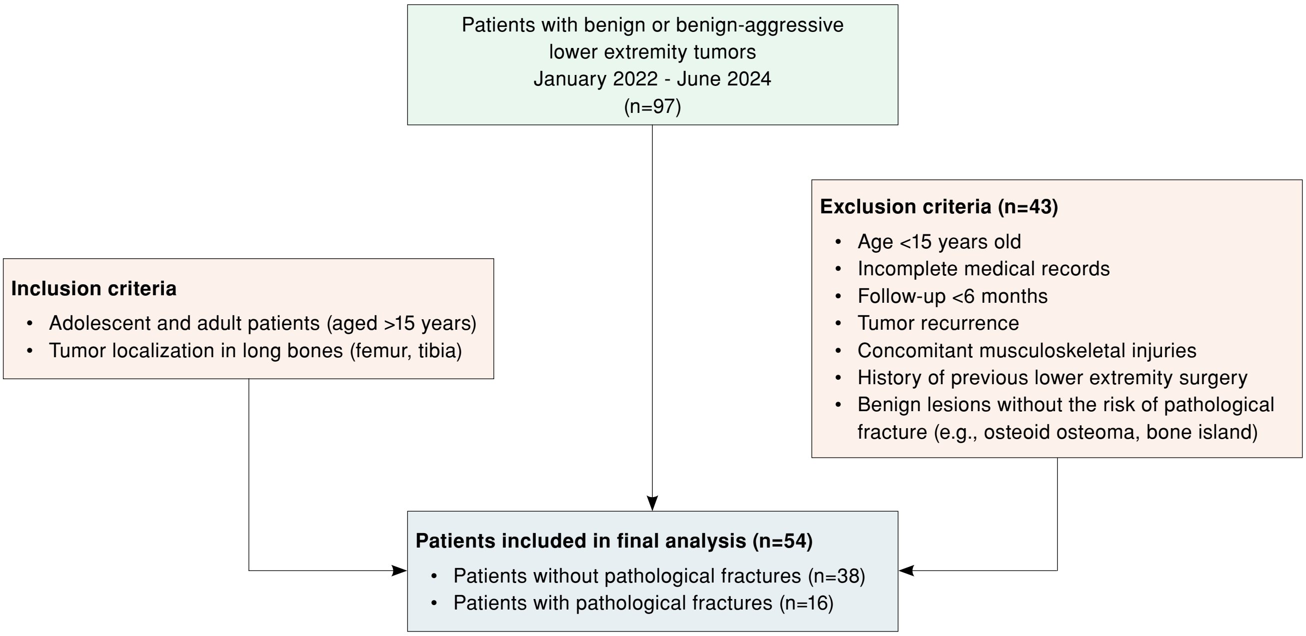

FIGURE 1. Study flowchart.

ranges between 0.83 and 0.87, while the test-retest reliability ranges between 0.71 and 0.86.

Statistical analysis

The sample size was calculated using G*Power version 3.1 software (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) based on an effect size reported in the literature (Cohen's d=0.86). The analysis indicated that a total of 48 participants would be sufficient to detect a significant difference with an alpha level of 0.05 and a statistical power of 80%.[15]

Statistical analysis was performed using the SPSS version 25.0 software (IBM Corp., Armonk, NY, USA). The demographic data were analyzed using the Kolmogorov-Smirnov test. While age and the STAI-II score followed a parametric distribution, the TKS score and the STAI-I score exhibited a non-parametric distribution. Continuous data were expressed in mean ± standard deviation (SD) or median (min-max), while categorical data were expressed in number and frequency. Statistical differences between the groups were analyzed using the independent t-test for parametric data and the Mann-Whitney U test for non-parametric data. The Kendall tau test was used to assess the relationship between the survey results and related measurements. The correlation values (r) were interpreted as described in the literature.[16] The effect size for the t-test in independent groups was measured with the Cohen's d test.[17] A *p* value of <0.05 was considered statistically significant.

RESULTS

Of all lesions, 63% were located in the right lower extremity. A total of 29.6% of the 54 patients had pathological fractures (Table I). The three most common pathological diagnoses were 44.4% enchondroma, 18.5% giant cell tumor, and 11.2% aneurysmal bone cyst.

There was a statistically significant difference between the group (n=16) who underwent surgery after a pathological fracture and the group who underwent surgery without a pathological fracture in terms of the TKS STAI-I and STAI-II scores (p<0.001, 0.034, <0.001, respectively). The TKS, STAI-I, and STAI-II scores were higher in patients who underwent surgery after a pathological fracture (Table II, Figure 3).

There was a large difference in TAMPA scores between those with and without pathological fractures (0.484). There was a moderate difference in STAI-I scores between the groups (0.248). There was a small difference in STAI-II scores between the two groups (0.07) (Table II).

The relationships between TKS, STAI-I, and STAI-II scores were evaluated. A weak positive

FIGURE 2. Illustrative radiological images of patients who underwent prophylactic treatment **(a-e)** and treatment after pathological fracture **(f-h)**. Early postoperative radiographs of the patient who underwent prophylactic fixation **(d, e)**. Early postoperative radiograph **(g)** and 6-month follow-up radiograph (h) of the patient operated after pathological fracture.

TABLE I
Demographic and clinical characteristics of patients

	n	%
Sex		
Female	31	57.4
Male	23	42.6
Tumor type		
Benign	35	64.8
Benign-agressive	19	35.2
Side		
Right	34	63
Left	20	37
Localization		
Femur proximal	14	25.9
Femur diaphysis	6	11.1
Femur distal	11	20.4
Tibia proximal	11	20.4
Tibia diaphysis	4	7.4
Tibia distal	8	14.8
Pathological fracture		
Yes	16	29.6
No	38	70.4

correlation was found between TKS and STAI-I ($r=0.295$, $p=0.002$). Similarly, a weak positive correlation was observed between TKS and STAI-II ($r=0.238$, $p=0.015$). Additionally, a weak positive correlation was detected between STAI-I and STAI-II ($r=0.308$, $p=0.002$).

The relationships between TKS, STAI-I, and STAI-II scores in patients who underwent surgery after a pathological fracture were evaluated. A weak positive correlation was found between TKS and STAI-I ($r=0.330$, $p=0.089$). A moderate positive correlation was observed between TKS and STAI-II ($r=0.400$, $p=0.039$). Additionally, a strong positive correlation was detected between STAI-I and STAI-II ($r=0.688$, $p<0.001$).

The relationships between TKS, STAI-I, and STAI-II scores were evaluated in patients without pathological fractures. A weak positive correlation was found between TKS and STAI-I ($r=0.268$, $p=0.023$). A moderate negative correlation was observed between TKS and STAI-II ($r=-0.052$, $p=0.664$).

TABLE II
Comparison of TKS, STAI-I and STAI-II scores between groups with and without pathological fractures (n=54)

	Mean±SD	Median	Min-Max	*p*	Effect size
Age (year)	35.17±14.54	33.5	15-67		
No pathological fracture (n=38)	37.42±15.33	35.5	16-67	0.079*	
Pathological fracture (n=16)	29.81±11.11	33	15-49		
TKS	40±7.21	40	23-61		
No pathological fracture	37.68±5.65	38	23-55	<0.001†	0.484
Pathological fracture	45.50±7.69	46	28-61		
STAI-I	37.65±10.55	36	21-66		
No pathological fracture	38.87±12.05	34.5	21-66	0.034†	0.248
Pathological fracture	39.50±5.47	38	32-56		
STAI-II	37.96±5.73	37	29-60		
No pathological fracture	35.39±3.20	35	29-42	<0.001*	0.07
Pathological fracture	44.06±5.85	43	34-60		

SD: Standard deviation; TKS: Tampa scale of kinesiophobia; STAI-I: State anxiety inventory-I; STAI-II: Trait anxiety inventory-II; * Independent samples t-test; † Mann-Whitney U test.

Additionally, a very weak positive correlation was detected between the STAI-I score and the STAI-II score (r=0.169, p=0.155). Weak correlations indicate different psychological constructs.

DISCUSSION

In the current study, we evaluated the levels of kinesiophobia and anxiety in patients with benign and benign-aggressive bone tumors of the lower extremities. The main finding of this study was that all patients with symptomatic benign and benign-aggressive bone lesions of the long bones in the lower extremity who underwent surgical treatment had high average kinesiophobia and anxiety scores. The fact that patients with pathological fractures had higher kinesiophobia and anxiety scores than patients who underwent prophylactic surgical treatment suggests that unfavorable experiences of traumatized individuals may lead to fear of movement and anxiety. More importantly, these results imply that prophylactic fixation may help counteract trauma-induced kinesiophobia.

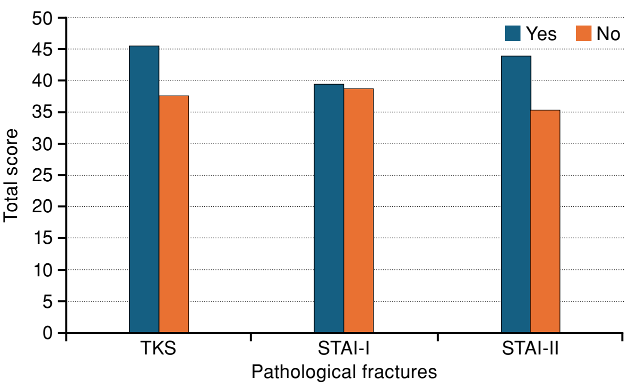

FIGURE 3. Bar chart comparing kinesiophobia (TKS) and anxiety scores (STAI-I and STAI-II) between patients with and without pathological fractures.
TKS: Tampa kinesiophobia scale; STAI-I: State anxiety inventory-I; STAI-II: Trait anxiety inventory-II;

Pathological fractures associated with benign bone tumors are significant and relatively common complications that further complicate their management. A study conducted on pediatric patients analyzed 233 patients with bone tumors and tumor-like lesions and reported that 17.6% of patients presented with a pathological fracture at the time of admission.[12] Moreover, when lesions originating from the bone surface were excluded, the incidence of pathological fractures in intramedullary lesions increased to 31%. The study also identified simple bone cysts (41.5%) and non-ossifying fibromas (24.4%) as the two most common tumor types associated with fractures. In the literature, studies on the management of pathological fractures and fracture risk assessment in benign bone tumors have emphasized the importance of preventing pathological fractures.[3,18-21] It is crucial to detect the lesion before the onset of a pathological fracture, as this can avert complications associated with fractures, promote early mobilization, and reduce morbidity.[3,22] Pain experienced both before and after surgery significantly affects the patient's psychological state. This pain not only causes physical discomfort but also imposes a substantial psychological burden, often leading to fear of movement, known as kinesiophobia.[23] When a painful event resulting from fracture development is perceived as a threat, it can lead to catastrophic thoughts that physical activity will lead to more pain and injury. This can prevent patients from cooperating with treatment, negatively affecting their mental health and overall recovery outcomes.[24] Fractures of the lower extremities adversely impact the quality of life post-trauma, presenting as psychosocial, physical, and emotional burdens.[25] Furthermore, long-term patient-related symptoms following lower extremity fractures have been documented to endure significantly, even decades post-treatment. These symptoms result in functional impairments, particularly in activities necessitating elevated physical performance, and significantly diminish overall quality of life. In this context, irrespective of the fracture's etiology, its impediment to the capacity for independent living is a considerable source of concern for patients.[26] Additionally, the presence of a tumor, even if benign, can be a source of concern for patients. Patients may consider the possibility of malignancy, which can further increase their anxiety levels. In the present study, increased kinesiophobia and anxiety scores among patients with pathological fractures reinforce the importance of preventing the development of pathological fractures, consistent with the existing literature. Prophylactic treatment to prevent the development of pathological fractures in lesions with fracture risk may have a positive effect on the psychological status of patients. We believe that this is a crucial consideration for surgeons dealing with musculoskeletal tumors.

There are studies in the literature evaluating the impact of kinesiophobia on musculoskeletal disorders. Research has shown that kinesiophobia significantly affects the recovery process of patients with orthopedic injuries.[8-10,27-29] Kinesiophobia has been reported as a significant factor affecting the return to previous activity levels in patients who have undergone anterior cruciate ligament reconstruction.[9] Among patients who are unable to return to sports, half experience a fear of reinjury.[10] In patients who underwent surgery for degenerative spine disease, fear of movement in the postoperative period has been reported as a risk factor for increased pain, disability, and decreased physical health within the first six months after surgery.[29]

Similar to the aforementioned studies, patients with lower extremity bone tumors may think that their physical activities could be adversely affected. We consider that these tumors may adversely impact their psychological condition by inducing kinesiophobia and anxiety, particularly in patients who experience pathological fractures. To the best of our knowledge, our study is the first to evaluate kinesiophobia and anxiety in patients with musculoskeletal tumors of the lower extremity, comparing those who underwent surgical treatment after a pathological fracture with those who received prophylactic treatment during the study period. Patients who developed pathological fractures experienced higher levels of kinesiophobia and anxiety compared to those who underwent prophylactic fixation (Table II). Post-traumatic stress disorder is common in patients after injury, including those with orthopedic trauma, and has been associated with pain, poor physical and mental functioning, depression, and difficulties returning to work.[30] The weak to moderate correlations found between kinesiophobia and anxiety scores reported in this study may arise from the similar psychological effects that traumatic experiences have on patients. The relationship between kinesiophobia and anxiety can be assessed in a context where both disorders arise in connection with post-traumatic stress, pain experiences, and challenges in the recovery process. In this context, we believe that post-traumatic stress disorder, kinesiophobia, and anxiety have the potential to co-occur and interact in the post-traumatic period. Stress resulting from trauma can negatively affect both physical and mental recovery processes in patients by increasing kinesiophobia and anxiety levels. The development of a pathological fracture results in a more severe traumatic experience for patients, which we believe contributes to kinesiophobia and anxiety.

The negative impact of kinesiophobia on recovery after injury has been recognized, leading to increased interest in therapeutic approaches for its management in the literature. Various treatment methods, including therapeutic exercises, cognitive-behavioral therapy, relaxation techniques, and virtual walking training, have been implemented to alleviate kinesiophobia, and these approaches have been reported to be effective in reducing its severity.[31-34]

Although fracture development usually causes temporary activity restriction, it can also lead to permanent functional limitations and, depending on the severity of the fracture, the general quality of life of patients can be negatively affected.[35] Non-fatal orthopedic traumas are among the leading causes of chronic pain, decreased quality of life, prolonged medical leave, and disability.[36] Return-to-work rates as low as 50% have been reported up to 24 months following orthopedic trauma.[8,36] We believe that the prevention of pathological fractures is essential in mitigating the adverse effects of trauma, which include chronic pain, diminished quality of life, and an increased financial burden on the healthcare system. The prophylactic fixation of bone lesions at risk of fracture before a pathological fracture occurs serves as an effective preventive intervention. This approach is a simpler and more effective strategy compared to the treatment of pathological fractures, and through prophylactic fixation, it may be possible to prevent significant future health issues, complications, and costs.

The strength of this study lies in being the first to evaluate kinesiophobia and anxiety in patients with musculoskeletal tumors of the lower extremity, comparing those who underwent surgical treatment after a pathological fracture with those who received prophylactic treatment during the study period. Another strength is that the treatment and follow-up of patients were conducted in a two-center design within a tertiary hospital, which serves as a referral center for musculoskeletal system tumors.

Nonetheless, the study has certain limitations. The limited sample size and retrospective design of the study may restrict the generalizability of the results. Multivariate analyses were not performed for variables such as gender, fixation methods, and tumor location. The heterogeneous nature of the tumor subtypes analyzed in the study (e.g., enchondroma and giant cell tumor), the presence of different benign and benign-aggressive lesions, may have different effects on psychology. Although this situation has the potential to affect the results, considering the low prevalence of primary bone tumors in the general population, longer-term, larger-scale, multi-center studies could be planned to enable separate analyses based on tumor subgroups, achieve a larger sample size, and increase the generalizability of the results. Another limitation to our study is that preoperative kinesiophobia and anxiety levels were unable to be evaluated. Preoperative psychological status may affect postoperative kinesiophobia and anxiety levels. Postoperative outcomes are likely to be more affected, particularly in patients with poor preoperative psychological status. Finally, the lack of long-term follow-up data to assess whether psychological outcomes resulting from pathological fractures persist over time is another limitation. These limitations draw attention to the need for future prospective studies, including homogeneous groups, greater samples, and long-term follow-up data.

In conclusion, to the best of our knowledge, this study is the first to compare kinesiophobia and anxiety levels in bone tumor patients with and without pathological fractures. According to our study results, in benign and benign-aggressive musculoskeletal lesions of the lower extremity, implementing prophylactic surgical intervention by predicting fracture risk reduces patients' levels of kinesiophobia and anxiety. Preventing pathological fractures in weight-bearing long bones allows for early mobilization, prevents fracture-related complications, and helps to preserve psychological well-being. Further prospective studies are needed to confirm the positive effect of prophylactic surgery on anxiety and kinesiophobia.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Idea/concept, design, writing the article, literature review: İ.K., M.Ç.; Drafting, data collection, analysis and/or interpretation: S.Y.; Data collection, materials: S.B.Y., B.T.; Control/supervision, critical review: Ş.M.A.

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