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Research Article

Investigating the Correlations between Patient Demographics and Complications Following Total Knee Arthroplasty: A Cross-Sectional Study

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ABSTRACT

Introduction: This study investigates the relationship between patient age, gender, and various complications, such as pain, restricted range of motion (ROM), and hemorrhage following total knee arthroplasty.

Materials and Methods: This cross-sectional study included 62 patients (Mean±SD age= 65.9±7.38 years; female participants=74.2%) who underwent total knee arthroplasty at Atieh Hospital in Tehran, Iran, between 2020 and 2021. Pain levels were assessed using the numerical pain rating score. Meanwhile, knee joint ROM was evaluated using a reliable mobile application. Hemorrhage was measured through knee joint drainage. Statistical analyses were performed to analyze the data.

Results: Women reported higher pain levels and more restricted ROM in passive knee extension and active/passive knee flexion compared to men ($P<0.05$). However, no significant differences were observed between genders in active knee extension and hemorrhage. A significant inverse correlation was found between pain and ROM in passive knee extension (rho=-0.41, $P\leq0.001$), as well as in active (rho=-0.5, $P\leq0.001$) and passive knee flexion (rho= -0.59, $P\leq0.001$). However, no significant relationship was observed between pain and active knee extension or hemorrhage. Age showed no statistically significant correlation with the other variables.

Conclusion: This study highlights the association between higher pain levels and greater ROM restrictions in passive knee extension and active/passive knee flexion following total knee arthroplasty; however, patient age and gender were not found to be associated with postoperative hemorrhage. These findings underscore the importance of closely monitoring pain and ROM, particularly in women undergoing total knee arthroplasty.

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Introduction

Knee osteoarthritis is one of the leading causes of disability worldwide [1]. In this disease, the cartilage of the synovial joints is focally destroyed, accompanied by an increase in bone mass, such as osteophyte or sclerosis of the bone below the cartilage, as well as an increase in the thickness of the joint capsule [2]. According to radiographic evidence, osteoarthritis occurs in many people over the age of 75 years [3]. Severe pain and functional impairment are among its consequences [4]. Knee arthroplasty is known as the main treatment for advanced knee osteoarthritis [5]. Significant improvement in pain, range of motion (ROM), function, and quality of life has been reported at intervals of 3 to 6 months, which is evident even at intervals of 7 to 15 years after surgery [6]. Although knee arthroplasty has many achievements in the subacute phase after surgery, it is associated with various complications, such as pain, local swelling, restricted ROM, and bleeding in the acute phase. Attention to these problems is important because of their effect on the number of analgesic drugs used, the need for blood transfusions, and the risks that may arise, such as addiction or drug reactions from analgesic medications and reactions from blood transfusions. Attention is also important due to the negative impacts on the rehabilitation process after surgery, like restricted ROM and muscle weakness, or delays in beginning physiotherapy [7]. Together, these factors can lead to increased hospitalization time and increased costs of treatment units [8].

This cross-sectional study investigates the relationship between patients' pain and other complications and examines the relationship between the age and gender of patients with complications such as pain, limited ROM, and bleeding after total knee arthroplasty (TKA). By examining these variables, we can gain a better understanding of the condition of patients after TKA surgery and develop suitable treatment and rehabilitation programs to improve their condition as soon as possible.

Materials and Methods

Study design and setting

This cross-sectional observational study was conducted at Atieh Hospital in Tehran City, Iran from November 2020 to September 2021, following ethical approval from the Institutional Review Board. The study report adhered to the strengthening of the reporting of observational studies in Epidemiology guidelines, specifically using the checklist for cross-sectional studies.

Study participants

We used a convenience sampling method to recruit 62 patients who underwent TKA with a two-compartment posterior stabilized prosthesis due to pain and disability caused by osteoarthritis of the knee joint. The inclusion criteria were as follows: 1) Age between 50 and 80 years old; 2) No prior history of knee replacement; 3) Absence of rheumatoid arthritis or other systemic inflammatory diseases, neurological disorders, blood coagulation disorders, cognitive impairment, or language limitations. Meanwhile, patients with active infections in the knee or a history of deep vein thrombosis thrombosis or pulmonary embolism were excluded from the study. Informed consent was obtained from all participants.

Variables and data collection

The time to evaluate the variables for people who underwent surgery under general anesthesia was after full consciousness stabilization of vital signs and elimination of complications caused by anesthesia. For those who underwent spinal anesthesia, the variables were evaluated at least 4 h after surgery and after the return of complete sensation and movement of the lower limbs. Data collection was performed by a trained research assistant. The variables studied and the measurement method of each are as follows:

Pain

Patients' pain was measured by the numerical pain rating scale (NPRS). The NPRS is a commonly used tool to assess the intensity of pain experienced by patients. It is a 0–10-point scale, where 0 indicates no pain and 10 indicates the worst possible pain. Patients are asked to rate their pain on the scale based on their personal experience. NPRS is a simple and reliable method for measuring pain intensity, and it is widely used in clinical practice and research studies [9, 10].

Range of motion

The knee joint's ROM was measured in degrees using mobile phone goniometry software (Goniometer Pro). The validity and reliability of this software were investigated by Hancock et al. [11]. For the knee joint's ROM during active and passive flexion and extension. The length of the lower limb was first determined by measuring the distance between the upper angle of the greater trochanter of the femur and the lower angle of the external ankle malleolus. The mobile phone was positioned relatively vertically from the side edge of the reference

measurement place, which was half of the patient's thigh, to measure the angle of the knee joint. The zero-degree calibration option was used to set the angle of the device to zero, and by placing the mobile phone in the middle of the leg, the angle of the knee joint was shown. The study included four knee joint movement tests, which included flexion and extension, in both active and passive forms. These tests required the patient to adopt different positions, and pressure was applied to achieve the maximum ROM of the knee joint during the passive movement tests. The mobile phone was used to measure the angle of the knee joint in each test. This method provides a simple, reliable, and accurate way to measure knee joint movement for clinical and research purposes.

Joint hemorrhage

Joint hemorrhage refers to bleeding that occurs within the knee joint, as a result of surgery. The amount of joint hemorrhage after surgery, measured in mL through drainage of the knee joint [12]. This involves inserting a drain into the joint to allow the excess blood and fluid to be collected and measured. The amount of joint hemorrhage can then be calculated by measuring the volume of the collected fluid in milliliters. However, if the amount of hemorrhage in the drain is less than 150 mL per day in the days following surgery, the drain will be removed from the patient's knee.

Statistical analysis

The statistical analysis of data was performed using SPSS software, version 16. Assessment of the normal distribution of data was tested using the Kolmogorov-Smirnov test. The Pearson correlation coefficient (r) was used to investigate the correlation between variables with normal distribution and Spearman's rank correlation coefficient (rho) was applied to examine the linear correlation between variables with abnormal distribution. Additionally, an independent parametric t-test or non-parametric Mann-Whitney test was used to examine the differences between the mentioned variables between the two genders according to the distribution of data.

Sample size

All patients who underwent TKA in Atieh Hospital, Tehran City, due to advanced osteoarthritis of the knee from November 2020 to September 2021 were included in the study, provided they met the inclusion criteria. A total of 67 patients were initially evaluated for inclusion in the study TKA. Meanwhile, 5 patients were excluded from the study as they did not meet the inclusion criteria. The reasons for exclusion were as follows: One patient had undergone TKA due to rheumatoid arthritis disease, one did not meet the age requirements for the study due to knee osteoarthritis after a fracture, one had a history of deep vein thrombosis in the lower extremities, and two patients underwent revision surgery on the same knee. The remaining 62 patients who met the inclusion criteria were included in the study and their data were statistically evaluated.

Results

Descriptive data

Table 1 presents the demographic information of the study participants, as well as descriptive statistics and the distribution of variables in the study.

Main results

Data distribution was found not to be normal for all variables except for active and passive knee extension and age (P>0.08). Therefore, the Spearman correlation coefficient was used to investigate the correlation between pain and age variables with other variables that have abnormal distribution, and the Pearson correlation coefficient was used to investigate the correlation between age and active and passive knee extension, which have a normal distribution of data. The correlation analysis results are presented in Table 2.

The correlation analysis revealed a strong inverse correlation between pain and ROM of passive knee extension (rho=-0.41, P≤0.001) and active (rho=-0.5, P≤0.001) and passive knee flexion (rho=-0.59, P≤0.001). Patients who reported less pain showed more ROM in active and passive knee flexion movements as well as passive knee extension. The relationship between pain and active knee extension (rho=-0.14) and the bleeding of the knee joint (rho=-0.19) showed a weak correlation between these variables that was not statistically significant.

The correlation analysis between age and other variables showed a weak correlation between age and pain, ROM, and knee bleeding after surgery, but these correlations were not statistically significant.

The analysis revealed that men experienced less pain and had more ROM in active and passive knee flexion movements as well as passive knee extension. However, there was no significant difference between genders regarding active knee extension and knee bleeding (Table 3).

Table 1. Demographic and clinical characteristics of study participants (n=62)

Variables	Mean±SD (Range)/No. (%)
Gender (female)	46(74.2)
Side (left)	32(51.6)
Age (y)	65.9±7.38 (50-80)
Pain (score)	8.3±2.25 (1-10)
Active flexion (degree)	41.83±14.72 (20-86)
Passive flexion (degree)	52.17±16.72 (30-97)
Active extension (degree)	144.04±9.33 (120-158)
Passive extension (degree)	162.35±6.51 (145-179)
Bleeding (mL)	314.33±175.16 (50-650)

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Discussion

TKA is considered one of the most effective treatments for advanced knee osteoarthritis [13]. This surgery significantly improves pain, mobility, function, and quality of life in the short and long-term periods [14]. The success of this surgery, as well as the increase in the elderly population, increases the number of such surgeries worldwide [15]. Despite the encouraging results of TKA, the postoperative period due to tissue damage and inflammatory response is associated with important problems, such as pain, postoperative ROM restriction, hemorrhage, and soft tissue swelling [12]. It is important to pay attention to these complications because of their effect on the amount of analgesic medicine used, the need for blood transfusions, and the risks that may follow, as well as the negative effects on the rehabilitation process after surgery [7]. The present study investigated the relationship between patient age, gender, and complications such as pain, restricted ROM, and hemorrhage following TKA. The findings provide valuable insights into the post-operative outcomes of TKA and have implications for patient management and care.

Table 2. Correlation between pain and age with other variables

Variables		Correlation Coefficient	P
Pain	Active flexion	-0.5*	0.001
	Passive flexion	-0.59*	0.001
	Active extension	-0.14*	0.3
	Passive extension	-0.4*	0.001
	Bleeding	-0.19*	0.13
Age	Pain	-0.11*	0.37
	Active flexion	0.22*	0.09
	Passive flexion	0.24*	0.05
	Active extension	0.11**	0.4
	Passive extension	0.06**	0.6
	Bleeding	-0.16*	0.21

Notes: * shows the Spearman correlation and ** indicates the Pearson correlation.

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Table 3. Differences in variables between the two genders

Variables	Mean±SD		P
	Women	Men	
Pain	8.8±1.5	6.64±3.39	0.001
Active flexion	38.52±10.78	52.71±20.38	0.001
Passive flexion	48.89±14.28	62.93±20.04	0.01
Active extension	143.49±8.22	145.77±12.44	0.45
Passive extension	161.22±6.07	166.07±6.78	0.01
Bleeding (mL)	315.43±180.38	310.71±163.12	0.93

The study's results show that patients experience considerable pain after TKA, with the average pain reported by them on the NPRS at 8.3. This level of pain can affect the rehabilitation process and the patients' return to normal life, requiring careful consideration of effective measures to control pain after surgery [16]. The results of this study revealed that women reported higher pain levels and experienced more restricted ROM in passive knee extension and active/passive knee flexion compared to men. These findings suggest that gender may play a role in the post-operative recovery of TKA patients. The observed gender differences in pain and ROM could potentially be attributed to variations in anatomical factors, hormonal influences, or differences in pain perception and tolerance between men and women [17-19]. The higher pain levels reported by women highlight the need for tailored pain management strategies, including appropriate analgesic administration and rehabilitation interventions, to ensure optimal post-operative recovery and patient satisfaction.

Furthermore, the significant inverse correlation found between pain and ROM in passive knee extension, as well as in active and passive knee flexion, indicates that greater pain levels are associated with more restricted ROM. Tissue damage caused by surgery leads to inflammation, swelling, and pain after surgery [20]. Additionally, stretching the operated tissues during knee movements exacerbates the pain and causes autogenic inhibition of muscle contraction [21]. The study by Konishi et al. [22] on the inhibitory effect of the gamma system on the contractile strength of the quadriceps muscle also shows that the pain and inflammation caused by surgery, during various neuromuscular processes, leads to the inhibition of muscle contraction and weakness of them. A study by Thompson et al. [23] shows that in the chronic postoperative period, limited ROM and joint fibrosis are associated with pain and disability. Due to the physiological mechanisms involved, it is expected that the level of pain in patients after such surgeries would affect the ROM of the joints and muscle strength after surgery. The study findings revealed that those patients with higher levels of pain during the study phase exhibited greater limitations in both active and passive knee flexion. These results align with the underlying physiological mechanisms. Given the anterior location of the surgical incision in TKA, tension on the joint capsule and sutures of the wound, along with pain inhibition mechanisms, contribute to increased sensitivity to knee flexion and tension on the surgical site sutures. Consequently, individuals experiencing elevated post-operative pain are expected to encounter more restrictions in the knee flexion range. Furthermore, all participants in this study underwent a wide surgical procedure involving a medial parapatellar incision. The extensive nature of this surgical site intensifies tissue sensitivity to tension, further strengthening the correlation between pain level and knee flexion range.

The results revealed a significant association between passive knee extension range and patient pain. Higher levels of pain are linked to greater limitations in the passive knee extension range. However, no significant correlation is observed between pain level and the active knee extension range. It was initially anticipated that individuals experiencing more pain would exhibit limited ROM in both active and passive knee extension. However, this expectation is not supported by the findings. It is crucial to consider the context of the study, which was conducted during the acute inpatient phase. The impact of the surgical procedure on the knee extensors is substantial, and this assessment of the relationship may lack sensitivity during hospitalization due to the acute nature of the surgical wound. Most patients experience

such high levels of pain that they are unable to actively extend the knee by contracting the quadriceps muscle, which is the muscle most affected by the surgical procedure. This emphasizes the importance of effective pain management in patients undergoing TKA to facilitate early mobilization and improve functional outcomes. The findings suggest that prioritizing pain management strategies in the early postoperative period can reduce pain levels and enhance ROM. Studies have shown that physiotherapy interventions such as cryotherapy, electrotherapy, and appropriate exercise regimens can contribute to pain management, relieve muscle strength, and improve joint ROM [4, 12, 16, 24].

No significant differences were observed between genders in hemorrhage. This indicates that gender may not be a significant factor influencing this particular outcome following TKA. The absence of a significant association between gender and hemorrhage suggests that hemorrhage complication is not influenced by patient gender in the context of TKA.

On the other hand, age did not show a statistically significant correlation with pain, ROM, or hemorrhage. This implies that patient age may not be a major determinant of these post-operative outcomes in TKA patients. However, it is important to note that the age range of the participants in this study was relatively narrow, and further research with a larger and more diverse sample could provide a clearer understanding of the relationship between age and postoperative outcomes.

Conclusion

This study demonstrates that higher pain levels are associated with greater ROM restrictions in passive knee extension and active/passive knee flexion following TKA. Gender was found to be a significant factor in pain and ROM outcomes, with women experiencing more pain and ROM limitations compared to men. However, patient age and gender were not found to be associated with postoperative hemorrhage. These findings emphasize the importance of closely monitoring pain and ROM, particularly in women undergoing TKA, and tailoring pain management strategies and rehabilitation interventions to optimize patient outcomes in the postoperative period.

Study limitations

Due to the COVID-19 epidemic, elective surgeries, including TKA, were postponed or canceled at different times depending on the prevalence of the disease. As a result, it was not possible to collect a larger sample size in this study period. Due to the study design (cross-sectional), our study does not have any causal effect but as an observational study, this research is subject to potential biases and confounding factors. To address this, the study used rigorous inclusion and exclusion criteria, standardized outcome measures, and statistical methods to minimize the impact of confounding factors on the study results. The research assistant who collected the data was blinded to the study hypothesis. Additionally, the same surgeon performed all TKA procedures using the same surgical method and prosthesis to reduce variability in the surgical technique and prosthesis design. Our study was conducted in a single center with a relatively small sample size and did not include long-term follow-up data. Therefore, the study findings may not be fully representative of the broader population of TKA patients in other settings or regions. Future research could build on these findings by conducting larger, multicenter studies with longer follow-up periods to further explore the generalizability of these findings in different patient populations and settings.

Ethical Considerations

Compliance with ethical guidelines

This study protocol was approved by the Ethics Committee of the Iran University of Medical Sciences (Code: IR.IUMS.REC.1399.840). All participants provided written informed consent.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

All authors declared no conflict of interest.

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