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Unlocking the Secrets of Post-Surgical Flexion: The Vital Role of Rehabilitation in Total Knee Arthroplasty Recovery

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Abstract: This article delves into the critical aspect of postoperative flexion, particularly in the context of total knee arthroplasty (TKA), commonly known as total knee replacement. Postoperative flexion serves as a pivotal metric for assessing the success of the procedure and a patient's ability to regain functional knee movement. The exploration encompasses the desired range of post-surgery flexion, the surgical factors influencing it, and the indispensable role of rehabilitation in facilitating patients in achieving functional flexion. The study tracks the progress of 713 patients who underwent total knee arthroplasty utilizing the cemented technique, categorizing them based on whether they received non-steroidal anti-inflammatory drugs for postoperative treatment. The monitoring of prosthetic and knee complications, along with the evaluation of the Knee Association Score (KSS) for functional assessment, revealed postoperative complications in approximately 18.23% of the patient cohort. These complications were predominantly associated with a restricted range of motion (ROM < 90°) and patellar clunk syndrome. Significantly, the KSS scale exhibited notable enhancements in the quality of life at 12 months post-surgery compared to preoperative and 6-month assessments. The majority of patients achieved scores classified as good or excellent, underlining the positive impact of the surgical approach and postoperative management on functional outcomes and overall patient well-being.

Keywords: total knee arthroplasty; flexion; patellar clunk syndrome

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1. Introduction

Total knee arthroplasty (TKA), commonly referred to as total knee replacement, is a surgical procedure aimed at alleviating pain and improving knee function for individuals suffering from severe knee arthritis and other joint-related issues [1]. A pivotal aspect of this procedure is the achievement of adequate flexion, as it significantly influences a patient's ability to engage in various activities and directly impacts the overall success of the surgery [2]. The range of motion, particularly flexion, after TKA can vary depending on several factors, including preoperative knee health, surgical techniques, rehabilitation, and patient compliance [3].

Post-surgical flexion in the realm of total knee arthroplasty (TKA), commonly known as total knee replacement, is a crucial yardstick for evaluating the success of the procedure and the patient's ability to regain knee function [4]. This key metric gauges the range of motion achievable in the knee joint following the surgical intervention, directly influencing the patient's capacity to resume daily activities and improve their overall quality of life [5]. Achieving optimal post-surgical flexion is at the core of TKA's objective: to alleviate pain and restore functional knee movement [6]. The first critical aspect of post-surgical flexion involves establishing a target range [7]. Typically, surgeons aim for a postoperative flexion

range between 120 and 130 degrees [4]. This range provides patients with the ability to bend and extend their knees, perform daily tasks, and lead to a more active lifestyle [8].

Post-surgical flexion is routinely evaluated by orthopedic surgeons during follow-up appointments [9]. These assessments gauge the extent to which the patient has regained knee flexibility and the achievement of the desired post-surgical flexion [10]. This continuous monitoring is essential for tracking progress and adjusting rehabilitation plans as needed [11]. With the aim of improving the success rate of total knee arthroplasty surgery, rehabilitation is initiated even before the surgical procedure [12,13]. The most effective approach to rehabilitation is a personalized multimodal program [14]. Postoperatively, it is advised to engage in early and progressive mobilization, coupled with immediate cryotherapy and continuous passive motion within a predefined range of motion [15]. By the end of the first week, the target is to achieve a flexion angle of 90 degrees and full extension of the knee. Over the subsequent two weeks, the goal is to increase knee flexion to 100 degrees. After 6 weeks, it is recommended to attain a flexion range of 110–120° [16]. According to the guidelines of the American Physiotherapy Association, it is further recommended to continue exercises aimed at enhancing the muscle strength of the specified muscle groups to achieve optimal motor control, encompassing aspects such as mobility, stability, controlled mobility, and overall functionality [17].

While the surgical procedure is pivotal, the journey towards optimal post-surgical flexion heavily relies on postoperative rehabilitation [18]. Through physical therapy and exercise regimens, patients work to strengthen the muscles surrounding the knee joint, enhance flexibility, and incrementally increase their flexion [19]. The rehabilitation process plays a pivotal role in helping patients regain their knee function and reach their targeted range of motion [20].

Actively participating in postoperative rehabilitation exercises and adhering to medical instructions are fundamental to achieving [7] and maintaining post-surgical flexion [21]. Patient commitment and diligence in the rehabilitation process are instrumental in their progress, directly impacting the extent of flexion they can attain post-surgery [22]. This collaborative effort between patients and healthcare providers is central to the ultimate success of TKA [18] in restoring knee function and enhancing patients' quality of life [23].

The Knee Association Score (KSS) score is a measure utilized to evaluate the function and clinical outcomes of patients who have undergone knee surgery, including procedures like total knee arthroplasty [24]. The KSS score comprises two primary components:

Pain and Function Score: This component evaluates the level of pain experienced by the patient and its impact on daily activities. It also assesses the patient's ability to perform specific knee movements and overall functionality.

Radiographic Score: This component analyzes knee radiographs to evaluate the correct alignment of the implant, bone condition, and potential complications or pathological changes.

The purpose of this article is to underscore not only the effectiveness of recovery without NSAID treatment but also the vital importance of the rehabilitation process in enhancing patients' quality of life. Our objective is to delve into not only the issues related to postoperative flexion, the desired range, and the surgical factors influencing it, but also to highlight the crucial role that rehabilitation plays in supporting patients on their journey towards achieving functional flexion after surgery. Through this, we aim to emphasize not only the significance of flexion in TKA (total knee arthroplasty) but also the essential contribution of the rehabilitation process in facilitating the recovery of functional flexion, thereby significantly impacting the quality of life of patients. Over time, additional studies will be necessary to compare classic and robotic surgery, aiming to identify the most effective method of rehabilitation.

2. Materials and Methods

The progress of 713 patients who underwent total knee arthroplasty using the cemented technique was monitored, depending on the administration of non-steroidal

anti-inflammatory drugs for postoperative treatment. The patients were consecutively recruited from the orthopedic department of the Oradea County Emergency Clinical Hospital, Oradea, Romania, between 2018 and 2022 (ethics approval no. 14146/15.06.2020).

Study parameters included primary gonarthrosis, secondary gonarthrosis, knee pathogenesis and pathology, bone density, metabolic disorders, and non-cartilaginous pain.

2.1. Inclusion Criteria

This study has specific criteria for the inclusion and exclusion of participants. To be eligible for inclusion, individuals must be at least 18 years old and willing to sign the informed consent agreement, indicating their voluntary participation in the study.

2.2. Exclusion Criteria

Conversely, individuals who fail to furnish informed consent will be ineligible for participation. Furthermore, individuals exhibiting substantial neurological problems, severe comorbidities, or any condition hindering effective patient monitoring will also be excluded from the study. These exclusion criteria are implemented to safeguard the safety and credibility of the research, as well as to uphold an appropriate participant cohort aligned with the study's goals.

2.3. Rehabilitation Process

To enhance the success rate, a preoperative preparation strategy involving a muscle toning program, encompassing knee flexion and extension exercises lasting 1–3 weeks, was employed. Isometric and resistance exercises were incorporated, with particular emphasis on the triceps sural for its stabilizing role, as indicated in prior descriptions, as well as attention to the middle gluteal muscles, tensor of the fascia lata, and the adductors.

Subsequently to the surgery, an early and progressive mobilization regimen was implemented, involving immediate cryotherapy and continuous passive movement. The rehabilitation program monitored physical abilities, fatigue, and cardiovascular endurance as components of a multimodal approach, with intensity adjustments based on pain levels. The sessions focused on assessing neuromuscular function, postural control, flexibility, muscle strength, and cardiovascular function. In a hospital setting, training occurred with a frequency of two to four sessions per day, lasting 30 to 50 min each. After discharge, the frequency reduced to once a day.

2.4. Clinical Analysis

Based on the type of intervention, risk factors, clinical evaluation, surgical approach, complications, applied treatments, and benefits were followed. Post-operative evaluations were conducted at 2 weeks, 6 weeks, 3 months, and 6 months.

The description of the clinical parameters was categorized into two parts: the description of the risk factors contributing to the development of knee arthropathies and the specific clinical evaluation.

2.5. Statistical Analysis

We used SPSS 20 software, version 20 (New York, NY, USA) for statistical data analysis. One-way ANOVA was employed to examine whether there were statistical differences in surface roughness, hardness, and tensile parameters among the three types of resins used. Chi-square was used for non-parametric statistical analysis. Skewness and Kurtosis statistical tests were conducted. Additionally, the Bonferroni multiple comparison test was employed to identify the statistically significant differences in each possible paired sample. The statistical analysis was performed with a significance level of $p < 0.05$.

3. Results

3.1. Demographic Description

The research cohort, comprising 713 individuals, was selected from among the patients who presented themselves at the Orthopedics Department of the County Clinical Hospital between 2018 and 2022. The cohort was divided into two study groups: those who received anti-inflammatory treatment in the first 7 postoperative days (NSAIDs) and those who did not receive non-steroidal anti-inflammatory drugs (N-NSAIDs). The average age per cohort was 52.48 (11.78), with more men in the N-NSAIDs group, and there were no significant differences observed between individuals from urban and rural environments, presented in Table 1.

Table 1. Demographic description of the cohort and the two research groups.

Parameters		Groups					Total	
		N-NSAIDs		NSAIDs				
		N	%	N	%	*p*	N	%
Age (Mean + SD)		57.77 (12.45)		58.29 (7.61)		0.916	58.03 (10.03)	
Gender	Masculine	248	34.8	138	19.4	0.001	386	54.1
	Feminine	146	20.5	181	25.4		327	45.9
Environment	Urban	165	23.1	132	18.5	0.893	297	41.7
	Rural	229	32.1	187	26.2		416	58.3

N = number of patients; *p* = statistical significance; SD = standard deviation; NSAIDs = those who received anti-inflammatory treatment; N-NSAIDs = those who did not receive non-steroidal anti-inflammatory drugs.

3.2. Prosthetic Complications

Regarding postoperative complications, they occurred in 18.23% of the cohort, with the most common issues being a restricted range of motion (ROM < 90°) and the occurrence of patellar clunk syndrome. It is important to note that the majority of patients did not experience any complications (583 individuals), as described in Table 2. If the range of motion after arthroplasty is limited to less than 90 degrees, several problems could be indicated:

- Postoperative Restriction: It is common for patients to experience some degree of joint stiffness or swelling after surgery. Physical therapy and prescribed exercises can aid in improving joint range of motion over time.
- Inadequate Healing: Excessive scar tissue formation or adhesions around the joint can limit movement. In such cases, additional surgery may be necessary to remove scar tissue and improve ROM.
- Misalignment of the Prosthesis: If the prosthesis is not correctly positioned or is misaligned, it can restrict the normal movement of the joint. In some instances, surgical revision may be required to correct the issue.

Table 2. Prosthetic complications in the two research groups.

Parameters		Groups			
		N-NSAIDs		NSAIDs	
		N	%	N	%
Prosthetic complications	Without complications	375	52.6%	208	29.2%
	ROM < 90°	11	1.5%	54	7.6%
	Patellar clunk syndrome	8	1.1%	57	8.0%

N = number of patients; NSAIDs = those who received anti-inflammatory treatment; N-NSAIDs = those who did not receive non-steroidal anti-inflammatory drugs.

From Figure 1, it is evident that there is a 6.1% higher incidence of patients experiencing complications related to normal range of motion in the NSAIDs group, with statistically significant differences (χ^2 = 106.511, p = 0.001). Additionally, regarding patellar clunk syndrome, 6.9% more patients were observed in the NSAID group, also showing a statistically significant difference (χ^2= 113.230, p = 0.001).

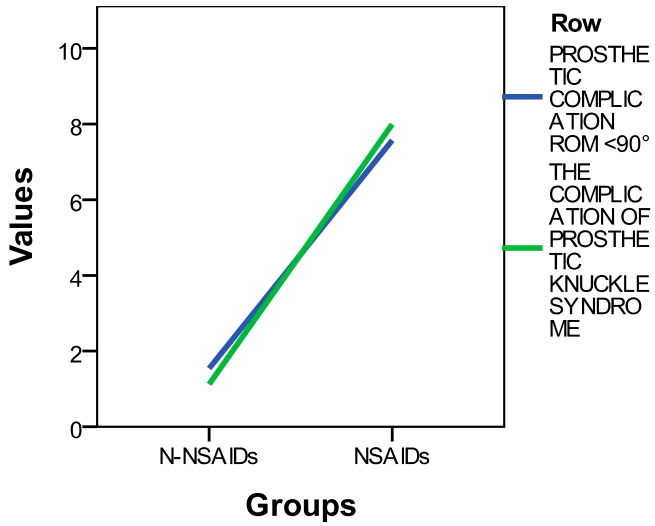

Figure 1. Graphical representation of prosthetic complications in the two research groups.

3.3. Knee Complications

Knee complications, including redness, clunk, rigidity, mechanical issues, septic complications, and fractures, were monitored. In Figure 2, there is a graphical representation of the six types of complications monitored throughout the cohort.

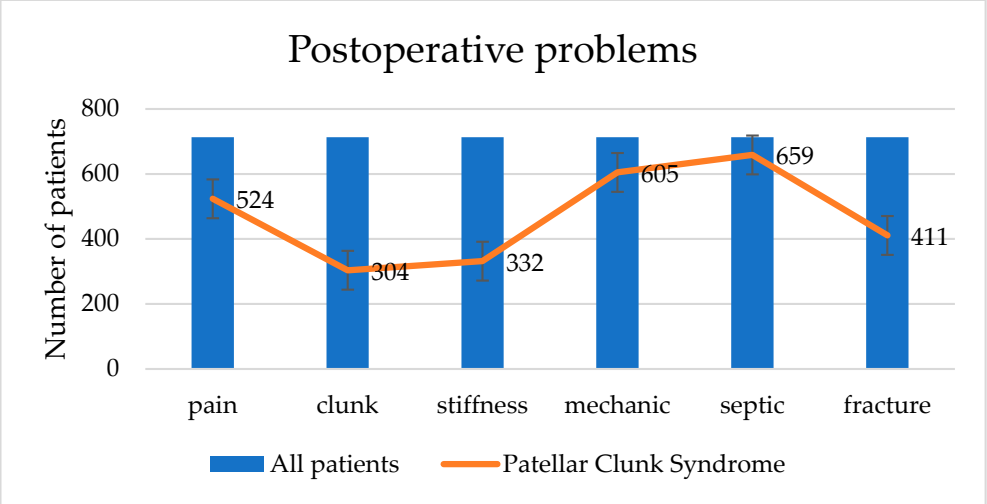

Figure 2. Graphical representation of the six types of complications monitored throughout the cohort.

A total of 275 patients experienced all six problems, 28 individuals had five different problems, 136 patients were affected by four different types of problems, 84 people had three, and 108 patients had two different types of problems. Additionally, 27 patients had only one of the six problems, while 54 had none of the six types of problems, as illustrated in Figure 3.

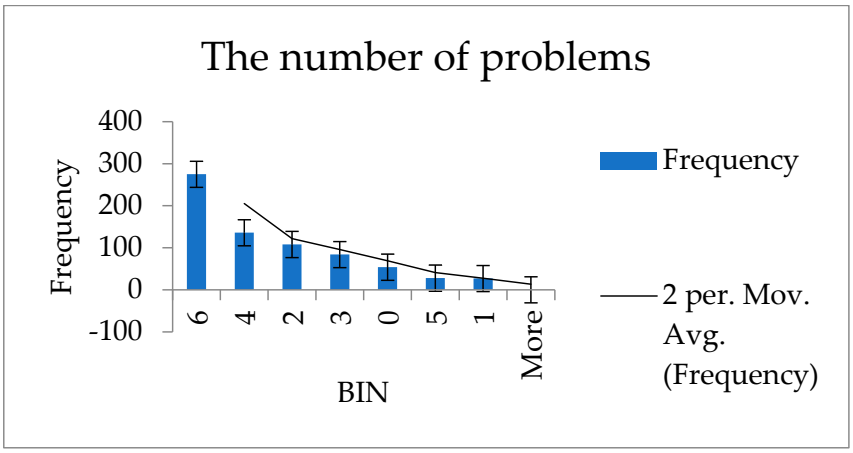

Figure 3. Graphical representation of the number of problems for each individual patient.

3.4. Knee Society Score (KSS)

In our case, we divided the KSS score into two parts, which are presented in Table 3 (Part 1, focusing on the knee score and stability, including maximum movement in any position; and Part 2, covering the functions of the musculoskeletal system).

Table 3. Statistical description of initial and final KSS Scores in the two research groups.

Parameters		Testul t Student						
		N	t	*p*	Medie	SD	95% CI	
							Lower	Upper
KSS preoperator	N-AINS	394	−0.643	0.520	60.6168	5.72285	−1.12135	0.56802
	AINS	319	−0.643	0.520	60.8934	5.69905	−1.12104	0.56771
KSS 6 months	N-AINS	394	2.684	0.007	73.0635	4.61589	0.24015	1.54819
	AINS	319	2.713	0.007	72.1693	4.17196	0.24705	1.54130

CI = confidence interval; N = number of patients; t = Student's t coefficient; *p* = statistical significance; KSS = Knee Association Score; N = number of patients; NSAIDs = those who received anti-inflammatory treatment; N-NSAIDs = those who did not receive non-steroidal anti-inflammatory drugs.

The graphical representation of the KSS scale, utilizing the point cloud technique, illustrates the distribution of patients at three evaluation points. Prior to surgery, most patients were concentrated between scores of 40 and 70, while at 6 months post-surgery, the distribution extended from 65 to 85. By the 12-month evaluation, patients were clustered between scores of 65 and 90. This expansion in the range of values indicates an increase in the score, signifying an improved quality of life at the 12-month evaluation (Figure 4).

The interpretation of scores is contingent upon the range of achieved scores, with scores falling within the range of 80–100 considered Excellent, 70–79 as Good, 60–69 as Acceptable, and scores below 60 as Poor. The function score (Knee Society Score) is 0 (NB: consider a negative result as zero) at 6–8.

The average KSS scale values, obtained at the two assessment points and presenting statistically significant results following statistical analysis using the Student *t*-test, are provided in Table 3. The enhancement of quality of life, as assessed through this scale, is depicted in Figure 5, showing an increase in scores at the 12-month evaluation in comparison to the preoperative and 6-month assessments.

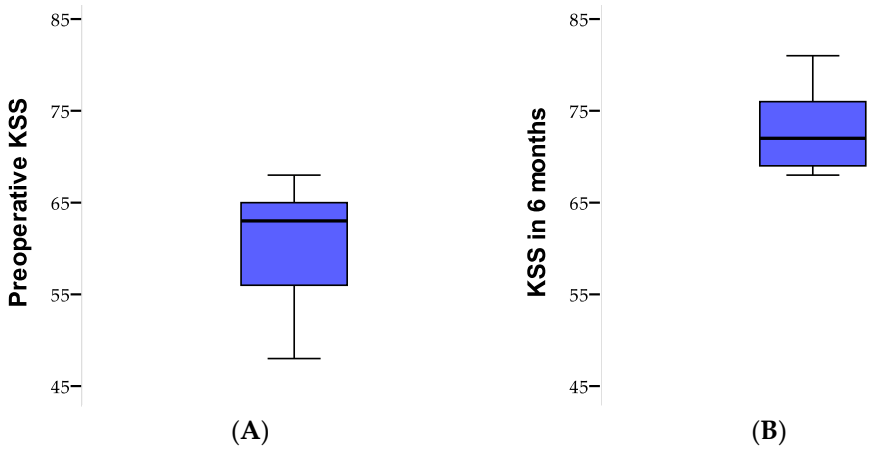

Figure 4. Graphical representation of mean KSS scale scores at the study's commencement and conclusion in preoperative stage (**A**) and after 6 months (**B**).

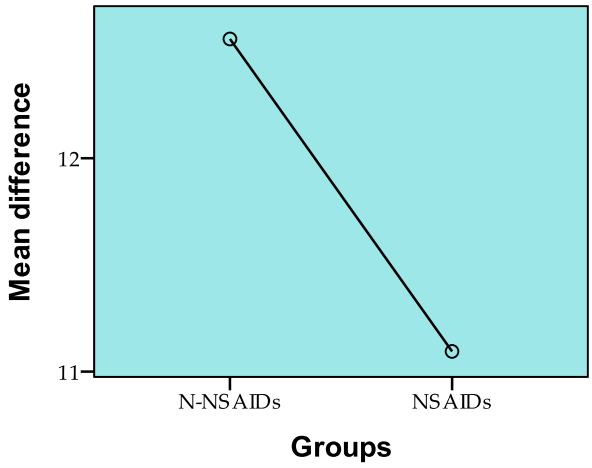

Figure 5. Graphical representation of the average values of the KSS scale at the three evaluation time points.

Figure 5 illustrates the discernible variations in the final outcomes as compared to the initial data concerning the progression of Knee Association Score (KSS). A comprehensive statistical analysis revealed a noteworthy disparity between the two research groups. The calculated F-statistic (ANOVA) of 4640 yielded a *p*-value of 0.032, indicating statistical significance. Importantly, the group receiving non-steroidal anti-inflammatory drugs (NSAIDs), denoted as the "N-group", exhibited significantly superior results in comparison to the counterpart group.

The observed statistical difference underscores the impact of NSAIDs on the evolution of KSS, implying a meaningful influence on the functional outcomes measured by this scoring system. These findings suggest a potential association between the use of NSAIDs and enhanced postoperative knee function, providing valuable insights into the factors contributing to the divergent results within the studied patient cohorts. Further investigation into the specific mechanisms and implications of NSAID administration in the context of total knee arthroplasty may illuminate pathways for optimizing patient outcomes and guiding clinical decision making.

4. Discussion

Only a few studies have directly compared the outcomes of uncemented knee arthroplasty (UKA) and cemented UKA. However, a prospective study of 1000 cases of cemented UKA with a 10-year follow-up was conducted by Pandit et al. at a center similar to the one in Mohammad et al.'s study, which was also conducted at the same center. Both studies

used the same unicompartmental implant with a mobile bearing, in the cemented version, and employed a minimally invasive procedure, evaluating the same functional results. The ten-year follow-up results showed a mean flexion angle of 127°, a mean Oxford Knee Score (OKS) of 40, a Knee Society Score Objective (KSS-O) score of 80, a Knee Society Score Functional (KSS-Functional) score of 76, and a Tegner score of 2.7. Patients with excellent results (OKS > 41) represented 55% of the total, while patients with poor results (OKS < 27) represented 10%. These were similar studies, and although there is limited reporting of functional outcomes in cemented UKA research, no statistical analysis is available for these studies [25,26].

Surgical technology is undergoing continuous development. The exploration of robotic interventions [27] is currently under study, and, as is customary with new advancements, opinions are divided. Surgical systems such as MAKO [28], THINK [29], ROBODOC [30], and others have been subject to both praise and criticism. However, in the wake of the rapid advancements in informatics and artificial intelligence, these systems are now perceived as more effective, economical, and increasingly intelligent alternatives in surgery [30]. In our study, classical surgery was synergistically combined with the proven effectiveness of rehabilitation. The most favorable outcomes were observed in the N-NSAIDs group, showcasing the synergistic benefits of traditional surgical approaches complemented by the integration of rehabilitation practices.

Biomechanical and anatomical improvements are being made in implant design for TKA (total knee replacement). However, it is important to note that TKA represents a less accurate approximation of the physiological biomechanics of the knee. Normally, the human knee moves by means of the cruciate ligaments, but in the case of TKA, the movement is mainly supported by a polyethylene insert. There are several options for inserts available, made of various types of materials [31–34], including fixed bearing, rotating, or posteriorly stabilized ones [35]. These inserts cannot fully replicate genuine knee motion, including backward rolling of the femoral condyles on the tibial plateau. However, different types of inserts have demonstrated comparable clinical results in practice [36]. A structure has been recently developed that replicates the two cruciate ligaments, but independent long-term follow-up studies are lacking [5]. The anatomical structure of the implant was improved in later stages. Initial anatomical research revealed greater flexibility in the distal femur compared to existing implant designs. A significant difference was observed between male and female implants. Consequently, implants with adjusted quadriceps-angles and a new correlation between frontal and anteroposterior diameters were developed. Although a wide variety of implants have been introduced, there are still no randomized clinical trials to confirm positive results. Another aspect of implant development is a design that supports the movement of the patella by creating a more anatomical trochlea. In addition, implants have been created that allow greater flexion of the knee prosthesis, reaching up to an angle of 155°. These improvements resulted in an improved offset/balance of the posterior condyle, allowing for better posterior femoral motion and greater knee flexion [29]. Considering all these aspects, randomized clinical trials (RCTs) have failed to demonstrate a significant difference between the standard knee prosthesis and the high-flexion prosthesis in terms of clinical outcomes [37]. With the increasing widespread use of total knee and total hip arthroplasty, postoperative pain management is an important clinical challenge. Effective pain control has been associated with early mobilization, reduced length of hospital stay, and fewer postoperative complications. Currently, the multimodal approach to pain management is considered the optimal option for pain control after total knee or total hip arthroplasty [38,39]. Goladay et al. [40] recommended multimodal analgesia as part of a preventive approach to pain control in patients undergoing knee or hip arthroplasty.

The use of local infiltration analgesia (LIA) in joint arthroplasty surgery has been shown to be effective in reducing postoperative pain. A study by Tran and Schwarzkopf found that the use of LIA in postoperative pain management after total knee arthroplasty resulted in a decrease in hospital length of stay and total morphine consumption [41]. In a systematic review by Jimenez-Almonte et al., it was found that there were no significant

differences between local infiltration analgesia and peripheral nerve blocks in terms of analgesia or opioid consumption 24 h after total hip arthroplasty [42]. However, this approach has been criticized for its limited effect on long-term pain [43].

Opioid consumption is also an important indicator for evaluating the analgesic effect of acetaminophen. It has been commonly used as an adjunct in a multimodal analgesia protocol. The analgesic effect of additional opioids ensures a long postoperative period without the participants experiencing any pain. According to Lee et al., this was demonstrated in a previous study [44] where they reported an improvement in pain scores, both at rest and during movement, as well as a reduction in the incidence of severe pain, in patients who received analgesia [45]. However, according to several previous studies, patients were frequently found to experience drug-related adverse reactions such as gastrointestinal events, headache, and constipation [46,47]. Streamlining the analgesia protocol is essential to reduce opioid use. A significant amount of the literature demonstrates that intravenous acetaminophen could reduce narcotic requirements in patients admitted for major orthopedic surgery. However, the use of intravenous acetaminophen for pain control after TKA (total knee arthroplasty) has been rarely reported. Postoperative complications are a major concern after additional opioid administration. Gastrointestinal events are well-known side effects associated with the systemic use of morphine. An appropriate analgesia protocol could reduce opioid consumption and, implicitly, the risk of postoperative complications.

5. Conclusions

Postoperative complications affected approximately 18.23% of the patient cohort, primarily concerning normal range of motion (ROM < 90°) and patellar clunk syndrome.

Inadequate healing, such as excessive scar tissue formation or adhesions around the joint, can limit movement and may necessitate additional surgery.

Misalignment of the prosthesis can result in restrictions in the normal movement of the joint, often requiring surgical revision.

The group of patients who experienced complications related to normal range of motion recorded a significantly higher percentage (6.1%) when NSAIDs were administered, and in terms of patellar clunk syndrome, the percentage was 6.9% higher in this group.

The KSS scale showed a significant increase in the 6-month quality-of-life assessments, with the majority of patients achieving scores considered good or excellent. The mean values of the KSS scale exhibited statistically significant improvements at the two evaluation points, reflecting an enhancement in the patients' quality of life.

Limitations noted include small sample sizes, which could affect the overall results. We did not perform a range of motion analysis due to limited data availability, and the existence of a risk of bias in the articles may influence our results. Short-term follow-up may underestimate side effects. Additionally, clinical heterogeneity could not be completely eliminated, requiring more randomized controlled trials for subgroup analysis.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of the University of Oradea. The patients were consecutively recruited from the orthopedic department of the Oradea County Emergency Clinical Hospital, Oradea, Romania, between 2018 and 2022 (ethics approval no. 14146/15.06.2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: All the data processed in this article are part of the research for a doctoral thesis, being archived in the aesthetic medical office, where the interventions were performed.

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Conflicts of Interest: The author declares no conflict of interest.

References

1. Ditton, E.; Johnson, S.; Hodyl, N.; Flynn, T.; Pollack, M.; Ribbons, K.; Walker, F.R.; Nilsson, M. Improving Patient Outcomes Following Total Knee Arthroplasty: Identifying Rehabilitation Pathways Based on Modifiable Psychological Risk and Resilience Factors. *Front. Psychol.* **2020**, *11*, 1061. [CrossRef]
2. Lai, P.-L.; Jang, H.; Fang, M.; Peng, K. Determinants of customer satisfaction with parcel locker services in last-mile logistics. *Asian J. Shipp. Logist.* **2022**, *38*, 25–30. [CrossRef]
3. Jette, D.U.; Hunter, S.J.; Burkett, L.; Langham, B.; Logerstedt, D.S.; Piuzzi, N.S.; Poirier, N.M.; Radach, L.J.L.; Ritter, J.E.; Scalzitti, D.A.; et al. Physical Therapist Management of Total Knee Arthroplasty. *Phys. Ther.* **2020**, *100*, 1603–1631. [CrossRef] [PubMed]
4. Kittelson, A.J.; Elings, J.; Colborn, K.; Hoogeboom, T.J.; Christensen, J.C.; van Meeteren, N.L.U.; van Buuren, S.; Stevens-Lapsley, J.E. Reference chart for knee flexion following total knee arthroplasty: A novel tool for monitoring postoperative recovery. *BMC Musculoskelet. Disord.* **2020**, *21*, 482. [CrossRef] [PubMed]
5. Lin, J. Posterior Cruciate-Retaining vs. Posterior Cruciate-Stabilized Prosthesis in Total Knee Arthroplasty: A Meta-Analysis. *Altern. Ther. Health Med.* **2023**, *29*, 191–197. [PubMed]
6. Amano, T.; Tanaka, R.; Tanaka, S. Clinical prediction rule for early recovery of knee range of motion after total knee arthroplasty: A prospective cohort study. *Phys. Ther. Res.* **2020**, *23*, 202–208. [CrossRef]
7. Oka, T.; Wada, O.; Asai, T.; Maruno, H.; Mizuno, K. Importance of knee flexion range of motion during the acute phase after total knee arthroplasty. *Phys. Ther. Res.* **2020**, *23*, 143–148. [CrossRef] [PubMed]
8. Hurley, M.; Dickson, K.; Hallett, R.; Grant, R.; Hauari, H.; Walsh, N.; Stansfield, C.; Oliver, S. Exercise interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: A mixed methods review. *Cochrane Database Syst. Rev.* **2018**, *4*, CD010842. [CrossRef] [PubMed]
9. Hendricks, T.J.; Chong, A.C.M.; Cusick, R.P. The Cost of Routine Follow-Up in Total Joint Arthroplasty and the Influence of These Visits on Treatment Plans. *Kans. J. Med.* **2018**, *11*, 59–66. [CrossRef]
10. Spierings, J.; Van den Hengel, M.; Janssen, R.P.; Van Rietbergen, B.; Ito, K.; Foolen, J. Knee instability caused by altered graft mechanical properties after anterior cruciate ligament reconstruction: The early onset of osteoarthritis? *Front. Bioeng. Biotechnol.* **2023**, *11*, 1244954. [CrossRef]
11. Jensen-Doss, A.; Haimes, E.M.B.; Smith, A.M.; Lyon, A.R.; Lewis, C.C.; Stanick, C.F.; Hawley, K.M. Monitoring Treatment Progress and Providing Feedback is Viewed Favorably but Rarely Used in Practice. *Adm. Policy Ment. Health* **2018**, *45*, 48–61. [CrossRef]
12. Villadsen, A.; Overgaard, S.; Holsgaard-Larsen, A.; Christensen, R.; Roos, E.M. Postoperative effects of neuromuscular exercise prior to hip or knee arthroplasty: A randomised controlled trial. *Ann. Rheum. Dis.* **2014**, *73*, 1130–1137. [CrossRef] [PubMed]
13. Calatayud, J.; Casaña, J.; Ezzatvar, Y.; Jakobsen, M.D.; Sundstrup, E.; Andersen, L.L. High-intensity preoperative training improves physical and functional recovery in the early post-operative periods after total knee arthroplasty: A randomized controlled trial. *Knee Surg. Sports Traumatol. Arthrosc.* **2017**, *25*, 2864–2872. [CrossRef] [PubMed]
14. Larsen, J.B.; Mogensen, L.; Arendt-Nielsen, L.; Madeleine, P. Intensive, personalized multimodal rehabilitation in patients with primary or revision total knee arthroplasty: A retrospective cohort study. *BMC Sports Sci. Med. Rehabil.* **2020**, *12*, 5. [CrossRef] [PubMed]
15. Lee, B.C.; Moon, C.W.; Choi, W.S.; Kim, Y.M.; Joo, Y.B.; Lee, D.G.; Lee, S.J.; Choi, E.S.; Ji, J.H.; Suh, D.W.; et al. Clinical evaluation of usefulness and effectiveness of sitting type continuous passive motion machines in patients with total knee arthroplasty: A study protocol for a single-blinded randomized controlled trial. *BMC Musculoskelet. Disord.* **2022**, *23*, 565. [CrossRef] [PubMed]
16. Kornuijt, A.; de Kort, G.J.L.; Das, D.; Lenssen, A.F.; van der Weegen, W. Recovery of knee range of motion after total knee arthroplasty in the first postoperative weeks: Poor recovery can be detected early. *Musculoskelet. Surg.* **2019**, *103*, 289–297. [CrossRef] [PubMed]
17. Wang, J.; Zhu, R.; Xu, X.T.; Liu, S.; Li, Z.; Guo, C.; Tao, X.; Qian, L.; Charles, R.; Fang, L. Effects of strength training on functional ambulation following knee replacement: A systematic review, meta-analysis, and meta-regression. *Sci. Rep.* **2023**, *13*, 10728. [CrossRef]
18. Zhao, B.; Liu, H.; Du, K.; Zhou, W.; Li, Y. Effectiveness and safety of outpatient rehabilitation versus home-based rehabilitation after knee arthroplasty: A systematic review and meta-analysis. *J. Orthop. Surg. Res.* **2023**, *18*, 704. [CrossRef]
19. Suzuki, Y.; Iijima, H.; Tashiro, Y.; Kajiwara, Y.; Zeidan, H.; Shimoura, K.; Nishida, Y.; Bito, T.; Nakai, K.; Tatsumi, M.; et al. Home exercise therapy to improve muscle strength and joint flexibility effectively treats pre-radiographic knee OA in community-dwelling elderly: A randomized controlled trial. *Clin. Rheumatol.* **2019**, *38*, 133–141. [CrossRef]
20. Biggs, A.; Jenkins, W.L.; Urch, S.E.; Shelbourne, K.D. Rehabilitation for Patients Following ACL Reconstruction: A Knee Symmetry Model. *N. Am. J. Sports Phys. Ther.* **2009**, *4*, 2–12.

21. Logan, C.A.; O'Brien, L.T.; LaPrade, R.F. Post operative rehabilitation of grade III medial collateral ligament injuries: Evidence based rehabilitation and return to play. *Int. J. Sports Phys. Ther.* **2016**, *11*, 1177–1190. [PubMed]
22. Doi, K.; Yii Chia, D.S.; Hattori, Y.; Sakamoto, S. Virtual Rehabilitation of Elbow Flexion Following Nerve Transfer Reconstruction for Brachial Plexus Injuries Using the Single-Joint Hybrid Assisted Limb. *J. Hand Surg. Glob. Online* **2022**, *4*, 97–102. [CrossRef] [PubMed]
23. Feng, J.E.; Novikov, D.; Anoushiravani, A.A.; Schwarzkopf, R. Total knee arthroplasty: Improving outcomes with a multidisciplinary approach. *J. Multidiscip. Healthc.* **2018**, *11*, 63–73. [CrossRef] [PubMed]
24. Wang, K.; Sun, H.; Zhang, K.; Li, S.; Wu, G.; Zhou, J.; Sun, X. Better outcomes are associated with cementless fixation in primary total knee arthroplasty in young patients: A systematic review and meta-analysis of randomized controlled trials. *Medicine* **2020**, *99*, e18750. [CrossRef] [PubMed]
25. Kyriakidis, T.; Asopa, V.; Baums, M.; Verdonk, R.; Totlis, T. Unicompartmental knee arthroplasty in patients under the age of 60 years provides excellent clinical outcomes and 10-year implant survival: A systematic review: A study performed by the Early Osteoarthritis group of ESSKA-European Knee Associates section. *Knee Surg. Sports Traumatol. Arthrosc.* **2023**, *31*, 922–932. [CrossRef]
26. Mohammad, H.R.; Kennedy, J.A.; Mellon, S.J.; Judge, A.; Dodd, C.A.; Murray, D.W. Ten-year clinical and radiographic results of 1000 cementless Oxford unicompartmental knee replacements. *Knee Surg. Sports Traumatol. Arthrosc.* **2020**, *28*, 1479–1487. [CrossRef]
27. Tokgoz, E.; Levitt, S.; Sosa, D.; Carola, N.A.; Patel, V. Robotics Applications in Total Knee Arthroplasty. In *Total Knee Arthroplasty: A Review of Medical and Biomedical Engineering and Science Concepts*; Tokgoz, E., Levitt, S., Sosa, D., Carola, N.A., Patel, V., Eds.; Springer Nature Switzerland: Cham, Switzerland, 2023; pp. 155–174.
28. Batailler, C.; Fernandez, A.; Swan, J.; Servien, E.; Haddad, F.S.; Catani, F.; Lustig, S. MAKO CT-based robotic arm-assisted system is a reliable procedure for total knee arthroplasty: A systematic review. *Knee Surg. Sports Traumatol. Arthrosc.* **2021**, *29*, 3585–3598. [CrossRef]
29. Khow, Y.Z.; Liow, M.H.L.; Lee, M.; Chen, J.Y.; Lo, N.N.; Yeo, S.J. Posterior condylar offset and posterior tibial slope targets to optimize knee flexion after unicompartmental knee arthroplasty. *Knee Surg. Sports Traumatol. Arthrosc.* **2022**, *30*, 822–831. [CrossRef]
30. Li, T.; Badre, A.; Alambeigi, F.; Tavakoli, M. Robotic Systems and Navigation Techniques in Orthopedics: A Historical Review. *Appl. Sci.* **2023**, *13*, 9768. [CrossRef]
31. Ormanci, O.; Akin, I.; Sahin, F.; Yucel, O.; Simon, V.; Cavalu, S.; Goller, G. Spark Plasma Sintered Al_2O_3–YSZ–TiO_2 Composites: Processing, Characterization and in Vivo Evaluation. *Mater. Sci. Eng. C* **2014**, *40*, 16–23. [CrossRef]
32. Cavalu, S.; Banica, F.; Simon, V.; Akin, I.; Goller, G. Surface Modification of Alumina/Zirconia Ceramics upon Different Fluoride-Based Treatments. *Int. J. Appl. Ceram. Technol.* **2013**, *11*, 402–411. [CrossRef]
33. Chopra, H.; Baig, A.A.; Cavalu, S.; Singh, I.; Emran, T.B. Robotics in surgery: Current trends. *Ann. Med. Surg.* **2022**, *81*, 104375. [CrossRef] [PubMed]
34. Youssef, M.E.; Abdel-Reheim, M.A.; Morsy, M.A.; El-Daly, M.; Atwa, G.M.; Yahya, G.; Cavalu, S.; Saber, S.; Ahmed Gaafar, A.G. Ameliorative effect of dabigatran on CFA-induced rheumatoid arthritis via modulating kallikrein-kinin system in rats. *Int. J. Mol. Sci.* **2022**, *23*, 10297. [CrossRef] [PubMed]
35. Wiradiputra, A.E.; Dharmayuda, C.G.O. Does Posterior Stabilized Better than Posterior Cruciate Retaining in Total Knee Replacement? A Systematic Review and Meta-analysis. *Eur. J. Med. Health Sci.* **2023**, *5*, 11–17. [CrossRef]
36. Kersten, R.; de Vries, A.; van Raaij, J.; Brouwer, R. 12-Year clinical and radiological results of a double-blind randomized controlled trial comparing posterior cruciate-retaining versus posterior-stabilized total knee arthroplasty. *Knee* **2023**, *45*, 110–116. [CrossRef]
37. Ueyama, H.; Kanemoto, N.; Minoda, Y.; Yamamoto, N.; Taniguchi, Y.; Nakamura, H. No Difference in Postoperative Knee Flexion and Patient Joint Awareness Between Cruciate-Substituting and Cruciate-Retaining Medial Pivot Total Knee Prostheses: A 10-Year Follow-Up Study. *J. Arthroplast.* **2022**, *37*, 279–285. [CrossRef]
38. Lamplot, J.D.; Wagner, E.R.; Manning, D.W. Multimodal pain management in total knee arthroplasty: A prospective randomized controlled trial. *J. Arthroplast.* **2014**, *29*, 329–334. [CrossRef]
39. Schwartz, A.; Cochrane, N.H.; Jiranek, W.A.; Ryan, S.P. Periarticular Injection in Total Knee Arthroplasty. *JAAOS-J. Am. Acad. Orthop. Surg.* **2022**, *31*, 614–619. [CrossRef]
40. Golladay, G.J.; Balch, K.R.; Dalury, D.F.; Satpathy, J.; Jiranek, W.A. Oral Multimodal Analgesia for Total Joint Arthroplasty. *J. Arthroplast.* **2017**, *32*, S69–S73. [CrossRef]
41. Tran, J.; Schwarzkopf, R. Local infiltration anesthesia with steroids in total knee arthroplasty: A systematic review of randomized control trials. *J. Orthop.* **2015**, *12*, S44–S50. [CrossRef]
42. Jiménez-Almonte, J.H.; Wyles, C.C.; Wyles, S.P.; Norambuena-Morales, G.A.; Báez, P.J.; Murad, M.H.; Sierra, R.J. Is Local Infiltration Analgesia Superior to Peripheral Nerve Blockade for Pain Management After THA: A Network Meta-analysis. *Clin. Orthop. Relat. Res.* **2016**, *474*, 495–516. [CrossRef] [PubMed]
43. Li, Y.; Zhu, S.; Luo, J.; Tong, Y.; Zheng, Y.; Ji, L.; He, Z.; Jing, Q.; Huang, J.; Zhang, Y.; et al. The Protective Effect of Selenium Nanoparticles in Osteoarthritis: In vitro and in vivo Studies. *Drug Des. Devel. Ther.* **2023**, *17*, 1515–1529. [CrossRef] [PubMed]

44. Kim, M.K.; Ko, S.H.; Hwang, Y.J.; Kwon, D.G.; Jeon, Y.S.; Ryu, D.J. Effectiveness of continuous femoral nerve block for pain relief after total knee arthroplasty: Comparison with epidural patient-controlled analgesia and periarticular injection. *J. Int. Med. Res.* **2022**, *50*, 4. [CrossRef] [PubMed]
45. Murvai, G.F.; Hozan, C.T.; Magheru, C.; Szilagyi, G.; Bulzan, M.; Murvai, V.R.; Cavalu, S.; Ghitea, T.C. Highlighting the Advantages and Benefits of Non-NSAID Treatment after Total Knee Arthroplasty: A Cross-sectional Study. *In Vivo* **2023**, *37*, 2371–2380. [CrossRef]
46. Ban, M.; Choi, Y.S.; Koo, B.-N. Analgesic Effect of Intrathecal Morphine Combined with Low-Dose Bupivacaine on Postoperative Analgesia after Liver Resection: A Randomized Controlled Study. *J. Pers. Med.* **2022**, *12*, 211. [CrossRef]
47. Louters, A. A Qualitative Study to Map Drug-Related Problems Orthopaedic Patients Experience within Six Weeks Post Discharge. Master's Thesis, Utrecht University, Utrecht, The Netherlands, 2023. Available online: https://studenttheses.uu.nl/handle/20.500.12932/45535 (accessed on 1 April 2023).