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Methods of rehabilitation treatment after revision knee Arthroplasty

Abstract

Purpose: To determine the most effective approach to the rehabilitation of patients after revision TKA of the knee joint.

Materials and methods: An analysis of scientific sources in the international electronic databases PubMed and Scopus was conducted in the period from 2015 to 2025, 12 relevant sources were selected that met the inclusion criteria and covered various aspects of revision arthroplasty and postoperative rehabilitation.

Results and their discussion: Patients undergoing primary total knee arthroplasty (TKA) usually demonstrate good functional outcomes and improved joint performance. However, complications are frequent and often arise after surgery, particularly with revision procedures. These complications include a higher risk of infection, thrombosis, and implant failure. Although many patients report improvements in function and reductions in pain, only about 60% achieve full functional recovery following revision TKA. Several key factors influence the success of the procedure, such as the number of previous interventions, preoperative functional status, overall health, and psychosocial factors.

It has been established that intensive rehabilitation programs with personalized load selection are the most effective. At the same time, the lack of standardized protocols and the low level of evidence of available studies make it difficult to formulate clear clinical recommendations. Further randomized studies are needed to develop optimal rehabilitation strategies.

Conclusions: Despite the gradual improvement in functional status, the final results of revision TKA are inferior to the primary one. The lack of standardized rehabilitation protocols and the low quality of available evidence necessitate further randomized studies and the development of optimal treatment strategies for this category of patients.

Keywords: revision arthroplasty, knee joint, rehabilitation, functional results, complications, KOOS, KSS

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Introduction

Total knee arthroplasty (TKA) is one of the most successful orthopedic procedures, but the need for revision surgery is increasing over time, especially among younger and more active patients. According to recent data, approximately 5-10% of primary knee arthroplasty procedures require revision within 10 years. The reasons for such revisions range from aseptic loosening of the implants to infectious complications, instability, mechanical wear, and unsatisfactory functional outcome.

The number of revision knee arthroplasty is increasing due to the active use of primary implants in young and physically active patients. Compared with primary total knee arthroplasty, revision surgery is associated with higher risks of complications, poorer functional outcomes, and longer recovery. Rehabilitation after such operations is a key component of treatment, but it still lacks clearly defined standards and evidence-based support.

Revision TTE differs significantly from primary surgery in terms of complexity, duration, surgical intervention, and prognosis. Despite improvements in implants and surgical techniques, functional outcomes after revision TTE are often inferior and the rate of postoperative complications is higher. In this context, postoperative rehabilitation is of particular importance, as it can significantly affect functional recovery, pain levels, quality of life, and patient satisfaction.

Therefore, unlike rehabilitation after primary TKA, approaches to recovery after revision surgery are not standardized, and the evidence base is limited. The available literature lacks high-quality studies comparing the effectiveness of different rehabilitation methods in this specific population. Practice recommendations are mainly based on clinical experience, rather than on higher-level evidence. Effective rehabilitation programs for practical rehabilitation of patients after revision TKA have not been identified, and their outcomes are not predictable.

The purpose of the work. To systematize current scientific data on rehabilitation approaches after revision knee arthroplasty, as well as to identify the most effective methods.

Materials and methods

This review was prepared by a targeted analysis of scientific sources related to rehabilitation after revision knee arthroplasty. The literature search was conducted in the international electronic databases PubMed and Scopus from 2015 to 2025. Search queries included combinations of keywords: "revision total knee arthroplasty", "rehabilitation", "functional outcome", "return to activity", "patient satisfaction", "predictive factors".

The review included:

i. original studies (prospective, retrospective, cohort),

ii. systematic reviews and meta-analyses,

iii. only publications in English are available in full text.

Inclusion criteria

i. studies that directly relate to rehabilitation treatment, functional recovery, or outcome assessment after revision TKA;

ii. availability of a description of the scales used, indicators of function or quality of life (WOMAC, KOOS, OKS, KSS, EQ-5D, FJS, etc.);

iii. studies that clearly state the reason for revision or predictors of outcomes.

Exclusion criteria

i. publications dedicated to primary arthroplasty without separate analysis of revisions;

ii. descriptive articles, clinical reports without analysis of outcomes or rehabilitation methods;

iii. studies containing only data on surgical technique without postoperative follow-up.

A total of 12 relevant sources were selected that met the inclusion criteria and covered various aspects of revision arthroplasty and postoperative rehabilitation. The analysis was conducted taking into account the quality of study design, sample type, parameters assessed, and relevance to the review purpose.

Results

As a result, differences between primary and revision knee arthroplasty were identified, which determine the specifics of approaches to the rehabilitation of patients after revision

Namely, revision knee arthroplasty is performed in cases of failure of the primary surgery (implant loosening, infection, mechanical instability, etc.), therefore it differs significantly in nature and scope of intervention from the primary one. Such a reoperation is technically more difficult due to the presence of scar changes and bone tissue deficiency, requires removal of the old implant and the use of specialized components. As a result, the duration of revision surgery is almost twice as long, and the average duration of postoperative hospital stay is significantly longer compared to primary arthroplasty.[1] The frequency of intra- and postoperative complications is also higher: in particular, the risk of deep infection and thrombosis during revision is approximately twice as high as for primary surgery.[2] In general, revision interventions are more resource-intensive and complex for the surgeon and the patient, and their results are somewhat worse than after primary TKA.[3,4]

Clinical outcomes for patients after revision arthroplasty are generally inferior to those after primary joint replacement. Studies have shown that chronic postoperative pain is more common in patients after revision, with severe or intolerable pain reported at some point after surgery in nearly 47% of patients compared with ~19% after primary TKA.[4] Functional outcomes are also more modest: patients after revision walk less, require more mobility aids, and have lower quality of life and functional test scores than patients after primary knee arthroplasty.[2,4] Although revision surgery usually improves the joint condition compared to preoperative levels and provides symptomatic relief, its efficacy and functional gains are inferior to those of primary arthroplasty.[1,2] Accordingly, patient satisfaction after revision is lower: many patients report that the outcome did not fully meet expectations and did not achieve the level of comfort that is usually achieved after primary total hip arthroplasty.[2] It is worth noting that the reason for which revision is performed has a significant impact on success: for example, revision surgery for unexplained pain has the worst outcome, with such patients showing significantly lower questionnaire scores and lower satisfaction than patients undergoing revision surgery for aseptic loosening of the implant.[5] Despite these difficulties, most patients after revision hip arthroplasty still experience clinically significant improvement and are able to maintain a relatively active lifestyle, returning to daily activities and even work.[6]

It has been determined that complications affect the course of rehabilitation after revision knee arthroplasty

The main types of complications include septic complications (infections around the endoprosthesis) and aseptic problems (mechanical failures such as loosening of the implant). The clinical consequences of these complications vary, which affects the duration and effectiveness of postoperative rehabilitation. The key complications and their impact on the course of recovery after revision surgery are discussed below.

Periprosthetic infection can occur as a cause of the initial revision or develop after a revision. Septic complications usually require aggressive treatment: repeated surgical interventions (debridement, spacer placement, re-revision) and prolonged antibiotic therapy. This inevitably prolongs rehabilitation - active recovery is postponed while the infection is being fought, which leads to muscle loss, contractures and reduced functional outcomes. Statistically, revisions performed due to infection have the worst prognosis: within 8 years after surgery, more than 25% of such patients require re-revision, mainly due to recurrence of infection.[7] Functional outcomes are also worse - knee joint parameters and walking ability after treatment of septic loosening are significantly inferior to those in patients without infection, and mortality in the septic complication group is higher.[8] Thus, septic complications not only pose a threat to life and limb, but also seriously slow down and complicate the rehabilitation process.

Aseptic loosening is the gradual loss of fixation of the endoprosthesis components without infection, and is one of the most common reasons for revision surgery. In the postoperative period of revision TKA, aseptic loosening may occur several years later due to wear, osteolysis, or technical problems. Although aseptic loosening also requires repeated surgical correction, the consequences for rehabilitation are usually less severe than in the case of infection. The absence of infection allows for a planned revision and the start of rehabilitation in an optimal time frame, without the need for interruption for long-term treatment of the infection. Studies show that patients after revisions performed for aseptic loosening demonstrate a better restorative functional outcome compared to patients after septic revisions: in particular, after 10 years, the implant survival is higher (about 95% versus 86% in the case of septic cases) and the average knee function scores are significantly better.[8] A higher percentage of such patients regain independent walking and return to daily activities. Therefore, in the absence of infection, rehabilitation is more effective and long-term functional outcomes are more favorable.

The impact of complications on the course of rehabilitation and functional outcomes was determined. That is, the presence of postoperative complications directly affects the duration and success of rehabilitation after revision knee arthroplasty. Septic complications usually lead to a break in the rehabilitation process: the patient is forced

to endure a period of immobilization and treatment of the infection, which delays the restoration of joint mobility and muscle strength. Each additional surgical intervention (for example, repeated revision due to infection or mechanical failure) actually sets the rehabilitation back - after it the rehabilitation cycle begins anew, extending the overall recovery period. As a result, the functional indicators and quality of life of patients can be significantly lower than in cases without complications. In particular, patients who undergo revision for unexplained pain (a functional complication where the cause of the pain is not obvious) have worse quality of life (median EQ-5D-5L score of 0.6 vs. 0.8) and lower satisfaction with the outcome 1–3 years after surgery compared with those who undergo revision for a specific mechanical problem (e.g., aseptic loosening).[5] These data suggest that complications or unresolved causes that prompted revision may limit the effectiveness of rehabilitation and ultimate functional success. In contrast, in the absence of serious complications, rehabilitation proceeds more quickly, with patients achieving foot support, full range of motion, and return to daily activities earlier. Therefore, minimizing complications and properly treating existing problems are crucial to shortening recovery times and improving functional outcomes after revision knee arthroplasty.[3,5,7,8]

Modern rehabilitation approaches and current practice after revision TKA of the knee joint are quite controversial

Currently, there are no standardized rehabilitation protocols specifically designed for revision TKA, and in clinical practice, rehabilitation programs are often similar to those used after primary knee arthroplasty.[9] According to a recent survey of arthroplasty centers, in most cases, rehabilitation after revision is organized according to similar principles as after primary surgery. The rehabilitation process usually begins before surgery: about 73% of clinics provide preoperative education to patients to prepare them for surgery and recovery.[9] These educational sessions are usually conducted by a multidisciplinary team (orthopedic surgeon, physiotherapist, occupational therapist, nurse) and include information about the surgical procedure, the postoperative period, pain management methods, and exercises to improve the outcome.

The authors recommend that rehabilitation begin as soon as possible after revision knee arthroplasty. In the hospital, physical therapy begins on the day of surgery or the first day after surgery and is performed at least once a day (in many institutions, twice a day). The main goals of early rehabilitation are to restore range of motion in the joint, learn to walk with assistive devices, and prevent complications (thrombosis, contractures). In addition to physiotherapy, in about half of the cases, patients after revision receive the services of an occupational therapist who helps them master self-care skills, taking into account temporary limitations.Discharge from the hospital is carried out when basic functional criteria are achieved: the patient walks safely with assistive devices, can independently ascend and descend stairs, and has adequate support at home.[9] In some cases, after complex revisions, surgeons impose additional restrictions in the early postoperative period – for example, partial weight-bearing on the operated limb, prohibition of twisting movements of the knee or kneeling – in order to protect the implant and soft tissues.[9]

After discharge, all patients usually continue their rehabilitation in an outpatient setting or at home under specialist supervision. As the survey showed, rehabilitation after revision arthroplasty is organized for all patients or at least for those who have significant mobility impairments or knee flexion limitations at the time of discharge. Outpatient rehabilitation usually begins within the first month after surgery and can be carried out in a hospital (outpatient clinic), rehabilitation center, community, or home. The formats of the classes vary: individual sessions with a physiotherapist are the most common, but group classes (e.g., "knee school"), tele- or video-consultations, written instructions for self-exercise, and sometimes home visits by a rehabilitation therapist. Most facilities prescribe a combination of methods: therapeutic gymnastics (development of thigh muscle strength, increase in amplitude of movements, balance and gait exercises), training in correct motor stereotypes and self-care, advice on a physical activity regimen, use of ice/heat to reduce swelling and pain, manual therapy to improve joint mobility, and sometimes hydrotherapy. The number of outpatient sessions may vary depending on the needs of the patient and the capabilities of the health care system; according to the survey, 2 to 6 sessions of active rehabilitation after discharge are most often prescribed.[9] Thus, at present, the rehabilitation program after revision TKA is mainly built according to a scheme similar to rehabilitation after primary total knee arthroplasty, with an emphasis on early mobilization and gradual restoration of joint function.

The effectiveness of rehabilitation programs using intensive and multidisciplinary approaches has been studied.

The intensity of postoperative rehabilitation after revision arthroplasty is selected individually, taking into account the patient's condition. In standard cases, patients perform the recommended set of exercises independently between sessions with a physiotherapist, gradually increasing the load according to tolerance. Multidisciplinary support is important: in addition to physical rehabilitation, patients are provided with effective pain relief, supervision by an orthopedic surgeon, and, if necessary, consultations with other specialists (for example, a rheumatologist, if there is concomitant arthritis, or a psychologist for the patient's adaptation and motivation). Already at the stage of preoperative preparation, the involvement of a multidisciplinary team (doctors and therapists of different profiles) contributes to better patient readiness for complex surgery and rehabilitation.[9]

Patients with significant postoperative complications or very low preoperative function may require more intensive and prolonged rehabilitation. Intensive rehabilitation programs in a rehabilitation hospital setting have been described in practice and have shown improved outcomes in patients after revision TKA. In particular, Larsen et al. reported the successful use of a 3-week personalized multimodal rehabilitation program in patients after TKA (including revision) with postoperative complications.[10] This program included comprehensive daily exercises aimed at neuromuscular coordination, postural control, flexibility, muscle strength, cardiovascular function, and gait restoration; the frequency of exercises was 2–4 sessions per day.[10] In a retrospective analysis, patients who received such an intensive course experienced clinically significant pain relief, improvements in the Knee Injury and Osteoarthritis Outcome Score (KOOS), and objective tests of walking and stair climbing.[10] Other studies also support the effectiveness of such approaches: a 2023 systematic review found that all currently available rehabilitation programs for revision TKA included intensive inpatient physiotherapy (approximately 2–3 hours of active exercise daily, either individually or in groups) in combination with occupational therapy, and all studies reported improved functional outcomes after such therapy.[9] However, it should be noted that ultra-intensive programs are resource-intensive and may not be appropriate for all patients; the decision to prescribe them should be made on an individual basis, taking into account age, comorbidity, patient motivation, and the nature of the revision. In general, the current trend in rehabilitation after revision knee

arthroplasty is to personalize the intensity of the loads: patients with an uncomplicated course can recover successfully with a standard outpatient protocol, while patients with complications or a more severe initial condition require a more intensive, multidisciplinary rehabilitation.[9,10] In all cases, the goal is to gradually restore knee function to an optimal level, allowing the patient to return to daily activities, work, or even sports, although achieving a high level of physical activity after revision remains a challenge.[6]

As a result of the systematization, the following differences in rehabilitation approaches were identified

In the absence of clear international guidelines, rehabilitation approaches after revision TKA may vary depending on the institution and country, as well as the specifics of the individual clinical case.[9] Many clinics adhere to the principle that "rehabilitation follows surgery", i.e. the rehabilitation program is determined by the intraoperative situation and the surgeon's instructions. For example, in cases of significant bone loss, the use of allografts, or complex ligamentous reconstructions during revision, the surgeon may recommend a more cautious rehabilitation regimen: a longer period of partial weight-bearing or avoidance of extreme angles of knee flexion to ensure implant engraftment and tissue healing.[9] In contrast, in cases where the revision procedure was less traumatic (e.g., isolated polyethylene insert replacement or revision without significant bone remodeling), rehabilitation can be performed according to a standard accelerated recovery protocol similar to protocols after primary arthroplasty. It is important to adapt the program to each patient: rehabilitation should take into account the reason for the revision, the extent of the lesion, and comorbidities. In particular, patients who undergo revision for periprosthetic infection suffer more tissue damage and are more likely to undergo multi-stage treatment, so their recovery may be longer and more difficult.[8] Indeed, long-term follow-up shows that functional outcomes in patients after revisions for septic loosening of the prosthesis are worse than after revisions for aseptic reasons.[8] This highlights the need for specifically designed rehabilitation strategies for different patient subgroups. Thus, there is no universal approach: the rehabilitation program is determined individually, taking into account the surgical findings and the patient's condition, as well as the available resources of the rehabilitation service. A common feature of all approaches is a gradual increase in the level of activity and function of the joint with careful monitoring of pain, mobility and muscle strength to avoid overloading the endoprosthesis and complications.

The lack of standardization in rehabilitation approaches is also reflected in the literature. There is currently a lack of consensus from professional communities on the optimal rehabilitation strategy for revision TKA.[9] For example, the British Orthopaedic Association of Surgeons (BOAST) guidelines for revision knee arthroplasty do not address postoperative rehabilitation at all.[9] As a result, many institutions rely on their own experience and the transfer of protocols developed for primary arthroplasty to revision cases. At the same time, clinicians recognize that patients after revisions often require more attention and support, and therefore rehabilitation should be more finely tuned to their needs.[9,10] Efforts to standardize approaches are limited, but are becoming more relevant as the number of revision surgeries increases.

We have identified the absence of a single effective approach to rehabilitation of patients after revision TKA, and a systematic review has not identified any randomized controlled trials evaluating the effectiveness of rehabilitation in this category of patients. Only three studies were included in the analysis, and all of them had an observational (retrospective) design. These studies describe the experience of individual centers in implementing intensive inpatient rehabilitation programs, and although all of them have demonstrated improved function in patients after revision, the level of evidence remains low. Limitations of the available studies include small sample sizes, lack of randomization, and short follow-up.[9] Thus, the evidence base regarding the optimal rehabilitation approach after revision TKA is currently very limited. Some publications emphasize that better quality studies are needed to fill this knowledge gap.[9,10] For example, Larsen et al. after the positive results of their intensive rehabilitation study, indicate the need for further RCTs to evaluate the effect of multimodal therapy both after primary and revision prosthetics.[10] The lack of clear data also makes it difficult to compare different approaches and develop general recommendations for practice.

Despite the limited direct studies, the importance of rehabilitation after knee revision has been highlighted in peer reviews and surveys. In particular, as mentioned above, clinicians agree that rehabilitation can play a key role in improving the outcome of revision TKA, given the often disappointing initial outcomes.[9] Some studies have focused on specific aspects of recovery, such as physical activity levels, return to sports or work after revision: although such studies do not provide direct guidance on rehabilitation techniques, they have shown that a significant proportion of patients do not achieve high levels of physical activity after surgery.[6] This indirectly suggests the need to improve rehabilitation programs to maximize patients' functional capabilities. Overall, the issue of rehabilitation after revision knee arthroplasty is only beginning to receive attention in the literature, and there is clear scope for expanding the research base.

Experts agree that specialized rehabilitation programs tailored to the needs of patients after revision TKA should be developed and tested.[9] Prospective randomized trials comparing different approaches (e.g., standard outpatient rehabilitation vs. intensive inpatient program) and evaluating their effects on pain, function, quality of life, complication rates, and return to active life are priorities.[9,10] The current lack of consistent guidelines leads to variability in practice, and standardization of approaches based on the best evidence is an important task for the medical community.[9]

With the participation of patients and doctors, a list of the most relevant issues that need to be studied during revision knee arthroplasty was formed, and one of the top 10 priorities was identified as the optimization of pre- and postoperative rehabilitation ("what can be done before and after revision surgery, including physiotherapy and exercises, to improve the outcome?").[9]

Modern functional scales and assessment tools were studied and analyzed

Standardized questionnaires (PROMs) are used to assess functional outcomes and quality of life after revision knee arthroplasty. Among the most common are the KOOS (Knee Injury and Osteoarthritis Outcome Score), a self-report scale that includes five subscales (pain, symptoms, daily activities, sports, and quality of life). The WOMAC scale is used in osteoarthritis and measures pain, stiffness, and physical function of the knee. The OKS (Oxford Knee Score) is a 12-item questionnaire that assesses knee pain and function (0–48 points).[5] The KSS (Knee Society Score) consists of two parts: clinical (pain, stability, mobility) and functional (walking, stairs) and is widely used in revision studies.[11] The EQ-5D is a generalized tool for assessing quality of life (five domains: mobility, self-care, etc.).[5] The FJS (Forgotten Joint Score) measures the "forgetfulness" of the implant in daily life (higher values are better). In addition, general questionnaires such as the SF-12/SF-36 and visual analogue scales (VAS) for pain are

used. According to a systematic review, the reporting of PROMs in revision cases varies, but the KSS is most commonly used.[11]

Studies have shown significant improvements in function and pain after revision TKA compared with baseline. For example, a meta-analysis showed significant improvements in PROMs (standardized mean difference ≈2.05) ≥5 years after revision.[11] In small cohort studies, the majority of patients demonstrate statistically significant improvements in functional and walking scores. For example, Quinn et al.[12] reported a mean OKS of ≈39/48 6.5 years after revision and 85% of patients were satisfied.[12] However, even after revision, outcomes are inferior to those of primary TKA. Petersen et al.[4] showed that twice as many patients had severe postoperative pain and worse walking and quality of life after revision than after primary TKA.[4] Similarly, Stirling et al.[1] found that revision interventions reduced pain, but AKSS ("Pain") scores remained worse in the revision group (36 vs. 44 in the primary group, p=0.002), although improvements in postoperative outcomes were similar. A review by Roman et al.[2] found that "although good outcomes were achieved, they were still inferior to primary TKA" and that there were higher risks of further interventions. The influence of age, gender, BMI, and other general biological factors on the results of rehabilitation after revision TKA was revealed.

In particular, gender correlates with final scores: in the Quinn et al.[12] cohort, men had higher OKS than women (40.5 vs. 37.7, p=0.02). Better baseline scores were also associated with better outcomes: better preoperative range of motion and fewer previous revisions contributed to higher OKS. The reason for revision significantly influences: according to Quinn, revisions for contracture or instability yielded higher OKS, while "revisions for pain" yielded the lowest.[12] Similarly, Arndt et al.[5] showed that patients undergoing revisions for unexplained pain had significantly lower OKS (median 25 vs. 31) and EQ-5D (0.6 vs. 0.8) compared with revisions for aseptic loosening. Septic processes are also important: in the Ahn et al.[8] study patients after revision due to septic loosening had worse functional outcomes (mean KSS 65.3) compared to aseptic loosening (KSS 76.8). Thus, revisions for septic reasons are associated with worse outcomes and higher mortality. Age and BMI in the cited studies are less correlated with the final scores or have no significant effect.

A difference in subjective assessment after revision TKA was determined

Patient satisfaction with revision TKA is generally high, but lower than after primary arthroplasty. In the Quinn et al.[12] cohort, 85% of patients were satisfied (i.e., "yes" to the question of whether they would have the surgery again) >6 years after revision TKA. At the same time, changes in clinical PROMs directly correlate with satisfaction: patients who remained with moderate to severe pain were more likely to be dissatisfied. For example, Arndt et al.[5] showed that individuals revised for unexplained pain were statistically less satisfied than those whose reason for revision was aseptic loosening. Satisfaction is often used as a separate PROM, and its predictors are less postoperative pain and better knee function (Table 1).

Table 1 Overview of function and quality of life indicators after knee revision

Authors and year	Scale / parameter	What does it measure?	Results
Petersen et al.,[4] 2015	KSS, VAS	Knee pain and function	After revision, twice as many patients had severe pain (47% vs 19%) and worse walking ability.
Stirling et al.,[1] 2020	AKSS, SF-12	Pain, knee function; QALY	The revision group had worse AKSS Pain (36 vs 44, p=0.002); SF-12 and OKS/PCS gains were similar.
Larsen et al.,[10] 2020	KOOS	Pain/symptoms/ADL/sports/QL	Primary: increases of 8.5–14.2 points; revision: 6.9–10.8.
Ahn et al.,[8] 2021	KSS	Knee function	Sepsis: KSS 65.3; aseptic loosening: 76.8 (p<0.05).
Matthews et al.,[11] 2022	KSS and others.	Function/Pain (PROMs)	Meta-analysis: significant improvement after revision (SMD ≈ 2.05 from baseline).
Roman et al.,[2] 2022	KSS	Audit results	Revision TKAs have worse outcomes: more complications, more reoperations.
Quinn et al.,[12] 2022	OKS	Knee pain/function	Average OKS 39.3/48; survival rate 93.5%; 85% satisfied.
Arndt et al.,[5] 2023	OKS, EQ-5D, FJS	Function, QALY, joint awareness	OKS: 25 vs 31; EQ-5D: 0.6 vs 0.8; FJS ≈50; satisfaction worse with pain (75 vs 50).

The timing and pace of return to activity, work, and sports after revision TKA of the knee joint have been determined.

Patients after revision TKA generally have worse baseline joint function and more complaints of pain compared to the primary TKA group.[1] However, analysis of the results shows that the degree of improvement in functional indicators in both groups is similar: for example, Stirling P et al.[1] showed that although the AKSS pain score was lower in the revision group (36 vs. 44 in the primary surgery group), the change in AKSS and SF-12 after surgery was not statistically different from the primary TKA group. According to a systematic review by van der Wilk,[6] most patients after revision self-report an increase in physical activity (mean increase in UCLA/Tegner activity score ≈+1.7 on a scale of 0–10). That is, despite a more "difficult" clinical start, revision arthroplasty leads to objective improvements that are comparable to the results of primary arthroplasty, although the absolute level of activity after revision may remain lower.

After revision TKA, most patients successfully resume basic activities. According to van der Wilk S et al.[6] return to usual physical activity is expressed in a significant increase in functional indicators (e.g., KOOS daily activity scale) and walking tests.[6,10] In a retrospective cohort study by Larsen JB et al.,[10] after three weeks of intensive rehabilitation, patients in both groups (revision and primary) had a significant improvement in all KOOS indicators and functional endurance tests. However, return to intensive sports was limited - only about 12% of revision patients resumed "not recommended" high-impact sports (hockey, football, tennis, etc.).[6] In contrast, the return to work rate was quite high - the combined data showed approximately 86% of patients who were able to return to their previous professional activities after revision TKA (10). Thus, the vast majority of patients after revision TKA restore their usual level of activity in everyday life and can return to work, although intensive sports activities are less common.

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Participants in various studies identify several key determinants of activity level after revision arthroplasty

Patient's age: Younger patients (under 65 years of age) are at higher risk for revision surgery and always require an active lifestyle. Some studies have shown that younger patients are less likely to be satisfied with their level of physical activity after revision.[6] In other studies, age differences in activity scores have been small, but an overall trend has been noted: older patients adapt better to resuming activity.

Sex: Men demonstrate higher levels of physical activity and greater mobility after revision than women.[6,12] For example, Quinn J et al.[12] noted that male gender was associated with better scores on the Oxford Knee Scale. Similar observations – higher UCLA scores – were found in the studies of van der Wilk S et al.[6]

Comorbidity and physical condition: A higher number of comorbid conditions negatively affects activity levels: patients with a higher number of chronic conditions are less likely to return to an active lifestyle. Unfortunately, most studies have not found a statistically significant effect of BMI on activity levels after revision TKA.[6]

Reason for revision: The type of revision surgery (aseptic loosening, infection, instability, etc.) may modify the results. For example, Ahn et al.[8] found that revisions associated with septic loosening of the component are associated with significantly worse functional outcomes and lower return to activity than revisions with aseptic loosening.[8] In addition, some authors have noted that patients with revisions due to joint instability experience a greater increase in activity compared to those whose cause was simple implant loosening.[6] However, the overall role of the reasons for revision remains ambiguous and requires further research.

Psychosocial aspects Patient expectations play an important role in the perception of the outcome of the operation. van der Wilk S et al.[6] emphasize that patients often overestimate their expectations of improvement after revision TKA, which may reduce satisfaction with their own activity indicators. Therefore, adequate counseling and realistic expectation formation are necessary to increase the level of rehabilitation and return to active life (Table 2).

Table 2 Analysis of results after revision TKA of the knee joint

Authors and year	Parameter / scale	Results
van der Wilk et al.,[6] 2023	Change in activity scores (UCLA/Tegner)	Increase by 1.71 points (p<0.0001)
van der Wilk et al.,[6] 2023	Return to "unrecommended" sports	12% of patients (1 study, n=206)
van der Wilk et al.,[6] 2023	Return to Work (RTW)	86% of patients (2 studies, n=234)
Larsen et al.,[10] 2020	KOOS (everyday activity)	Primary TKA: +14.2, revision TKA: +10.8 (p<0.001)
Quinn et al.,[12] 2022	OKS and satisfaction level	Average OKS 39.3, 85% of patients are satisfied with the result

Based on the results of the study, we identified the most effective rehabilitation programs for patients after revision TKA of the knee joint

Patient demographics (gender, age, BMI) usually have little or no effect on outcome. For example, Quinn J et al.[12] found that men had slightly higher OKS scores one year after revision (mean 40.5 vs. 37.7 in women, p=0.020), but no significant role for gender in other measures of function. Patient age also has a mixed effect – although in primary TKA younger age is sometimes associated with worse subjective outcomes (more chronic pain in patients ≤60 years), for revision arthroplasty data are limited and designs do not show a clear age-related relationship. Body mass index (BMI) was not statistically associated with functional outcomes (OKS, ROM; p=0.314) in the Quinn et al.[12] study, although overweight is traditionally considered a risk factor for complications after surgery.

The key characteristic is the reason for revision. Compared with revision due to aseptic loosening of the implant, revisions due to septic loosening or unexplained pain have worse outcomes. For example, Ahn et al.8 showed that patients who underwent revision due to septic loosening had lower mean KSS scores and less joint mobility, as well as higher postoperative mortality, than those who underwent revision TKA due to aseptic loosening. Similarly, Arndt et al.[5] demonstrated that patients who underwent revision for unexplained pain reported significantly worse outcomes on the Oxford Knee Score and were less satisfied with their surgery after the procedure than those who underwent replacement due to aseptic loosening. Other reasons for implant failure (instability, stiffness) are also associated with variable rehabilitation outcomes, but the evidence is conflicting. The reason for revision often appears to be a statistically significant predictor of functional outcomes and mobility.

A history of previous surgery is an important factor. A higher number of previous surgeries (articulations, twists, previous revisions) correlates with poorer recovery outcomes. A study by Quinn et al.[12] showed that each additional revision surgery statistically significantly reduced postoperative knee range of motion (ROM) and was associated with lower OKS scores. Similarly, Schneider et al. (2024) found that patients with a significant number of previous surgeries had significantly reduced ultimate joint flexibility (p=0.004). This suggests that multiple surgeries lead to increased fibrosis and shortening of soft tissues, making rehabilitation more difficult.

The patient's initial functional status is equally important. Better preoperative functional measures (knee range of motion, functional scale scores) predict better rehabilitation outcomes. The aforementioned cohort study found a strong positive correlation between preoperative and postoperative ROM ($p \leq 0.001$).[12] In other words, patients with higher initial preoperative range of motion had higher ROM after rehabilitation. Conversely, weak muscle condition or low baseline fitness may slow rehabilitation progress, although these parameters have not yet been sufficiently studied in revision cases.

Psychosocial factors (patient mood, presence of depression or anxiety, quality of social support, patient expectations) are not formally considered in most protocols for rehabilitation of revision arthroplasty and have been little studied in the literature. Belt et al.[3]noted that the impact of cognitive and psychosocial parameters on the outcome of revision arthroplasty is almost unexplored. At the same time, there is evidence from primary arthroplasty that depression, catastrophizing, and low levels of support can worsen postoperative pain and function.

This suggests a potential role for the psychological state of patients in rehabilitation, which is still understudied in revision cases.

Given the above, no single factor is sufficient to accurately predict the effectiveness of rehabilitation. A more reliable assessment is possible only with a comprehensive analysis of several variables simultaneously (Table 3).[5,8]

Table 3 Factors of rehabilitation effectiveness after revision TKA

Authors and year	Factor	Result/impact
Quinn et al.,[12] 2022	Gender (men vs women)	Men had higher OKS (40.5 vs 37.7), but the overall difference was clinically insignificant.
Quinn et al.,[12] 2022	Age	No significant relationship was found between age and audit results.
Quinn et al.,[12] 2022	BMI	No statistically significant association with OKS, ROM was found ($p > 0.3$).
Ahn et al.,[8] 2021	Reason for revision (sepsis vs asepsis)	Sepsis → lower KSS (65.3 vs 76.8), lower ROM and higher mortality.
Arndt et al.,[5] 2023	Reason for revision (pain vs loosening)	Unexplained pain → lower OKS (25 vs 31), EQ-5D (0.6 vs 0.8), lower satisfaction.
Quinn et al.,[12] 2022	Number of previous interventions	Each previous revision reduces ROM and OKS postoperatively.
Quinn et al.,[12] 2022	Initial functional status (pre-op ROM)	Better pre-op ROM → better postoperative ROM; strong positive correlation.
Belt et al.,[7] 2021	Psychosocial factors	Data are limited; the importance of depression, expectations, and support is recognized (extrapolation from primary TKA).

Discussion

Our study results suggest that patients generally experience less functional improvement after revision than after primary TKA.[2] The results suggest more frequent complications: revision patients experience worse immobilization, slower recovery, and a significantly higher risk of infections and thrombosis (the risks of infection and thromboembolism are approximately twice as high as with primary TKA).[2] Revision patients may also require more invasive procedures during surgery (e.g., excision of structures, additional fixation) and longer hospital stays.[1,2] For example, a cohort study showed significantly worse postoperative pain scores in the revision group (mean AKSS pain score of 36 versus 44 in the primary group), although the dynamics of improvement in both groups were similar.[1] At the same time, most patients after revision report a significant reduction in pain and improved function compared with pre-complex values.[1,2] However, full functional recovery is not guaranteed: only about 60% of those surveyed report significant improvement in daily functioning one year after revision TKA. Regarding physical activity, most patients who have undergone surgery report being able to lead an active lifestyle (including returning to work or sports), although existing data suggest that quality of life after revision is quite low.[6]

The literature also identifies prognostic factors that influence the outcome of revision surgery. In particular, it is known that revision after late failure of the primary prosthesis usually gives a better functional outcome than revision after an early complication.[2] Low baseline functional scores before surgery (e.g., severe contracture) are associated with lower final scores after revision, although the absolute improvement in such cases may be greater. Some patients with severe arthrofibrosis show a relatively large increase in range of motion after revision (by 30–40°).[2] In general, the most studied preoperative predictors in the literature are the reason for revision, the patient's gender, and the body mass index,[3] but their precise prognostic role remains controversial.

Contradictions also arise in the evaluation of clinical outcomes and patient satisfaction: some authors describe quite satisfactory results after revision TKA, comparable to those of primary prosthetics, while others, on the contrary, emphasize limited progress and low levels of satisfaction. Thus, the literature emphasizes that after primary TKA, usually more than 80% of patients are satisfied with the result, but there are heterogeneous reports on revision: some studies record similar effectiveness of the intervention, while others record only limited improvement and dissatisfaction of patients. Presumably, such discrepancies are associated with different patient populations (different general health status, reason for revision, etc.).

Current approaches to rehabilitation after revision knee replacement are not standardized and vary considerably between institutions. Existing reviews suggest that rehabilitation after revision TKA is typically intensive (2–3 hours of physiotherapy daily, often in hospital).[9] However, there is a lack of clear protocols, with many clinics providing patients with the same rehabilitation package after revision as for primary TKA.[9] National surveys show a wide variety of clinical practices, with some centres preferring inpatient multidisciplinary programmes, while others prefer outpatient or home-based programmes, but there is no consensus on the optimal approach.[9] This makes it difficult to compare the results of different studies and to implement evidence-based recommendations in the clinic.

Overall, the literature in this area is extremely limited. Most of the available studies are mainly descriptive observational studies with limited samples.[9] It is estimated that only a few retrospective studies have been published that have analyzed the outcomes of rehabilitation after TKA revision, and there are virtually no randomized controlled trials.[9] As a result, the ability to draw conclusions about the effectiveness of different rehabilitation methods is limited. The low quality of the evidence makes it difficult to formulate recommendations and necessitates the need for further research.

Therefore, based on the above data, it is necessary to emphasize a comprehensive and personalized approach to rehabilitation after revision knee arthroplasty. It is necessary to take into account not only physical (motor) parameters, but also the psychological state and social needs of the patient. Integration of multidisciplinary methods - physiotherapy, occupational therapy, psychosocial support - into a single rehabilitation plan can contribute to the maximum restoration of joint function and improvement of the quality of life of patients after complex revision interventions.[9]

Conclusion

Revision knee arthroplasty is a complex and technically demanding procedure with significant differences in the rehabilitation of such patients. It is often accompanied by significant bone defects, scarring, and a high risk of complications.

Most patients demonstrate significant functional improvement and a fairly high level of satisfaction with the result. Thus, in a large cohort study, the survival rate of the revision endoprosthesis at 6.5 years after surgery was 93.5%, and 85% of patients were satisfied with the result. The average amplitude of movements in the knee increased from approximately 100° to 112°. However, despite the improvement compared to the preoperative state, the final results of the revision are generally inferior to the indicators of the primary TKA.

In modern practice, there are no highly effective rehabilitation programs after revision TKA, they do not have uniform standards and often imitate approaches used after primary operations. In most clinics, patients are prescribed early mobilization with a physiotherapist and a complex of exercise therapy from the 1st to the 2nd day after surgery.

The most effective are intensive rehabilitation programs that are developed on the basis of a personalized approach to each specific patient, taking into account the size of the defects, damaged muscles, vessels, nerves. 2–3 hours/day of physiotherapy contribute to a faster restoration of knee joint function.

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None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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