

Redefining Outcomes in Robotic-Guided Knee Arthroplasty through Purposeful Rehabilitation

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Learning Point of the Article:

This article emphasizes that robotic-assisted knee arthroplasty enhances surgical precision and implant alignment, optimal outcomes primarily depend on structured rehabilitation. Prehabilitation helps patients prepare physically and mentally for surgery, while early post-operative physiotherapy promotes faster recovery and improved mobility. Phased rehabilitation with strengthening exercises, range of motion exercises and gait training, combined with modern approaches like ERAS protocols and multimodal pain management are essential for optimal functional recovery after knee replacement.

Robotic-assisted knee arthroplasty (RAKA) has transformed knee reconstruction by optimizing soft-tissue balance, improving implant alignment, and surgical precision. Even though technological advancements have enhanced surgical accuracy, comprehensive rehabilitation remains the key determinant of functional success. Optimal long-term patient-reported outcomes are achieved when surgical accuracy is supported by structured rehabilitation [1,2].

The Imperative of Pre-operative Rehabilitation (“Prehabilitation”)

Pre-operative rehabilitation, often known as prehabilitation, is a systematic approach that helps patients get ready for surgery both mentally and physically. It includes patient education, lifestyle changes, risk-factor optimization, and focused exercise regimens. Enhancing muscle strength, joint mobility, cardiovascular endurance, and psychological preparedness is the main goal of prehabilitation to provide the ideal physiological

environment for surgery and accelerate post-operative recovery [1,2].

Growing research supports the usefulness of prehabilitation in enhancing post-operative outcomes following total knee arthroplasty. An umbrella review of pre-operative rehabilitation suggests that exercises may facilitate early functional recovery and reduce post-operative functional disability, but functional improvements are inconsistent due to varied rehabilitation protocols [2]. According to systematic reviews and meta-analyses, structured exercise-based prehabilitation programs are linked to better early functional outcomes and less post-operative pain [3,4].

Individual-tailored prehabilitation programs are most helpful when they are adapted to comorbid conditions, pain severity, and baseline functional level. Aerobic conditioning, balance and proprioceptive exercises, progressive resistance training for the quadriceps and hamstrings, and patient education on post-operative expectations, use of assistive devices, wound care, and

Author's Photo Gallery



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pain management are important components. Importantly, patients who have a limited range of motion, obesity, or lower baseline function seem to gain most from tailored prehabilitation techniques [5].

Post-operative Rehabilitation: Phased and Personalized

Following a RAKA, post-operative rehabilitation is a goal-oriented, phased process that starts right after surgery and lasts until functional independence is attained. Modern rehabilitation practices, which prioritize early mobilization, multimodal analgesia, and progressive functional loading, are closely aligned with the principles of enhanced recovery after surgery (ERAS) [6].

Early quadriceps activation, safe transfers, aided ambulation, and pain and edema management are the main goals of rehabilitation during the early post-operative period. Research indicates that starting physical therapy within the first 12–24 h following surgery improves functional results and shortens hospital stays when compared to delayed mobilization [7, 8]. Early ambulation is particularly viable following robotic-assisted operations due to enhanced implant alignment and soft-tissue balance [8, 9]. Restoring knee range of motion, strengthening periarticular muscles, enhancing neuromuscular control, and retraining gait patterns become more important as rehabilitation goes on. Robotic precision in implant location has been related with speedier recovery of knee motion, allowing physicians to advance rehabilitation procedures with more confidence while minimizing compensatory movement patterns [9]. During the intermediate and late stages of recovery, balance training, proprioceptive exercises, stair climbing activities, and cardiovascular conditioning become more crucial [5].

Post-operative recovery is greatly improved by new recent rehabilitation methods and protocols. When compared to traditional rehabilitation alone, the utilization of robotic and exoskeleton-assisted rehabilitation systems inside ERAS pathways has shown improvements in knee range of motion,

functional outcomes, and shorter hospital duration [6]. Furthermore, tele-rehabilitation systems present viable ways to enhance long-term functional recovery and sustain to home-based exercise regimens.

Multimodal Integration: Pain, Function, and Technology

Effective rehabilitation requires the use of multimodal pain management techniques in addition to exercise recommendations. Modern analgesic regimens that include non-opioid systemic drugs, periarticular infiltration, and regional anesthesia promote early mobilization, lower opioid use, and increase patient involvement in rehabilitation programs [5]. Synchronizing pain management with functional advancement requires close coordination between anesthesiologists, surgeons, and rehabilitation specialists.

A paradigm change in knee arthroplasty care is represented by the combination of robotic surgery and evidence-based rehabilitation. Robotic devices improve surgical accuracy, but rehabilitation makes sure that these technological advances result in significant functional outcomes, such as walking endurance, stair-climbing ability, and return to activities of daily activities [9].

Conclusion

Despite advances in the precision of robot-assisted knee arthroplasty, successful outcomes primarily depend on post-operative functional performance. While organized, structured post-operative rehabilitation guarantees long-term functional improvements; pre-operative rehabilitation maximizes physical preparedness and improves post-operative recuperation. For robotic-guided knee arthroplasty to be successful, rehabilitation should be considered a key component rather than an adjunct. Personalized care pathways and new technologies will improve results as rehabilitation science advances. Rehabilitation continues to be the vital link between surgical accuracy and patient-centered recovery in the age of robotic knee replacement.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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References

1. Afzal W, Arif K, Rashid HM, Tariq M, Khalid J, Mohsin A, et al. Effect of pre-operative, post-operative and combined rehabilitation approaches in total knee replacement. *Insights J Health Rehabil* 2025;3:293-301.
2. Zhao Y, Tian C, Tian S, Han W, Shi H, Cao M, et al. An umbrella review for preoperative rehabilitation in primary total



knee arthroplasty: Quality assessment and summary of evidence. *BMC Musculoskelet Disord* 2025;26:630.

3. Karimijashni M, Yoo S, Barnes K, Lessard-Dostie H, Ramsay T, Poitras S. Prehabilitation in patients at risk of poorer outcomes following total knee arthroplasty: A systematic review. *J Arthroplasty* 2025;40:1367-76.

4. Zhang W, Lu X, Yang N, Zhu X, Hu H. Prehabilitation is effective in relieving pain after knee arthroplasty, but has little effect on length of stay and knee function: A meta-analysis of randomized controlled trials. *Front Med (Lausanne)* 2025;12:1457407.

5. Clark NC. Prehabilitation and rehabilitation for total knee replacement surgery: Physiotherapy interventions in personalized medicine and charting a course towards optimal outcomes. *Orthop Trauma* 2025;39:65-73.

6. Wang M, Tang Z, Lan Y, Lan R, Wang M, Song X, et al.

Application and postoperative rehabilitation effects of HURWA, Cori, and Brainlab robots in TKA under the ERAS concept. *J Robot Surg* 2025;19:669.

7. Thwin L, Chee BR, Yap YM, Tan KG. Total knee arthroplasty: Does ultra-early physical therapy improve functional outcomes and reduce length of stay? A retrospective cohort study. *J Orthop Surg Res.* 2024;19:288.

8. Zhou G, Yao Y, Shen Y, You X, Zhang X, Xu Z. Early ambulation after total knee arthroplasty: A retrospective single-center study. *J Orthop Surg Res.* 2024;19:446.

9. García-Sanz F, Sosa-Reina MD, Jaén-Crespo G, González-De-La-Flor Á, Villafañe JH, RoSmero-Morales C. Redefining knee arthroplasty: Does robotic assistance improve outcomes beyond alignment? An evidence-based umbrella review. *J Clin Med* 2025;14:2588.

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