

Treatment and Rehabilitation of Hip Replacement Surgery

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Abstract. For patients with end-stage hip joint disorders, total hip replacement (THR) is a crucial operation for enhancing function and quality of life. Optimizing associated intervention measures is clinically significant since prognosis is heavily influenced by postoperative rehabilitation effectiveness, safety, and patient experience. This study covers the etiological causes, treatment modalities and rehabilitation strategies for injuries after hip replacement surgery. The results of this article show that physical therapy improves muscle strength and function, TEAS reduces pain and improves cognition, combined preoperative-postoperative resistance training increases muscle strength/gait/balance, acetabular lip augmentation devices address prosthesis instability with surgical advantages, and bundled interventions reduce surgical site infections. Post-surgery injuries are caused by age-related factors, disease progression, physical dysfunction and rehabilitative imbalance. Additionally, VR/technology-assisted rehabilitation benefits both remote patients and those who are physically ill. These results offer thorough support for improving hip replacement patient outcomes and quality of life by streamlining perioperative care and rehabilitation procedures.

Keywords: Total hip replacement, postoperative rehabilitation, injury treatment, acetabular lip augmentation, technology-assisted rehabilitation.

1. Introduction

Over a million THRs are carried out annually throughout the world as a major treatment for end-stage hip joint illnesses like severe osteoarthritis and femoral head osteonecrosis. Patients' pain can be considerably reduced, joint function can be successfully restored, and their quality of life can be considerably enhanced by this operation. However, the result is affected by some variables such as patients' experiences, safety and postoperative rehabilitation [1,2]. For example, many patients may have problems after surgery, including limited joint movement and partial joint pain alleviation, which can have a negative influence on their quality of life. What's more, some senior patients are likely to suffer thrombosis and infections [3]. In reality, patients often encounter some problems, including differences in treatment plans and the possibility of complications [3]. In the end, it is very important to investigate effective and low-cost postoperative intervention approaches such as physical therapy, surgical devices and remote rehabilitation technologies. In recent years, the

treatment and rehabilitation after THR surgery have always been a research hotspot. Considering that postoperative joint instability in patients is prone to cause recurrent dislocation, acetabular lip augmentation devices (such as PLAD) have become a successful solution in treatment, as they shorten the recovery period for patients and enhance joint stability [4]. Bundled interventions can significantly lower the risk of revision and the infection rate of the surgical site [5]. Physical therapy is useful in the field of rehabilitation for enhancing patients' quality of life, muscle strength, and mobility, but it has minimal effect on pain management or hospital stay duration. Transcutaneous electrical acupoint stimulation (TEAS) can relieve pain, enhance cognitive function and reduce adverse reactions. In addition, the patient's muscle strength, gait and balance ability can all be continuously improved through progressive resistance training before and after the operation. Despite some progress, there are still numerous issues with the treatment and recovery following THR surgery. The potential mechanisms in the treatment and rehabilitation process have not been fully clarified. Research on the synergistic effects of treatment methods and rehabilitation approaches is still scarce, and personalized plans for special groups such as the elderly, frail patients, or those with multiple underlying diseases need to be improved immediately. Based on this, the main focus of this study is the treatment and rehabilitation of post-THR injuries, aiming to thoroughly examine the causes of the injuries, assess the impact of important treatment techniques, and comprehensively investigate the benefits of different rehabilitation methods. Through this approach, this study hopes to lay a solid foundation for the formulation and effective implementation of personalized treatment and rehabilitation plans, which will be tailored to each patient's unique physical condition, medical history, and functional needs. Meanwhile, this study also strives to provide comprehensive and persuasive information to guide the improvement of perioperative care, which involves processes such as preoperative risk assessment, intraoperative assessment, and postoperative monitoring.

2. Reasons and mechanisms of injuries in hip replacement surgery

Numerous factors contribute to the incidence of injuries following hip replacement surgery, but the main causes are age-related physiological changes and the progression of the disease. When conservative treatment for hip joint lesions is unsuccessful, osteoarthritis—a leading cause of persistent pain and disability globally—often necessitates replacement surgery. Statistics show that the radiographic prevalence of hip osteoarthritis in people over 60 years old reaches 7%, and the prevalence in women is higher than in men [1]. Additionally, because of aging organ systems and diminished physiological reserves, older patients are more likely to experience post-operative problems. These complications not only delay recovery but may also directly cause secondary injuries [2]. At the same time, patients with poor preoperative functional status (such as long-term activity restriction, muscle atrophy) find it more difficult to adapt to changes in joint load during postoperative rehabilitation, which will also increase the risk of injury [2].

Postoperative injuries are caused by a combination of physical dysfunction and rehabilitative imbalance. A patient's motor coordination may be directly impacted by early postoperative physical challenges (pain, reduced activity, and weakened muscles), which may result in an abnormal gait. This, in turn, may increase the abnormal load on the joint prosthesis, causing the prosthesis to loosen or damage surrounding tissues [2]. Insufficient strength in the muscles surrounding the hip joint, particularly the flexor and abductor muscles, has been shown to decrease joint stability. Inadequate or incorrect physical therapy therapies might worsen this issue, increasing the chance of trauma or falls during everyday activities [1].

3. Treatment and rehabilitation of injuries in hip replacement surgery

3.1. Treatment methods

In order to address the problem of repeated dislocation, the acetabular lip augmentation device is a selected treatment for instability after hip replacement surgery. Among these devices, the posterior lip augmentation device is the most commonly used [3,4]. In clinical practice, this device has shown certain therapeutic effects, providing a surgical choice for patients with recurrent dislocations. Structurally, the PLAD consists of an ultra-high molecular weight polyethylene bearing component and a stainless steel backplate. To form a congruent joint with the femoral head, the device can be fixed in place on the polyethylene cup using five screws and pre-drilled holes. It can also be fixed in the direction where hip dislocation is most likely to occur [4]. When it comes to surgery, PLAD has unique features that it different from other treatments. For instance, it shortens the duration spent in surgery, which helps patients recover better afterward [4]. There are other ways to deal with instability after THR too, like using dual-mobility acetabular cups. These cups have a small head design to cut down on polyethylene wear, along with a large and movable polyethylene liner to increase stability—though they may require more invasive procedures. All things considered, thanks to its advantages in surgical technique, PLAD serves as a feasible option in certain clinical situations. Postoperative problems remain a major challenge. Approximately 15% of hip joint repair surgeries are believed to result from infections at the surgical site, which can be life-threatening in severe cases. More importantly, these infections can lead to high costs, long recovery times, and a decline in long-term quality of life [5]. Therefore, researchers conducted a study on the impact of non-pathogen-specific bundling therapy on surgical site infections, which is caused by *Staphylococcus aureus* during hip replacement surgery. Compared with the control group that did not receive standardized bundled treatment, the experimental group that received intervention measures such as antibiotic prophylaxis, skin disinfection, preoperative bathing, appropriate hair removal and risk factor optimization had better compliance and standardization, thus resulting in a significant reduction in SSI. Each stage of the research has been successful, demonstrating that continuous use and packaging optimization offer benefits in the long run.

3.2. Rehabilitation methods

TEAS is a common physical therapy used in rehabilitation. One research investigated how TEAS works after hip replacement surgery, comparing the experimental group that received TEAS with the control group. The data measured in the results included postoperative cognitive dysfunction (POCD), scores from the Mini-Mental State Examination (MMSE), scores from the Visual Analogue Scale (VAS), and various side effects like nausea, vomiting, and dizziness [6]. When the two groups were compared, the experimental group showed improvements in POCD, MMSE scores, and VAS scores. They also had fewer side effects such as nausea, vomiting, and dizziness [6]. These findings suggest that TEAS effectively reduces side effects, improves cognitive function, and eases pain. The reasons behind these improvements might be ability of TEAS to regulate pain pathways and the release of neurotransmitters, improve blood flow to the brain, adjust the autonomic nervous system, and have positive effects on the autonomic and vestibular systems.

This points to TEAS's potential as a non-drug way to manage pain. While TEAS shows promise as a specific physical factor therapy, physical therapy encompasses a broader range of interventions in rehabilitation. Physical therapy is a very important part of rehabilitation treatment. Massage, passive stretching, interdisciplinary rehabilitation, functional rehabilitation, exercise, physical

fitness training, acupuncture, spinal manipulation, counseling, yoga, cognitive behavioral therapy, and martial arts are all included in physical therapy [1]. The advantages of physical therapy following THR are debatable. In order to compare patients who received physical therapy interventions following THR with those who did not, some studies have employed descriptive synthesis and meta-analysis. Physical therapy interventions were observed to increase muscle strength, mobility, health-related quality of life, and physical function after several months of monitoring [1]. However, neither hip pain nor hip function was improved, nor was the time of hospital stay decreased by physical therapy measures [1].

Even with these benefits, standard physical therapy has limitations in addressing certain long-term rehabilitation challenges. Physical treatment of any kind cannot completely avoid muscle atrophy in long-term rehabilitation following THR. Recovery may be hampered by this since it may increase the risk of revision and lower quality of life [7]. Therefore, progressive resistance training is necessary for focused muscle-strengthening in order to overcome the limits of standard physical treatment in terms of increasing muscular strength. Ankle stability and bilateral leg strength, including isometric and concentric contractions, are the main goals of progressive resistance training [7]. It improves the strength and endurance of the hip and lower leg muscles by progressively increasing resistance. A particular regimen was developed through controlled experiments that contrasted progressive resistance training with physical therapy alone [7]. Results are anticipated to assist muscle protection and functional improvement in post-THR rehabilitation, and efficacy data is still being monitored.

Progressive resistance training's focus on muscle strength aligns with the critical role of this factor in post-hip replacement recovery. For patients who have had hip replacement surgery, muscle strength is especially crucial for stability in walking and balance. 90 patients with hip osteoarthritis planned for unilateral primary THR were thus randomly assigned to one of three groups: the "preoperative group," the "postoperative group," or the "preoperative and postoperative group." Professional measuring tools were employed to perform multi-dimensional quantitative evaluations of hip joint function, muscle strength, gait, and balance both before and after the trial. The evaluation period covered key time points from preoperative to postoperative 1 year. Ultimately, the research results showed significant innovation and effectiveness [7]. This is the first study to confirm that preoperative combined with postoperative progressive resistance training can significantly and persistently improve patient muscle strength, gait, balance, and joint function compared to simple preoperative or postoperative training, providing important evidence for clinical rehabilitation programs [7,8].

In addition to physical therapy, with the advancement of technology, virtual reality (VR) devices have emerged as a new and effective tool for treating musculoskeletal and orthopedic conditions, such as osteoarthritis following THR [9]. Through sophisticated hardware and software, patients can experience a sense of presence (perceiving the environment as real) and immersion (being able to interact with virtual objects), particularly with non-immersive virtual reality (NIVR). Studies have shown that despite the low quality of sample evidence in research, cognitive training using NIVR can improve disability, physical function, cognitive abilities, and self-perceived improvements [9]. It is more effective than physical therapy alone and adds an element of fun.

For patients who live in remote or rural areas and have trouble getting outpatient physical therapy or home follow-ups, technology-assisted rehabilitation provides an alternative [10]. Recent studies have shown that it has therapeutic effects in treating musculoskeletal disorders, cardiac rehabilitation, and chronic diseases. A study utilized the PICO framework and RMC design. The population of this study is patients who have undergone hip replacement surgery, and the

intervention measures include technical assistance such as remote rehabilitation and video guidance. The comparison object is routine rehabilitation nursing, and the observation results involve walking tests, health-related quality of life (HRQOL), and functional independence measures (FIMs). Compared with traditional nursing, meta-analysis showed that technology assisted methods significantly improved gait indicators and Harris hip scores, reflecting the potential of remote treatment in promoting postoperative recovery [10].

4. Conclusion

In order to offer thorough support for enhancing patient outcomes, this study methodically investigates the causes, management, and rehabilitation techniques of postoperative injuries in THR. Age-related physiological changes, disease progression, preoperative physical dysfunction, and rehabilitative imbalance are the main causes of postoperative injuries following THR. Acetabular lip augmentation devices provide benefits such as reduced surgery length and a considerable reduction in surgical site infections. They are an excellent therapy option for prosthesis instability. Preoperative and postoperative progressive resistance training consistently improves muscle strength, gait, and balance; virtual reality and technology-assisted rehabilitation help remote patients and improve recovery outcomes; TEAS reduces pain and enhances cognitive function; physical therapy improves muscle strength and function but has limited effects on pain and hospital stay. These findings offer a theoretical foundation for creating individualized treatment and rehabilitation programs and optimizing perioperative care, all of which are essential for raising patient satisfaction and lowering social costs. Lack of study on the synergistic benefits of numerous interventions, poorly tailored plans for unique groups (e.g., elderly frail patients), and a lack of clarity regarding the mechanisms underlying therapy and rehabilitation are some of the limitations. To further improve THR postoperative care, future research should concentrate on examining the mechanisms underlying therapies, examining the synergy between various approaches, refining customized protocols for unique populations, and encouraging the use of technology-assisted rehabilitation.

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