Submitted: 08 June, 2023 Accepted: 08 October, 2023 Published: 30 October, 2023 DOI:10.22514/jomh.2023.103

ORIGINAL RESEARCH

JOMH Journal of Men's Health

Effect of ERAS management mode on postoperative functional exercise compliance and functional recovery in male anterior cruciate ligament injury

Shuang Zhang[1,*], Nan Lu[1], Li Zhu[1], Yuchen Li[1], Tong Zheng[1]

[1]Department of Sports Medicine, Beijing Jishuitan Hospital, Capital Medical University, 100035 Beijing, China

***Correspondence**
hzhang5779@163.com
(Shuang Zhang)

Abstract

The study aims to investigate the effect of ERAS (Enhanced Recovery After Surgery) management mode on functional exercise compliance and functional recovery after ACL (anterior cruciate ligament) reconstruction in males. Patients were admitted between June 2021 and December 2021 as the control group, and patients were admitted between January 2022 and June 2022 as the observation group. Routine nursing was adopted in the control group, while ERAS management mode was applied in the observation group for nursing. The clinical nursing efficacy, knee joint function (Lysholm score) and VAS (Visual analogue scale) score, patients' functional training compliance and complications were compared. After intervention, the swelling disappearance time, pain disappearance time, hospital stay and other indicators of clinical nursing effect in the observation group were better ($p < 0.05$); the preoperative Lysholm score and VAS score showed no statistical significance ($p > 0.05$). The Lysholm score and VAS score at each time point after operation were markedly higher, and repeated measures analysis of variance manifested that the Lysholm score, VAS score, intergroup effect, time effect and interaction effect in both groups had statistical significance ($p < 0.05$). The total compliance rate of functional training in the observation group was conspicuously higher ($p < 0.05$); the overall incidence of complications in the observation group (13.3%) was evidently lower (28.7%) ($p < 0.05$). ERAS management mode can improve the functional training compliance, accelerate the recovery of joint function, reduce the incidence of complications and promote the quality of life of patients with ACL injury.

Keywords

Male patients with ACL injury; Functional recovery; ERAS management model; Functional exercise compliance

1. Introduction

Currently, the incidence of anterior cruciate ligament (ACL) injury of the knee has been rising as the most common sports injury of the knee joint [1]. ACL of the knee remains as one of the key structures to maintain knee stability [2]. ACL rupture can give rise to anterior instability, causing further damage to the knee joint [3]. Complete ACL ruptures predispose to meniscus and articular cartilage injuries and severely impair knee function. Currently, arthroscopic reconstruction emerges as the most prominent treatment for ACL injury. However, ACL reconstruction of the knee joint easily give rise to periarticular muscle atrophy, infection, pain and even severe joint stiffness, thereby losing the chance of knee joint function recovery. Therefore, postoperative guidance must be cautiously followed to minimize the risk of complications and promote the recovery of knee joint function [4]. Enhanced Recovery After Surgery (ERAS) is a multidisciplinary perioperative care approach designed to accelerate postoperative recovery and reduce complications to optimize the physical and psychological status of patients [5]. ERAS aims to reduce the physical and psychological stress of surgery, minimizes the risk of complications, and allows patients to return to normal activities as soon as possible after surgery. ERAS has been developed for a wide range of surgical procedures, including colorectal surgery, orthopedic surgery, as well as gynecologic surgery. Besides, it has been shown to improve patient prognosis, shorten hospital stays and reduce medical costs [6]. To promote knee recovery, medical staff can perform balance and muscle strength exercises for patients with ACL injury as part of a rehabilitation exercise treatment, typically lasting 12–13 weeks. This rehabilitation exercise treatment, which utilizes an ERAS management mode, can help simulate natural movements of the human body, facilitating passive movement of the affected limb and accelerating recovery of the articular cartilage and surrounding tissues, in comparison to patients' active function exercise [7]. In this study, ERAS management was applied to patients with ACL injury of the

knee to analyze its rehabilitation effect, and the results are reported as follows.

2. Subjects and methods

2.1 Study subjects

A retrospective study was conducted on male patients with ACL injury who received reconstruction at our hospital from June 2021 to June 2022. Inclusion criteria: 1. Patients who aged 18 to 50 years old; 2. Patients who were diagnosed with ACL injury; 3. Arthroscopic ACL reconstruction; 4. On the second day after surgery, patients were transferred to our rehabilitation department for postoperative rehabilitation; Exclusion criteria: 1. Patients who had old ACL injury; 2. Patients who had coagulation dysfunction; 3. Patients who had complicated with heart, lung, liver, kidney and other vital organ dysfunction; 4. Patients with mental illness who cannot complete the postoperative rehabilitation program as planned.

2.2 Grouping methods

In our hospital, since January 2022, all patients with ACL reconstruction have been nursed by ERAS management model based on routine nursing methods. Sixty patients who were nursed using the ERAS management model between January 2022 and June 2022 were selected as the observation group. 60 patients who were nursed using routine care between June 2021 and December 2021 were matched 1:1 as the control group. The difference in the general data between both groups showed no statistical significance ($p > 0.05$). The outcomes were shown in Table 1.

2.3 Study methods

2.3.1 Study methods for control group

Control group conventional conservative treatment (1) Range of motion exercises were started on the second day after ACL reconstruction treatment, with knee extension goals of 0°, reaching 90° at 4 weeks and 120° at 8 weeks, with the same as 12 weeks. Patients returned to daily activities at 3 months and low-intensity sports activities such as jogging and squatting at 6 months. Then, patients returned to sports after 10 months according to the recovery of neuromuscular coordination ability. (2) The distribution of education manuals. The content closely follows the theme of ACL injury with pictures and texts, which is simple and clear. The responsible nurse distributed them after the patient is admitted to the hospital to explain the course of treatment for ACL injury and related precautions. (3) Centralized teaching. Department shall train three nurses to master the basic teaching skills and specialist knowledge, and give centralized teaching to patients and their families. The contents of the lecture included knowledge of the prevention and treatment of ACL injury and possible complications, pain management, diet management, how to perform rehabilitation exercises in life, and how to accompany the patient.

2.3.2 Study methods for observation group

2.3.2.1 Team formation

The ERAS management team is composed of one orthopedic surgeon, one rehabilitation therapist, one head nurse, and one responsible nurse. It began with hospitalization and ended 3 months after discharge ERAS care plans were developed. Domestic and foreign journals, dissertations and other literatures on postoperative care of ACL reconstruction were searched, and the application of ERAS research were focused. Based on ERAS, the interview results of orthopedic experts and rehabilitation experts in the hospital were summarized. Doctors, rehabilitation therapists and nurses jointly participated in the development of rehabilitation training and rehabilitation training management, developed ERAS nursing plan, and collected relevant information about the patient's condition and care progress. Nursing intervention strategies were implemented as planned. Among them, the care plan should be documented in the patient's medical record, containing the patient's goals, interventions and progress to ensure continuity of care by healthcare providers.

2.3.2.2 Health education

Physical and emotional state of patients were assessed: a care plan is based on a comprehensive assessment of physical and emotional state and includes evaluation of pain, mobility, swelling and joint mobility. Additionally, it entailed estimation of the patient's emotional state and readiness to participate in a rehabilitation program. Personalized education was provided: the responsible nurse developed individualized self-care education according to the patient's family residence, such as correct use of assistive devices, exercise and wound care. Second, the responsible nurse should also provide health education and preventive measures related to signs and symptoms of complications like infection, deep vein thrombosis and pulmonary embolism. Responsible nurses, rehabilitation therapists and doctors work together to develop rehabilitation programs to ensure coordinated and comprehensive rehabilitation training.

2.3.2.3 Pain management

The patient's pain level was assessed *via* using multimodal pain management techniques such as non-opioid pain medication, nerve blocks and physical therapy to manage pain and discomfort following the procedure. Meanwhile, the nurse should monitor the patient's pain level, joint mobility, strength and activities of daily living.

2.3.2.4 Target setting and monitoring

Identification of patient's rehabilitation goals: a plan of care was developed based on the rehabilitation goals of patients, which include relieving pain, promoting mobility and range of motion, restoring strength and function and returning to normal activities. Development of a care plan: a care plan is developed by a rehabilitation therapist in collaboration with a physician. The plan involved specific interventions such as pain management, wound care, mobility training, range of motion exercises, strength training and self-care education to meet the needs of patients and achieve their rehabilitation goals. The progress of the recovery was monitored: regular assessment of the patient's progress was evaluated, and the care

TABLE 1. Comparison of general data between both groups ($\bar{x} \pm s$, n (%)).

Item	Observation group	Control group	χ^2/t	p
Case	60	60		
Age	28.40 ± 5.368	27.22 ± 6.143	1.124	0.263
Surgical site			0.534	0.465
Left knee	27 (45%)	31 (51.7%)		
Right knee	33 (55%)	29 (48.3%)		
Procedure time	118.40 ± 6.368	120.98 ± 8.325	1.909	0.059

plan was promptly modified.

2.3.2.5 Rehabilitation training program

Stage 1: In immediate postoperative period (0–2 weeks), pain and swelling was controlled, joint Range of Motion (ROM) was restored, and the healing was promoted. Besides, pain and inflammation were minimized, blood circulation was improved, and complications was prevented. Exercise was done daily for 20–30 minutes, and the main exercise items included rest, ice, compression and elevation (RICE), gentle joint motion and isometric muscle contraction such as patellar pushing, isometric quadriceps contraction and isometric hamstring contraction, straight leg raising, manual therapy like assisted knee flexion exercise and muscle strength training.

Stage 2: In early mobilization phase (2–6 weeks), complete ROM was restored, muscle strength was improved, and functional activity was enhanced. Frequency: 2–3 times per week (or as advised by the rehabilitation therapist). It was performed 45–60 minutes each time, which can efficiently promote joint mobility, muscle strength and endurance as well as functional activities. The main exercises contained combined mobilization, stretching, resistance training and balance and coordination exercises.

Stage 3: In intermediate stage (6–12 weeks), most strength, endurance and joint stability were restored, and it was ready for returning to normal activities. It was conducted 3–4 times per week (or as advised by a rehabilitation therapist). The exercise lasted 60–90 minutes each time. The strength, endurance and joint stability can be enhanced and sport-specific or functional activities was reintroduced. The major exercise program included resistance training, aerobic exercise, plyometric training and specific exercise training.

Stage 4: In advanced stage (12+ weeks), it returned to normal activity level and re-injury should be prevented. The exercise was taken 4–5 times per week (or as advised by a rehabilitation therapist). It continued for 90–120 minutes each time. The strength, endurance and agility were advanced. Gradually, movements and activities specific to exercise were reintroduced. The main exercise program contained high intensity resistance training, cardiovascular conditioning, specific exercise training and functional testing.

2.4 Outcome measures

(1) Effect of clinical nursing. The indicators were comprised of time for getting up, the first defecation time, the first ambulation time and hospital stay after surgery.

(2) Knee function and pain scores. Lysholm score [8] was utilized to assess knee joint function, including joint rest pain, joint movement pain, tenderness, swelling, morning stiffness and walking ability, with a full score of 100 points. Better score indicated better knee joint function.

(3) Pain. Visual analogue scale (VAS) score [9] was utilized to evaluate the patient's pain, with a total score of 10 points. Higher score indicated more severe pain of patients.

(4) Compliance of functional exercise. The self-made compliance scale of functional exercise derived from our hospital was employed for evaluation, which was classified into complete compliance, partial compliance and non-compliance. Complete compliance referred to active completion of rehabilitation training. Partial compliance meant that the nurses urged the patients to complete rehabilitation training. Non-compliance implied that the patients still did not complete rehabilitation training after being urged by the nurses. Overall compliance rate = (complete + partial) compliance/total cases $\times$ 100%.

(5) Complications. Complications such as incision infection, incision oozing, joint stiffness and deep venous thrombosis occurred during the intervention were recorded. Incidence (%) = complication cases/total cases $\times$ 100%.

2.5 Statistical methods

SPSS 22.0 (IBM Corporation, Armonk, NY, USA.) was employed for data analysis. The enumeration data such as functional exercise compliance and incidence of complications were presented as frequency or percentage (%), and the comparison was conducted *via* χ^2 test; the measurement data such as clinical nursing effect, knee joint function and pain score were presented as mean ± standard deviation ($\bar{x} \pm s$). For the measurement data in accord with normal distribution, two independent samples *t*-test was applied. The comparison at different time points before and after intervention was conducted *via* repeated measures analysis of variance. $p < 0.05$ manifested that the difference was statistically significant.

3. Results

3.1 Comparison of clinical nursing effect

After the intervention, the first time to get up, the first defecation time, the swelling disappearance time, the pain disappearance time, and the hospital stay in the observation group

were shorter than the control group. The differences were statistically significant between groups ($p < 0.05$), as presented in Table 2.

3.2 Comparison of knee function recovery and VAS score

There was no significant difference in Lysholm score and VAS score before intervention between both groups ($p > 0.05$). The Lysholm score and VAS score at 3 months and 6 months after intervention in the observation group were notably higher than that in the control group with difference showing statistical significance. The repeated measures analysis of variance demonstrated that the Lysholm score and VAS score on within-group effect, time effect and interaction effect in both groups had statistical significance ($p < 0.05$), as revealed in Table 3.

3.3 Comparison of rehabilitation exercise compliance between both groups

After intervention, the comparison of rehabilitation exercise compliance between both groups showed that the total compliance rate was 95% in the observation group and 81.7% in the control group. The results of χ^2 test revealed that the difference showed statistical significance ($p < 0.05$), as presented in Table 4.

3.4 Comparison of complications between both groups

After intervention, the incidence rate of complications in both groups was compared. The total incidence of complications in the observation group was 13.3%, which was evidently lower than that in the control group (28.7%). The outcomes of χ^2 test displayed that the difference had statistical significance ($p < 0.05$), as revealed in Table 5.

4. Discussion

4.1 ERAS management mode can effectively improve the clinical recovery effect of patients

The concept of knee rehabilitation has evolved over the past three decades, leading to significant improvements in motor ability recovery after knee surgery. The Enhanced Recovery After Surgery (ERAS) approach is a perioperative management strategy that utilizes evidence-based medicine (EBM) to reduce surgical trauma, physical and psychological stress, and accelerate patient recovery [10, 11]. The outcomes unveiled that after the intervention, the first time to get up, the first defecation time after surgery, swelling disappearance time, pain disappearance time and the length of hospital stay in the observation group were superior to the control group, and the differences were statistically significant ($p < 0.05$). It disclosed that the ERAS management mode could improve the postoperative recovery effect of patients with injury. The primary cause is that the ERAS management mode developed a comprehensive rehabilitation program for the rehabilitation plan of patients through the multidisciplinary team [12]. Second, the ERAS underlines the importance of continuous support and communication between healthcare professionals and patients, which can help patients feel supportive and motivated to continue their rehabilitation exercises [13]. Therefore, it can sufficiently improve the recovery of patients. Overall, the ERAS management model can improve patient compliance with rehabilitation exercises by providing education, multidisciplinary approach, goal setting and monitoring, pain management and ongoing support. Patients are more likely to comply with rehabilitation exercises, which can lead to better outcomes and faster postoperative recovery by following these steps.

4.2 ERAS management mode can promote the recovery of knee joint function and reduce pain

ACL is critical to maintain anterior knee stability and control knee rotation [14]. It is divided into anteromedial and posterolateral bundle. The unique anatomical features of the knee joint cause the tension of its two bundles to vary during movement, changing with the flexion and extension of the knee joint [15]. Results of this study showed that the recovery of joint function and the VAS pain score in the observation group were significantly better than those in the control group ($p < 0.05$). It exhibited that ERAS management mode can hasten knee function recovery and reduce pain. The reason was analyzed. On the premise of patient safety, ERAS management mode integrated multiple postoperative rehabilitation exercises and nursing measures with rapid recovery as the goal, so that patients can "safely and quickly" get through the perioperative period [16]. Second, through multimodal pain management, the ERAS management mode uses multimodal pain management techniques like non-opioid analgesic drugs, nerve blocks and physical therapy to manage postoperative pain and discomfort. It can ensure that patients recover more smoothly and safely with fewer complications and better overall outcomes after surgery [17]. The findings of Glattke KE [18] showed that early bed-rest exercise and functional training in an enhanced recovery protocol could improve symptoms of joint mobility limitation after ACL reconstruction, which is consistent with the results of this study.

4.3 ERAS management mode can improve compliance of rehabilitation exercises in patients

ACL is the most common sports injury in clinical practice, and ACL injury can result in some psychological distress in patients [19]. Patients with ACL injuries are often fearful and anxious about their injuries, arthroscopic ACL reconstruction, their ability to return to normal activities after surgery, as well as the possibility of re-injury. Hence, they are afraid of rehabilitation exercises [20, 21]. The results of this study revealed that the compliance of rehabilitation exercise in the observation group was remarkably better than the control group, and the difference was statistically significant ($p < 0.05$). The results displayed that ERAS management mode could improve the compliance of rehabilitation exercise in patients. The reason is that the ERAS management mode highlights the importance of patient education and allows patients to participate in the decision-making process [22]. Patients were told about the

TABLE 2. Comparison of clinical nursing effect ($\bar{x} \pm s$).

Item	Observation group	Control group	t	p
Case	60	60		
First time to get up (d)	3.47 ± 0.947	3.98 ± 1.200	2.618	0.010
First defecation time (d)	1.82 ± 0.537	2.02 ± 0.504	2.105	0.037
Swelling disappearance time (d)	5.92 ± 0.944	6.75 ± 1.271	4.078	<0.001
Pain disappearance time (d)	5.95 ± 0.928	6.73 ± 1.118	4.176	<0.001
Length of hospital stay (d)	5.02 ± 1.557	6.79 ± 1.544	5.947	<0.001

TABLE 3. Comparison of knee function recovery and VAS score ($\bar{x} \pm s$).

Lysholm score				$F_{intergroup}$	$F_{within\ group}$	$F_{interaction}$
	Pre-intervention	3 months after intervention	Intervention for 6 months	2900.200*	4.576*	3.067*
Observation group	58.85 ± 4.468	72.70 ± 4.28	87.63 ± 6.664			
Control group	58.68 ± 3.286	70.38 ± 3.015	84.25 ± 5.608			
t	−0.233	−1.469	−3.009			
p	0.816	0.040	0.003			
VAS score				$F_{intergroup}$	$F_{within\ group}$	$F_{interaction}$
	Pre-intervention	3 days after surgery	7 days after surgery	5069.878*	1.905	3.736*
Observation group	5.79 ± 1.20	5.95 ± 0.74	2.38 ± 0.85			
Control group	6.05 ± 1.01	6.04 ± 0.85	3.85 ± 0.55			
t	0.358	2.106	3.034			
p	0.721	0.037	0.001			

*Note: * indicates $p < 0.05$. VAS: Visual analogue scale.*

TABLE 4. Comparison of rehabilitation exercise compliance between both groups (n (%)).

Group	Complete compliance	Partial compliance	Non-compliance	Compliance rate
Observation group	33 (65%)	24 (40%)	3 (5%)	57 (95%)
Control group	27 (45.0%)	22 (36.7%)	11 (18.3%)	49 (81.7%)
χ^2				5.175
p				0.023

TABLE 5. Comparison of complications between both groups (n (%)).

Group	Incision infection	Incisional oozing	Joint stiffness	Deep vein thrombosis	Incidence
Observation group	1 (1.7%)	1 (1.7%)	1 (1.7%)	5 (8.3%)	8 (13.3%)
Control group	1 (1.7%)	2 (3.3%)	3 (5.0%)	11 (18.3%)	17 (28.3%)
χ^2					4.093
p					0.043

benefits of early mobilization and rehabilitation, and were helped to understand the importance of these activities and improve their compliance [4]. Second, ERAS involves a multidisciplinary team of healthcare professionals who work together to optimize patient care [23]. The team includes doctors, nurses, rehabilitation therapists and other health care professionals who can provide support and guidance to patients during rehabilitation [24]. Third, the ERAS management mode sets clear goals for patients and monitors their progress in achieving these goals. This helps patients stay motivated and committed to their rehabilitation exercises. It is consistent with the findings of Fouasson-Chailloux A [25].

4.4 ERAS management mode reduces the incidence of complications

ACL injury can result in the loss of knee stability and secondary damage to other joint structures. Arthroscopic ACL reconstruction has become a standard treatment for ACL and multiple ligament injuries of the knee due to advances in arthroscopic surgery. However, postoperative limb function recovery is hindered by a series of symptoms, such as limited limb movement [26]. The results of this study illustrated that the incidence of complications in observation group was significantly lower than the control group, and the difference had statistical significance ($p < 0.05$). The results showed that ERAS management mode could effectively diminish the incidence of complications. The main reason is that the ERAS management mode can develop an early rehabilitation exercise program and early nutritional support for patients, which is conducive to reducing the risk of complications such as infection, thrombosis and stress injury [27]. Second, joint range of motion and weight-bearing activity training will prevent lower limb muscle atrophy and accelerate knee joint function recovery to some extent. Studies have implied [28] that the concept of early active rehabilitation, which involves performing functional rehabilitation exercises as soon as possible, can shorten the time needed for knee joint function recovery and improve the effects of knee surgery. Deabate L [26] study suggested that the incidence of joint stiffness and limb movement limitation is lower when ACL reconstruction is performed within 3 weeks of ACL injury. This is because ACL injury can cause varying degrees of knee joint instability, which can affect knee joint function activities. ACL rupture also alters the stress pattern of the meniscus and intra-articular cartilage. Therefore, to restore knee joint function to normal activity level as much as possible, we should help ACL patients actively perform ligament reconstruction, adopt enhanced recovery program, perform early rehabilitation exercise. Hence, joint adhesions can be reduced and joint range of motion can be increased to restore the complete structure and stability of the injured knee joint and eliminate complications of knee joint surgery.

5. Conclusions

In brief, the ERAS management mode is an evidence-based care method that can minimize surgical trauma and stress response, promote functional recovery of patients, reduce the incidence of complications, and improve patient compliance with rehabilitation exercises and quality of life. However, there are still limitations in this study such as small sample size and lack of reliability. Therefore, we will plan to conduct a multicenter, multi-sample randomized controlled study to verify the reliability of these findings in the future.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

SZ—designed the study and carried them out; NL, LZ, YCL, TZ—supervised the data collection, analyzed the data, interpreted the data, prepared the manuscript for publication and reviewed the draft of the manuscript. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Ethics Committee of Beijing Jishuitan Hospital, Capital Medical University (Approval no. K20220610-03). Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research was funded by Research and transformation application of clinical characteristic diagnosis and treatment technology in the capital (Grant No. Z221100007422004).

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Bayer S, Meredith SJ, Wilson KW, de SA D, Pauyo T, Byrne K, *et al*. Knee morphological risk factors for anterior cruciate ligament injury. Journal of Bone and Joint Surgery. 2020; 102: 703–718.

[2] Webster KE, Hewett TE. Anterior cruciate ligament injury and knee osteoarthritis: an umbrella systematic review and meta-analysis. Clinical Journal of Sport Medicine. 2022; 32: 145–152.

[3] Musahl V, Karlsson J. Anterior cruciate ligament tear. New England Journal of Medicine. 2019; 380: 2341–2348.

[4] Reijman M, Eggerding V, van Es E, van Arkel E, van den Brand I, van Linge J, *et al.* Early surgical reconstruction versus rehabilitation with elective delayed reconstruction for patients with anterior cruciate ligament rupture: COMPARE randomised controlled trial. The BMJ. 2021; 372: n375.

[5] Ljungqvist O, de Boer HD, Balfour A, Fawcett WJ, Lobo DN, Nelson G, *et al.* Opportunities and challenges for the next phase of enhanced recovery after surgery: a review. JAMA Surgery. 2021; 156: 775–784.

[6] Smith TW, Wang X, Singer MA, Godellas CV, Vaince FT. Enhanced recovery after surgery: a clinical review of implementation across multiple surgical subspecialties. The American Journal of Surgery. 2020; 219: 530–534.
[7] Truong LK, Mosewich AD, Holt CJ, Le CY, Miciak M, Whittaker JL. Psychological, social and contextual factors across recovery stages following a sport-related knee injury: a scoping review. British Journal of Sports Medicine. 2020; 54: 1149–1156.
[8] Huang H, Zhang S, Wang Y, Tegner Y, Wang Y, Jiang Y, *et al.* Reliability and validity of a Chinese version of the Lysholm score and Tegner activity scale for knee arthroplasty. Journal of Rehabilitation Medicine. 2022; 54: jrm00317.
[9] Modarresi S, Lukacs MJ, Ghodrati M, Salim S, MacDermid JC, Walton DM. A systematic review and synthesis of psychometric properties of the numeric pain rating scale and the visual analog scale for use in people with neck pain. The Clinical Journal of Pain. 2021; 38: 132–148.
[10] Brindle M, Nelson G, Lobo DN, Ljungqvist O, Gustafsson UO. Recommendations from the ERAS® society for standards for the development of enhanced recovery after surgery guidelines. BJS Open. 2020; 4: 157–163.
[11] Debono B, Wainwright TW, Wang MY, Sigmundsson FG, Yang MMH, Smid-Nanninga H, *et al*. Consensus statement for perioperative care in lumbar spinal fusion: enhanced recovery after surgery (ERAS®) society recommendations. The Spine Journal. 2021; 21: 729–752.
[12] Xu J, Zheng M, Feng Z, Pan L, Peng Z. Meta-analysis of knee joint function recovery after anterior cruciate ligament reconstruction by accelerated rehabilitation surgery. Computational Intelligence and Neuroscience. 2022; 2022: 5085143.
[13] Kai Sun, Lei Chen, Yao M, Hua Hu, Liang Chen, Jun Zhong, *et al*. Clinical application of enhanced recovery after surgery in the perioperative period of anterior cruciate ligament reconstruction. Chinese Journal of Tissue Engineering Research. 2021; 25: 1647–1651. (In Chinese)
[14] Andrey Rusanov, Irina Roy, Olga Rusanova, Nataliia Yevpak, Liudmyla Podosinova. The effects of the comprehensive rehabilitation method on quadriceps activation: outcomes in patients with an injury to the anterior cruciate ligament. Sport Mont. 2020; 18: 15–18.
[15] Fleming JD, Ritzmann R, Centner C. Effect of an anterior cruciate ligament rupture on knee proprioception within 2 years after conservative and operative treatment: a systematic review with meta-analysis. Sports Medicine. 2022; 52: 1091–1102.
[16] Praz C, Vieira TD, Saithna A, Rosentiel N, Kandhari V, Nogueira H, *et al*. Risk factors for lateral meniscus posterior root tears in the anterior cruciate ligament–injured knee: an epidemiological analysis of 3956 patients from the SANTI study group. The American Journal of Sports Medicine. 2019; 47: 598–605.
[17] Jordan MJ, Morris N, Barnert J, Lawson D, Aldrich Witt I, Herzog W. Forecasting neuromuscular recovery after anterior cruciate ligament injury: athlete recovery profiles with generalized additive modeling. Journal of Orthopaedic Research. 2022; 40: 2803–2812.
[18] Glattke KE, Tummala SV, Chhabra A. Anterior cruciate ligament reconstruction recovery and rehabilitation. Journal of Bone and Joint Surgery. 2022; 104: 739–754.
[19] Nelson C, Rajan L, Day J, Hinton R, Bodendorfer BM. Postoperative rehabilitation of anterior cruciate ligament reconstruction: a systematic review. Sports Medicine and Arthroscopy Review. 2021; 29: 63–80.
[20] An YW, Lobacz AD, Baumeister J, Rose WC, Higginson JS, Rosen J, *et al*. Negative emotion and joint-stiffness regulation strategies after anterior cruciate ligament injury. Journal of Athletic Training. 2019; 54: 1269–1279.
[21] Piussi R, Berghdal T, Sundemo D, Grassi A, Zaffagnini S, Sansone M, *et al*. Self-reported symptoms of depression and anxiety after ACL injury: a systematic review. Orthopaedic Journal of Sports Medicine. 2022; 10: 232596712110664.
[22] Gennarelli SM, Brown SM, Mulcahey MK. Psychosocial interventions help facilitate recovery following musculoskeletal sports injuries: a systematic review. The Physician and Sportsmedicine. 2020; 48: 370–377.
[23] He X. Observation on the rehabilitation effect of athletes with anterior cruciate ligament injury of the knee based on multidisciplinary combined nondrug therapy. Journal of Healthcare Engineering. 2022; 2022: 9528354.
[24] Jenkins SM, Guzman A, Gardner BB, Bryant SA, del Sol SR, McGahan P, *et al*. Rehabilitation after anterior cruciate ligament injury: review of current literature and recommendations. Current Reviews in Musculoskeletal Medicine. 2022; 15: 170–179.
[25] Fouasson-Chailloux A, Crenn V, Louguet B, Grondin J, Menu P, Dauty M. Therapeutic patient education after anterior cruciate ligament reconstruction: evaluation of the knowledge and certitudes with a self-report questionnaire. Healthcare. 2022; 10: 934.
[26] Deabate L, Previtali D, Grassi A, Filardo G, Candrian C, Delcogliano M. Anterior cruciate ligament reconstruction within 3 weeks does not increase stiffness and complications compared with delayed reconstruction: a meta-analysis of randomized controlled trials. The American Journal of Sports Medicine. 2020; 48: 1263–1272.
[27] Kocher MS, Saxon HS, Hovis WD, Hawkins RJ. Management and complications of anterior cruciate ligament injuries in skeletally immature patients: survey of the Herodicus society and the ACL study group. Journal of Pediatric Orthopedics. 2002; 22: 452–457.
[28] Frassanito L, Vergari A, Nestorini R, Cerulli G, Placella G, Pace V, *et al*. Enhanced recovery after surgery (ERAS) in hip and knee replacement surgery: description of a multidisciplinary program to improve management of the patients undergoing major orthopedic surgery. Musculoskeletal Surgery. 2020; 104: 87–92.

How to cite this article: Shuang Zhang, Nan Lu, Li Zhu, Yuchen Li, Tong Zheng. Effect of ERAS management mode on postoperative functional exercise compliance and functional recovery in male anterior cruciate ligament injury. Journal of Men's Health. 2023; 19(10): 96-102. doi: 10.22514/jomh.2023.103.