Journal of Musculoskeletal and Neuronal Interactions JMNI

Original Article

A Study on the Effect of Precise Rehabilitation Therapy Guided by Three-dimensional-computed Tomography Reconstruction Technology in Hip Fracture Surgery Patients

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Abstract

Objective: To evaluate the effectiveness of precise rehabilitation therapy guided by three-dimensional computed tomography (3D-CT) reconstruction technology in hip fracture patients through a retrospective cohort study. **Method**: Data were retrospectively collected from 60 patients aged over 60 who had undergone hip fracture surgery. They were divided into two groups based on their chosen rehabilitation method: a control group and a test group. The study collected demographic data, fracture characteristics, and quality of life indicators to assess the impact of rehabilitation on economic indicators and daily living activities (ADL). Additionally, it included assessments of muscle strength, joint mobility, hip function, postoperative complications, and records of hospitalization information and costs. Cognitive function was also assessed postoperatively. **Results**: There were no significant differences in demographic data, fracture characteristics, ADL, or Fugl-Meyer assessment (FMA) between the two groups. However, the test group exhibited significantly higher post-surgery muscle strength recovery and hip mobility compared to the control group ($P<0.05$). Additionally, the test group had significantly fewer hospitalization days and lower hospitalization costs than the control group ($P<0.05$). **Conclusion**: Precise rehabilitation therapy guided by 3D-CT reconstruction technology for hip fracture surgery patients can enhance early muscle strength recovery, improve mobility of the affected limb, reduce hospitalization duration and costs, and enhance overall patient recovery outcomes.

Keywords: Hip Fracture, Prediction Model, Rehabilitation, Three-Dimensional-Computed Tomography

Introduction

Hip fractures are common among the elderly, with a significant increase in incidence, especially in those aged 65 or older. An estimated 16,000 hip fracture-related deaths occur each year, and China has one of the highest incidence rates globally[1]. Hip fractures have a significant impact on both patients' quality of life and the healthcare system. With advances in medical technology, surgery has become the primary treatment for hip fractures[2]. Common surgical approaches include hip arthroplasty, internal fixation, and external fixation. The choice of surgical method should be tailored to the patient's age, bone quality, fracture type, and clinical symptoms[3].

Rehabilitation therapy is crucial in the recovery process following hip fracture surgery. Traditional methods encompass physical therapy, functional exercise, and postural adjustments, but they lack specificity[3]. In recent years, precision rehabilitation therapy has gained prominence as a research focus. Precise rehabilitation therapy tailors treatment to the unique needs of each patient and employs scientific methods to create rehabilitation programs aimed at enhancing the overall rehabilitation outcome. While rehabilitation therapy is vital for hip fracture

The authors have no conflict of interest.

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Edited by: G. Lyritis
Accepted 2 November 2023

surgery recovery, it still has limitations[4]. For instance, the formulation of a rehabilitation treatment plan often relies on the experience and knowledge of medical professionals, making it challenging to achieve personalized treatment. Additionally, the patient's specific condition can impact the effectiveness of rehabilitation. The duration and cost of rehabilitation treatment are often high and require a lengthy commitment[5]. In recent years, precise rehabilitation treatment guided by three-dimensional-computed tomography (3D-CT) reconstruction technology has gradually gained attention. This method is based on 3D-CT reconstruction technology, and individualized rehabilitation plans are developed by analyzing the morphology, location and bone quality of the patient's fracture site. This method can help physicians better understand the fracture situation of patients, develop a more accurate rehabilitation plan, and improve the rehabilitation effect[5]. Furthermore, this method enhances patient understanding of their condition and boosts their participation and confidence in rehabilitation.

This study aims to assess the clinical effectiveness of precise rehabilitation therapy guided by 3D-CT reconstruction technology for hip fracture patients. Additionally, it conducts a retrospective analysis of postoperative hip function recovery to identify risk factors and establish a prediction model.

Methods

Patients

We retrospectively collected data from 60 patients who underwent hip fracture surgery and received rehabilitation treatment at the Third Affiliated Hospital of Qiqihar Medical University from January 2019 to December 2022, following inclusion and exclusion criteria. Patients were then divided into two groups: the control group (n=30) and the test group (n=30) based on their rehabilitation treatment. The control group received standard clinical postoperative hip rehabilitation therapy, while the test group received precise rehabilitation treatment guided by 3D-CT reconstruction technology.

Inclusion criteria: 1. Patient aged over 60. 2. Patients diagnosed with hip fracture after imaging and clinical diagnosis. 3. Patients who underwent surgical treatment for hip fracture in our hospital. 4. Patients who underwent rehabilitation in our hospital after surgery. 5. Patients with complete clinical data.

Exclusion criteria: 1. Patient aged under 60. 2. Patients treated conservatively in our hospital. 3. Patients with postoperative complications such as co-infection and thrombosis, which may affect the rehabilitation process. 4. Patients with missing clinical data.

Interventions

Control Group: Standard Clinical Postoperative Hip Rehabilitation

During the 1st and 2nd postoperative days, patients engaged in active and passive breathing exercises to prevent cardiopulmonary complications. Additionally, under effective pain management, patients received instructions from the doctor to perform isometric and isotonic contraction exercises for the muscles in the affected limbs, including training for the gastrocnemius, quadriceps, biceps, and gluteus maximus muscles

Post-Discharge Rehabilitation Training: The post-discharge rehabilitation training comprised wooden ladder exercises, practice in putting on shoes and socks, power bicycle training, and other activities.

Wooden Ladder Exercises

Upon hospital discharge, a multi-step wooden ladder with a height of 120cm and 4 or 5 steps was used to maintain and enhance hip joint mobility. The lowest step was set at 80cm, with a 10cm spacing between steps. Patients placed their feet on the steps and performed leg press exercises in hip and knee flexion positions, maintaining a hip joint range of motion at approximately 90 degrees for the first 3 weeks post-operation. After this initial period, the number of steps was gradually increased based on individual patient progress, with the goal of achieving normal hip flexion activity.

Exercise for Putting on Shoes and Socks

The exercise was performed three weeks after the operation. The patient sits in a chair with the healthy lower limb straightened and the knee and hip flexed. The affected lower limb is placed anterior to the healthy side's knee. With one hand, the patient holds the sole of the affected limb and gently presses down on its medial side with the other hand. Gradual flexion of the knee on the healthy side, along with hip joint flexion, internal rotation, and adduction, facilitates the patient's independent donning of shoes and socks.

Power Bicycle Training

This training was initiated three weeks after the operation. It began with raising the bicycle seat as high as possible. After completing a full circle of riding, the seat was gradually lowered to increase hip flexion. Leaning forward helped enhance hip flexion, and adjusting the position of the knees, either close together or apart, promoted internal and external rotation of the hamstring joints. The speed was initially set at 24 km/h and gradually increased, with sessions lasting 15 minutes each.

Test Group: Precise Rehabilitation Guided by 3D-CT Reconstruction Technology

The rehabilitation of the patients in the test group and control group share many similar aspects. For example, a variety of breathing exercises to prevent cardiopulmonary complications, including both active and passive exercises, are initiated on postoperative days 1 and 2. What's more, the patients were also instructed to perform isometric or isotonic contraction exercises, including gastrocnemius muscle training, quadriceps muscle training, biceps muscle training and gluteus maximus muscle training.

In the test group, rehabilitation was guided by 3D CT reconstruction technology, which involved a comprehensive analysis of each patient's skeletal and musculoskeletal characteristics, including hip joint structure and range of motion assessment. This approach allowed for the optimization of personalized rehabilitation programs, expediting recovery and improving the patients' quality of life.

Wooden Ladder Exercises

The goal of wooden ladder training is to enhance hip joint range of motion. In the test group, a comprehensive analysis of each patient's hip joint characteristics was conducted using 3D CT scan data. This analysis provided insights into the fracture nature, recovery process, and current hip function. Subsequently, a customized wooden ladder training program based on 3D models was created for each patient, allowing precise adjustments of height, step spacing, and step count according to individual hip conditions. This approach effectively aided in restoring and enhancing hip stability and function.

Exercise for Putting on Shoes and Socks

This functional exercise involves hip flexion, internal and external rotation. To ensure safe and accurate performance, the study employed 3D CT reconstruction technology, offering detailed visualizations of the hip joint and surrounding muscles. This visualization helps ensure the correct positioning of bones and optimal force application during the exercise.

Power Bicycle Training

This exercise aimed to enhance hip range of motion and muscle strength. 3D CT technology assessed each patient's hip range of motion, guiding the customization of bicycle saddle height, speed, and exercise duration to suit individual needs. Initial training focused on restoring the normal hip joint range of motion. Subsequently, as recovery progressed, training intensity increased, saddle height decreased, speed enhanced, and exercise duration extended.

Indices and Observation Time Points

1. Demographic Data: Collected data included age, gender, body mass index (BMI), type of surgery (PFNA, hip replacement), hypertension, and diabetes of the patients.
2. Muscle Strength Testing: Muscle strength was assessed before surgery and at 1 month, 3 months, and 6 months post-surgery. Muscle strength scores were recorded, and the ability of patients to overcome resistance during specific maneuvers was evaluated using a grading system.
   - Grade 0: No muscle contraction, and no muscle movement elicited.
   - Grade 1: Muscle contraction without joint movement.
   - Grade 2: Joint movement without resistance.
   - Grade 3: Complete joint movements but unable to resist mild resistance.
   - Grade 4: Complete joint movements and able to resist mild to moderate resistance.
   - Grade 5: Complete joint movements and able to resist greater resistance.
3. Joint Motion Testing: Changes in the mobility of the affected limbs after different functional rehabilitation exercises were recorded at 1 month, 3 months, and 6 months post-surgery.
4. Assessment of Life Quality: Patient life quality was assessed using the Activity of Daily Living Scale (ADL) questionnaire before surgery and at 6 months post-surgery.
5. Hip Function Assessment: The Fugl-Meyer Assessment (FMA) was used to comprehensively assess upper and lower extremity function, including hip range of motion, muscle strength, and balance. This assessment was performed before surgery and at 6 months post-surgery.
6. Mental Status Assessment: The Mini-Mental State Examination (MMSE) was used to assess cognitive function and intellectual status at 6 months post-surgery.
7. Economic Indicators: Data on hospitalization days and hospitalization costs were collected.
8. Postoperative Complications: Postoperative complications, including lung infections and surgical incision infections, were monitored.

Statistical analysis

Statistical analysis in this study was conducted using SPSS 26.0 and R 4.1.0 software. Continuous variables were assessed for normality using the Shapiro-Wilk test and presented as mean ± SD. Independent sample t-tests were used for between-group comparisons. Non-normally distributed data were expressed as median (25th quartile, 75th quartile) and analyzed using the U-test. Categorical variables were presented as 'n' (%), and comparisons between groups were made using the chi-square test or Fisher's test. Multi-factor COX regression analysis was performed with R 4.1.0, and a nomogram was created to demonstrate the prediction model. The model's performance was validated with calibration curves, C-index curves, and ROC curves. A significance level of $p<0.05$ indicated statistically significant differences in the comparison results.

Results

Comparison of Demographic and Baseline Data:

A total of 60 patients who underwent hip fracture surgery were retrospectively collected and categorized into two groups: the control group (n=30) and the test group (n=30) based on their chosen rehabilitation methods. The comparison of demographic and baseline data between the two groups is presented in Table 1. The results revealed no statistically significant differences between the control and test groups in terms of demographic factors such as age

Table 1. Comparison of demographic data and baseline data between the two groups.

		Control group (n=30)	Test group (n=30)	T / chi square value	P
Age		67.43±10.32	66.37±11.09	0.386	0.701
Gender	Male	19	17	0.278	0.598
	Female	11	13		
BMI		23.98±4.34	22.90±2.88	1.126	0.265
Type of surgery	PFNA	13	14	0.067	0.795
	Joint replacement	17	16		
Hypertension		6	5	0.111	0.739
Diabetes		4	3	0.000	1.000
Muscle strength		3 (2-4)	3 (2-4)	-0.099	0.921
Mobility of the affected limb		23.89±10.23	22.32±9.38	0.620	0.538
ADL scores		21.23±3.36	22.23±4.23	-0.1.014	0.315
FMA scores		54.23±8.22	57.32±7.23	-1.534	0.131

Table 2. Comparison of joint limb function rehabilitation between the two groups.

Time Point		Control group (n=30)	Test group (n=30)	T / chi square value	P
1 month postoperative	Muscle strength	4 (3-4)	4 (4-5)	2.058	0.04
	Mobility of the affected limb	56.34±12.22	78.32±10.46	-7.486	<0.001
3 months postoperative	Muscle strength	4 (3-5)	5 (4-5)	2.379	0.017
	Mobility of the affected limb	76.32±10.23	100.32±12.09	-8.298	<0.001
6 months postoperative	Muscle strength	4 (3-5)	5 (4-5)	2.510	0.012
	Mobility of the affected limb	125.93±9.19	135.83±13.24	-3.364	0.001

Table 3. Comparison of economic indicators of patients in the two groups.

	Control group (n=30)	Test group (n=30)	T / chi square value	P
Hospital day	7.87±1.07	6.53±1.22	4.484	<0.001
Hospital cost (10 thousand, RMB)	3.21±0.23	2.73±0.32	6.916	<0.001

(67.43 vs. 66.37), gender (male: 19 vs. 13), BMI (23.98 vs. 22.90), hypertension (6 vs. 5), history of diabetes (4 vs. 3), as well as muscle strength and mobility of the affected limb ($p>0.05$). Additionally, there were no statistically significant differences between the two groups in terms of ADL and FMA scores ($p>0.05$).

Comparison of Limb Function Rehabilitation

Muscle strength and joint mobility of the affected limbs were assessed after different rehabilitation treatments. The results indicated that with extended postoperative rehabilitation, patients experienced gradual recovery in both muscle strength and joint mobility of the affected limbs. Notably, the test group exhibited significantly higher muscle strength recovery levels compared to the control group at 1 month (4 vs. 4), 3 months (4 vs. 5), and 6 months (4 vs. 5) after surgery ($p<0.05$). Similarly, the joint mobility recovery levels of the test group were significantly higher than those of the control group at 1 month (56.34 vs. 78.32), 3 months (76.32 vs. 100.32), and 6 months (125.93 vs. 135.83) after surgery ($p<0.05$) (see Table 2).

Table 4. Comparison of the quality of long-term recovery in the two groups.

		Control group (n=30)	Test group (n=30)	T / chi square value	P
Before surgery	ADL scores	21.23±3.36	22.23±4.23	1.014	0.315
	MMSE scores	54.23±8.22	57.32±7.23	-1.534	0.131
6 months postoperative	ADL scores	54.30±3.98	59.33±1.21	-6.620	<0.001
	MMSE scores	88.47±5.48	94.50±3.97	-4.882	<0.001

Table 5. Comparison of infectious complications between the two groups.

	Control group (n=30)	Test group (n=30)	T / chi square value	P
Surgical incision infection	4	1	0.873	0.350
Pulmonary infection	3	2	0.00	1.00

Table 6. Univariate analysis of the poor effectiveness of rehabilitation treatment.

	coef	exp(coef)	se(coef)	z	Pr(>|z|)
CTbasedrehabilitaion	-2.40659	0.09012	0.78162	-3.079	0.00208
Age	0.11822	1.12549	0.03275	3.61	0.000307
Sex	-0.007416	0.992611	0.551415	-0.013	0.989
Height	0.06468	1.06682	0.02814	2.298	0.0215
weight	0.05758	1.05927	0.02214	2.601	0.00929
BMI	0.07308	1.07581	0.0824	0.887	0.375
Type	0.03955	1.04035	0.54112	0.073	0.942
Hypertension	-1.1801	0.3072	1.0416	-1.133	0.257
Diabetic	-18.18	1.277E-08	7328	-0.002	0.998
Mobility of the affected limb	-1.3134	0.2689	1.2278	-1.07	0.285
ROM	0.03983	1.04064	0.02962	1.345	0.179

Comparison of Economic Indicators

Hospital days (7.87 vs. 6.53) and hospital costs (3.21 vs. 2.73) were compared, and the results revealed that patients in the test group had significantly lower hospital days and hospital costs compared to those in the control group ($p<0.05$) (Table 3).

Comparison of Long-Term Recovery Quality

Life quality and mental status of the patients were assessed to evaluate the quality of long-term recovery. The results revealed that both groups exhibited significantly higher ADL and MMSE scores at 6 months after different rehabilitation treatments compared to scores before surgery. Furthermore, the test group had significantly higher scores than the control group ($p<0.05$) (Table 4).

Comparison of Infectious Complications

Incidence rates of infection complications (pulmonary infection and surgical incision infection) were assessed for both groups of patients. The results indicated a significantly lower incidence of surgical incision infection in the test group compared to the control group ($p<0.05$). However, there was no statistically significant difference in the incidence rate of pulmonary infection between the two groups ($p>0.05$) (Table 5).

Analysis of Risk Factors for Poor Rehabilitation Outcome

The normal range of motion for the hip joint in individuals is 120 degrees of flexion and 30 degrees of posterior extension. In this study, patients who achieved values close to the normal range were classified as having better recovery, while those who differed more from the normal

Table 7. Multivariate COX regression analysis of poor rehabilitation outcomes.

	coef	exp(coef)	se(coef)	z	Pr(>|z|)
Age	0.013562	1.013655	0.005643	2.403	0.016248
Weight	-0.009733	0.990314	0.007545	-1.29	0.197044
Height	0.018219	1.018386	0.006851	2.659	0.007833
Rehabilitation treatment based on CT	-0.183241	0.832567	0.053659	-3.415	0.000638

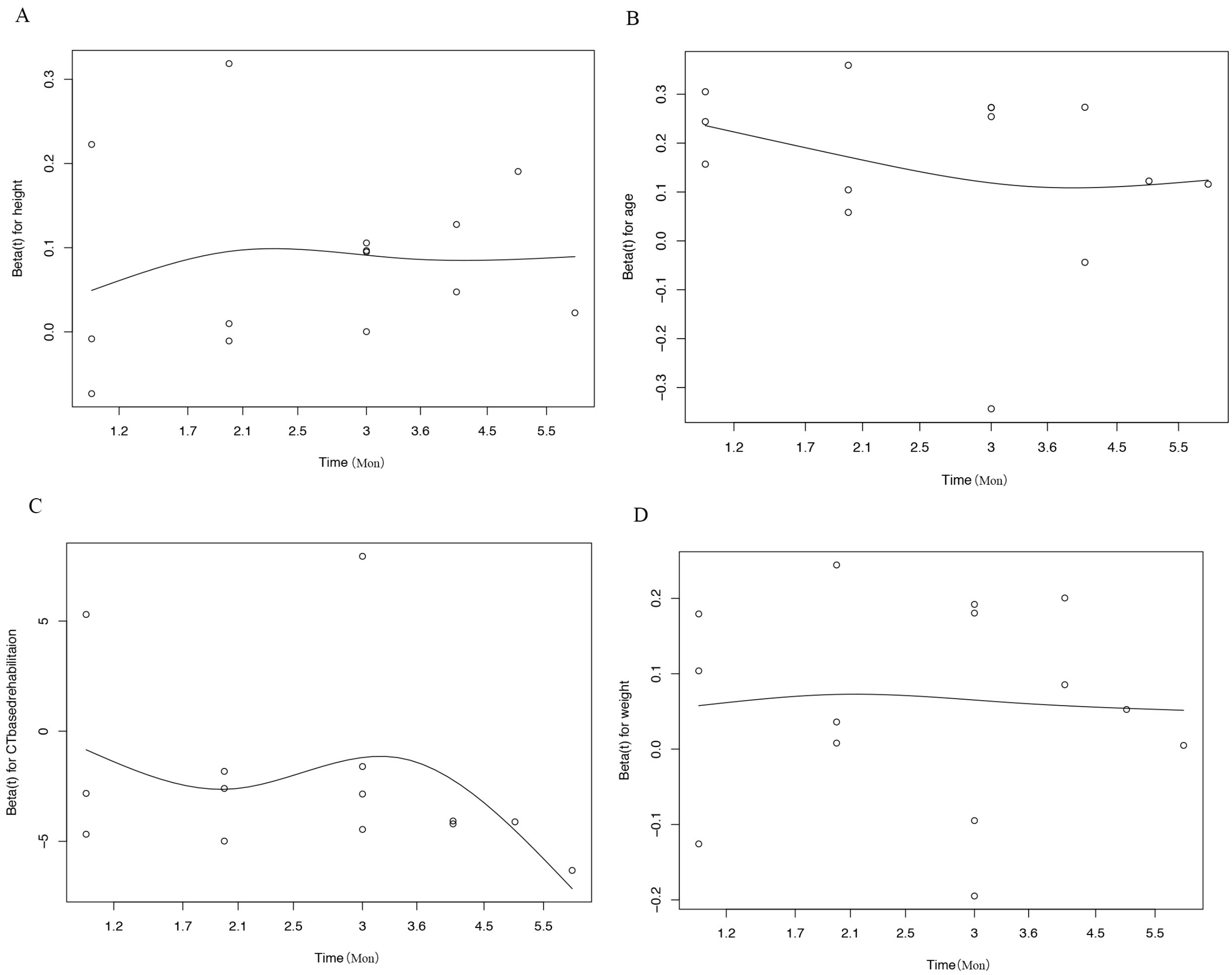

Figure 1. COX residual plot of various factors with poor rehabilitation treatment. A. Residual plots for age risk factors; B. Residual plots for weight risk factors; C. Residual plots for height risk factors; D. Residual plots for risk factors for whether rehabilitation treatment based on CT.

values were categorized as having poor recovery. Patients were categorized based on their level of improvement in hip mobility during postoperative follow-up, with 44 patients demonstrating better recovery and 16 patients experiencing poor recovery. Univariate analysis of the two groups is presented in Table 6. The results showed that patients in the better recovery group had significantly higher weight and muscle strength (p<0.05) and significantly lower age

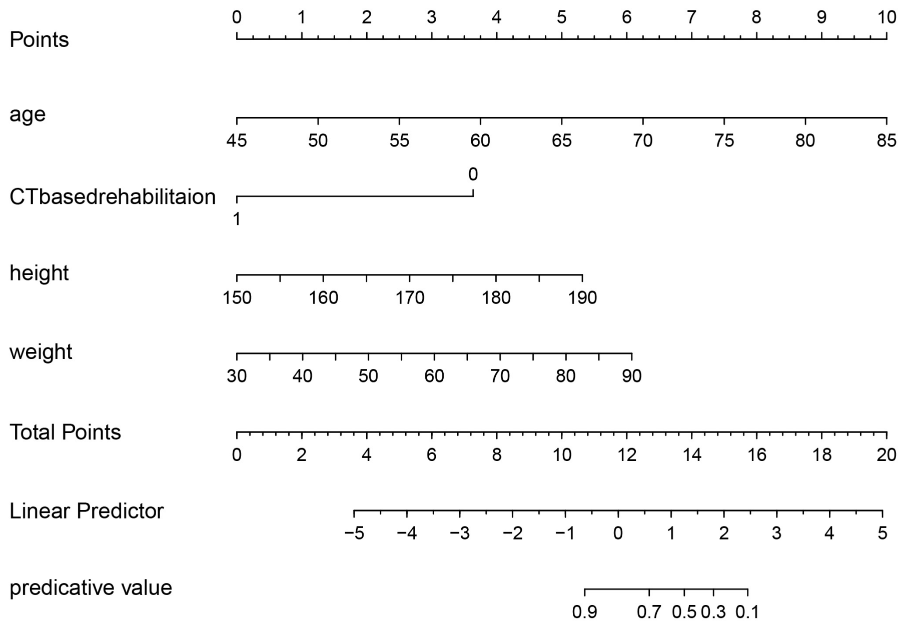

Figure 2. Risk prediction model for poor rehabilitation outcomes in patients with hip fractures.

and height ($p<0.05$) compared to the poor recovery group.

Subsequently, age, height, weight, and rehabilitation treatment based on CT were included in a multifactorial COX regression. The results indicated that age and height are independent risk factors for poor recovery, while rehabilitation treatment based on CT is an independent protective factor for poor recovery (Table 7). The residual plot of the COX for each risk factor is displayed in Figure 1, and each factor exhibited proportional risk, making them suitable for COX proportional risk regression.

Predictive Model of Poor Rehabilitation Treatment Outcomes

A COX proportional risk regression analysis was conducted based on age, weight, height, and rehabilitation treatment guided by CT. The prediction model is presented in Figure 2. This model underwent external validation, and ROC curves were generated, as depicted in Figure 3A-E. Figure 3E represents the ROC curve of the overall model, with an area under the ROC curve (AUC) calculated for patients experiencing poor hip recovery at 1 month, 3 months, and 6 months after discharge. The AUC values were 0.63, 0.67, and 0.72, indicating a fair predictive efficacy of the model.

The C-index was calculated and displayed in Figure 3F, consistently around 0.7 at various post-discharge time points. This suggests that the prediction model possesses good predictive value for assessing the risk of poor hip recovery during different periods. Calibration curves for various post-discharge periods are presented in Figure 3G-I, demonstrating that the predicted values align well with the actual values.

Discussion

This study initially assessed the impact of precise rehabilitation treatment guided by 3D-CT reconstruction technology in hip fracture surgery patients through a retrospective cohort study. The treatment was found to enhance early muscle strength recovery, improve mobility in the affected limb, reduce hospitalization duration and costs, and enhance overall patient recovery. Furthermore, it was identified that age and height serve as independent risk factors for poor rehabilitation outcomes, while CT-guided rehabilitation is an independent protective factor. Utilizing age, height, weight, and CT-based rehabilitation, an effective risk prediction model for poor patient rehabilitation outcomes was developed.

Feasibility of Precision Rehabilitation Treatment Using 3D-CT Reconstruction

Hip fractures are a common orthopedic trauma, particularly among the elderly. Surgical intervention is often required for hip fracture treatment, and postoperative rehabilitation plays a crucial role in restoring patients' function and enhancing their quality of life[6]. As medical technology advances, various

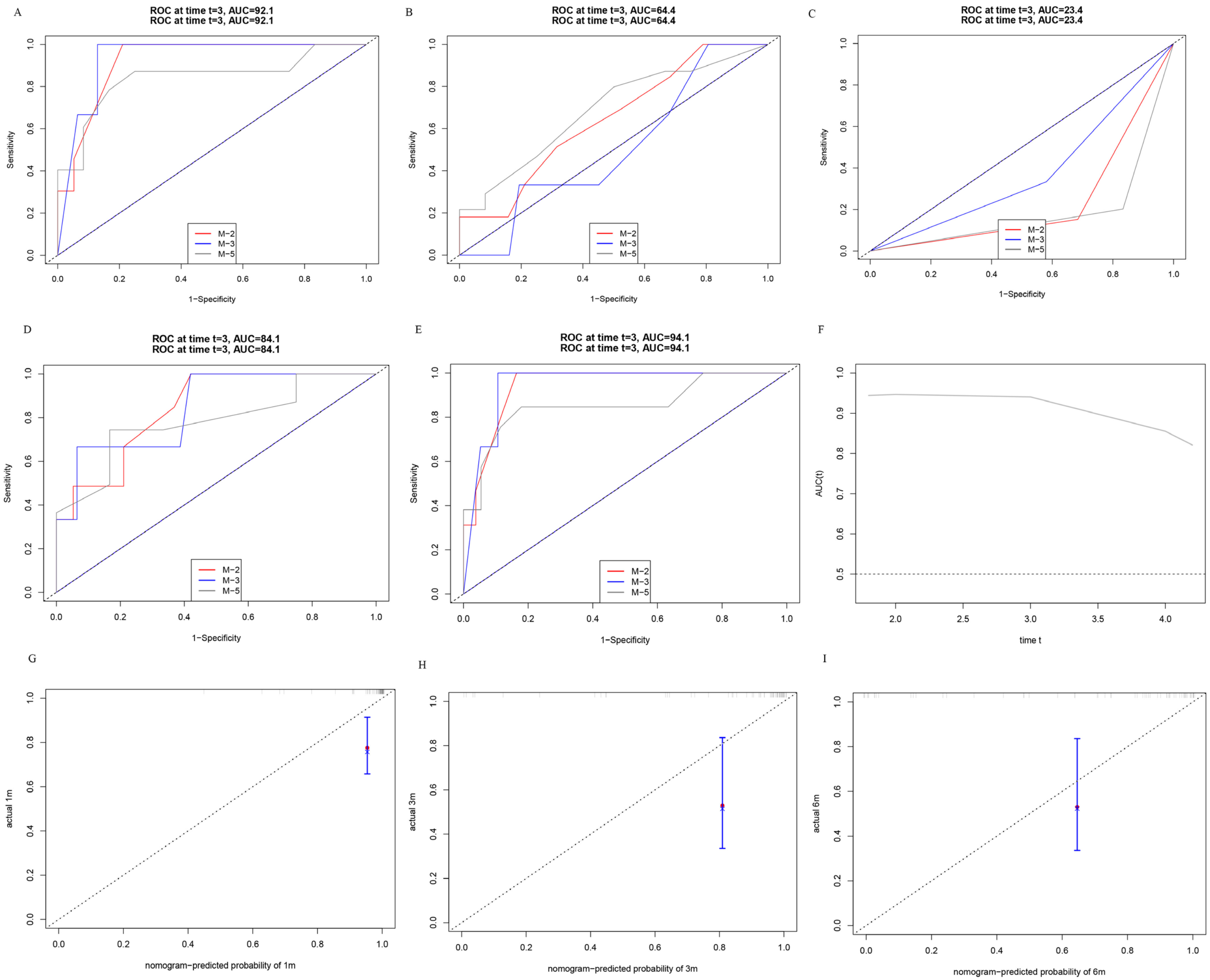

Figure 3. External validation of the prediction model. A. ROC curve for age. B. ROC curve for height. C. ROC curve for rehabilitation treatment based on CT. D. ROC curve for weight. E. ROC curve for the overall prediction model. F. Changes of the overall ROC curve over time. G. The 1-month calibration curve. H. The 3-month calibration curve. I. The 6-month calibration curve.

rehabilitation therapies have been proposed and investigated. Over the past few decades, traditional rehabilitation methods for hip fractures, including bedside rehabilitation, physical therapy, and exercise-based rehabilitation[7-8] have seen significant changes. However, these methods often lack personalized treatment plans[9-10]. In recent years, precision rehabilitation guided by 3D-CT reconstruction technology has emerged as a promising approach in hip fracture rehabilitation[11]. This method enables accurate assessment of the functional status and rehabilitation requirements of patients' hip joints through 3D-CT image reconstruction. Moreover, it offers precise guidance and individualized treatment plans for rehabilitation[12].

This technology allows precise localization and evaluation of fracture sites through 3D images, facilitating the design of individualized treatment plans based on each patient's unique conditions[13-16]. Studies have highlighted the significant advantages of precision rehabilitation therapy guided by 3D-CT reconstruction technology in functional hip joint treatment[17]. For instance, the treatment group exhibited remarkable improvements in muscle strength, functional recovery, and overall quality of life compared to the control group[18-19]. One notable study employed 3D-CT technology to assess the extent of ischemic necrosis in patients' caput femoris and developed individualized treatment plans, yielding superior results[20]. Numerous other studies have underscored the vast potential of 3D-CT reconstruction technology in rehabilitation[21]. Our study's results demonstrate that precision rehabilitation treatment, guided by 3D-CT reconstruction technology, fosters early muscle strength recovery, enhances overall recovery outcomes, reduces hospitalization duration and costs.

Analysis of risk factors for poor rehabilitation outcome in hip fracture patients

Age

Age is a significant risk factor for poor rehabilitation outcomes in hip fracture patients. Hip fractures are a particularly serious issue, predominantly affecting the elderly population. After sustaining a hip fracture, patients require rehabilitation to aid their recovery[22]. However, the elderly may face challenges in achieving full recovery. This article examines the impact of age as a risk factor in hip fracture patients, summarizing its causes and effects through a comprehensive analysis of existing research. Firstly, aging leads to muscle and bone regression, diminishing rehabilitation outcomes[23], Additionally, advanced age correlates with a decline in the immune system's function and rehabilitation capacity, which hampers the effectiveness of rehabilitation treatment and results in suboptimal outcomes[24]. Furthermore, older age can contribute to psychological conditions such as depression and anxiety[25], which may reduce patients' willingness to participate in rehabilitation programs and, consequently, hinder their effectiveness. Moreover, the elderly may be burdened by other health issues, including chronic diseases like hypertension and diabetes, which can further impede the success of rehabilitation treatments[26,27].

Height

This study suggests that height is one of the independent risk factors affecting the outcome of rehabilitation treatment for patients. Height is closely associated with bone metabolism-related factors such as bone mass and density. Previous studies have already demonstrated the impact of height on the effectiveness of rehabilitation during hip fracture recovery[28-29]. The findings of our study revealed a noteworthy correlation: approximately 50% of patients below 160 cm in height experienced poor treatment outcomes, in contrast to the approximately 30% of those above 160 cm. This implies that a connection exists between height and the effectiveness of rehabilitation treatment. Several factors might explain this relationship. Firstly, individuals with shorter stature tend to possess lower bone mass and reduced bone density, predisposing them to fractures and related complications. Secondly, those of shorter stature often exhibit less muscle mass and relatively weaker muscle strength, which can hinder their ability to cope with the intensity of rehabilitation exercises, ultimately leading to suboptimal treatment outcomes. Moreover, height may also influence factors like nutrition, metabolism, and other physiological indicators, which further impact patients' recovery[30].

Rehabilitation exercise model based on CT

Rehabilitation exercises play a crucial role in the recovery of hip fracture patients. These exercises help patients regain muscle strength in the affected limb through well-structured exercise plans, appropriate exercise intensity, and effective techniques. Research has demonstrated that rehabilitation exercises significantly enhance the recovery outcomes of patients following hip fracture surgery[31]. Notably, exercises guided by CT technology have the advantage of precisely identifying injuries through 3D reconstruction, providing precise targets for rehabilitation exercises and thus improving their effectiveness. CT technology also allows an assessment of a patient's muscle condition before exercise, facilitating the development of suitable and effective rehabilitation routines, ultimately enhancing the overall treatment effect[32]. Furthermore, individual patient characteristics should be considered during the rehabilitation exercise process. A prior study has shown that utilizing a risk prediction model based on factors like age, height, weight, and muscle strength can help healthcare professionals assess muscle injuries and the effectiveness of reconstruction training. This approach increases the accuracy and efficiency of rehabilitation exercises. Additionally, exercise programs need to be optimized to enhance their quality and effectiveness. Recent studies have emphasized the importance of tailoring exercise methods to different types of hip fracture patients[32]. For instance, older patients with weaker muscle strength benefit from lighter and simpler exercise regimens, while younger patients with better muscle strength should gradually increase the intensity of their exercises to enhance their physical adaptability and muscle growth[33].

Prediction Model for Poor Rehabilitation Outcomes in Hip Fracture Patients

The effectiveness of rehabilitation treatment significantly influences patients' rehabilitation progress and quality of life. Through the collection and analysis of patient data, this study identified age and height as independent risk factors for poor rehabilitation treatment outcomes. In contrast, rehabilitation treatment based on CT technology emerged as an independent protective factor. These findings underscore the importance of giving special attention to these factors in the context of rehabilitation treatment. To facilitate this, a risk prediction model for poor rehabilitation outcomes in patients was established using COX regression analysis. This model demonstrates high levels of accuracy and reliability, offering valuable insights for the rehabilitation treatment of hip fracture patients. Moreover, it equips medical professionals with more scientific and rational rehabilitation treatment plans aimed at promoting early recovery for patients.

In conclusion, the risk prediction model for poor rehabilitation treatment outcomes in hip fracture patients, based on factors including age, height, weight, and rehabilitation guided by CT technology, holds significant promise for enhancing the effectiveness of rehabilitation treatments. However, practical implementation should focus on refining the assessment indices and improving model accuracy to better serve patients' rehabilitation needs.

Nonetheless, it is crucial to acknowledge the limitations of this study. Firstly, the retrospective nature of the study introduces some degree of statistical bias. Secondly, the limited sample size prevents effective representation of a larger population of hip fracture patients.

Conclusion

The use of precise rehabilitation therapy guided by 3D-CT reconstruction technology for hip fracture surgery patients has demonstrated the potential to accelerate the early recovery of muscle strength, enhance mobility of the affected limb, reduce hospitalization duration and costs, and ultimately improve patient recovery outcomes. It's important to note that age and height emerge as independent risk factors for suboptimal rehabilitation outcomes, while the use of CT-based rehabilitation serves as an independent protective factor. By integrating age, height, weight, and CT-guided rehabilitation, a robust predictive model can effectively anticipate poor rehabilitation outcomes in patients.

Ethics approval

The study was approved by Ethical Committee of The Third Affiliated Hospital of Qiqihar Medical University (Approval number: 2019LW-2).

Funding

This work was supported by Science and Technology Bureau General Mandatory Scientific Research Projects of Qiqihar City (SFGG-201750).

Authors contribution

ZY and JJ designed the study and drafted the manuscript. WS, JZ, and JQ were responsible for the collection and analysis of the experimental data. YQ and PD revised the manuscript critically for important intellectual content. All authors have read and approved the final manuscript.

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