Systematic Team-Approach Rehabilitation After Knee Fracture Surgery Is Associated With Better Functional Outcomes

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Abstract

Purpose

In Western developed countries, patients commonly receive rehabilitation after orthopedic surgery to improve functional dysfunction. In China, however, rehabilitation is widely neglected. An appropriate perioperative rehabilitation model for early orthopedic rehabilitation is urgently needed in China. We evaluated the outcomes of perioperative rehabilitation patterns and promoted the functional recovery of orthopedic patients in China.

Methods

668 patients from 9 centers who underwent internal fixation surgery because of knee joint fracture were assigned to 2 groups: 1) control group: received the standard postoperative treatments, or 2) trial group: received perioperative rehabilitation in team-based approach. The visual analog scale (VAS), Hospital for Special Surgery (HSS) knee and Berg Balance Scale (BBS) scores were assessed 12 and 24 weeks postoperatively.

Results

The VAS scores at 12 and 24 weeks postoperative showed that the trial group had significantly less pain than control group ($P < 0.001$). Compared to the control group, the trial group had significantly better HSS knee scores at 12 weeks ($P < 0.05$) and significantly better BBS scores at both 12 and 24 weeks postoperative ($P < 0.05$).

Conclusions

Compared to common postoperative treatments, patients with systematic team-approach rehabilitation had better functional outcomes and pain relief after knee fracture surgery.

Introduction

Knee fractures, such as femoral condylar fractures, patellar fractures and tibial plateau fractures, are common fractures in adults. Knee fractures are commonly treated operatively because of the important role in knee function [1–2]. Those knee fracture often lead to a poor prognosis with functional deficits, such as stiffness, extension weakness, and post-traumatic osteoarthritis [3–5]. The situation encourages researchers to find a better method to improve functional outcomes after knee fracture. Several studies have confirmed that active exercise helps relief symptoms and improve functional recovery to a certain extent [6–10]. Early rehabilitation is recommended to avoid contractures and degeneration of the knee joint after surgery for patellar fractures [11].

In the current situation, a number of researchers focus on the post-operation rehabilitation of vertebral fracture and hip fracture, to reduce pain and improves physical function [12–14]. However, for individuals with knee fracture, most of the researches focus on various surgery techniques but neglect of postoperative rehabilitation, and lack of high-quality research, especially in Chinese patients.

As shown in the survey, only 52.26% of the patients in Beijing with an orthopedic surgery had a knowledge of rehabilitation [15]. What's more, there is a lack of connection between orthopedic clinicians and rehabilitation professors in China. Orthopedists and orthopedic nurses provide basic postoperative nursing instructions and few exercise tips, which is called the common postoperative treatment. Moreover, because of the absence of high-quality research in China, the effectiveness of the conclusion is limited, and more high-quality studies should be performed.

Therefore, in the present research, we aimed to explore the effectiveness of a team-based perioperative approach for patients who underwent knee fracture surgery and promote a suitable perioperative rehabilitation pattern in China.

Methods

Overall Study Design

This multicenter, prospective controlled trial had recruitment sites in 9 hospitals in Beijing. The study was divided into three phases: 1) the protocol development phase, 2) the intervention phase, and 3) the follow-up phase. In the protocol development phase, we developed the team-based perioperative rehabilitation approach in the 9 hospitals and standardized the perioperative rehabilitation intervention and testing protocols. The trial was registered online, see http://www.chictr.org.cn/showproj.aspx?proj=5713 for more information, registered on 29 May 2013, registration number: ChiCTR-TCH-13003852.

Ethical Principles

Ethical approval was received from the ethics committees of the participating hospitals. Written informed consent was obtained from all participants before enrollment in the study.

Subjects

From January 2013 to December 2015, a total of 668 patients who underwent internal fixation surgery because of knee joint fracture were involved in this research. All patients were recruited from 9 medical centers.

Inclusion Criteria

1) Underwent open reduction and internal fixation because of femoral condyle fracture, patella fracture or tibial plateau fracture.

2) Aged 15 or older.

3) Had imaging results that showed a good fracture reduction and reliable internal fixation.

Exclusion Criteria

1) History of previous trauma, infection, tumor or congenital malformation that resulted in lower limb dysfunction.

2) Combined with open fracture, vascular or nerve injury, knee meniscus and ligament injury, fractures in the pelvis, or serious early complications after operation.

3) Combined with severe medical complications, such as heart failure, respiratory insufficiency, or kidney failure.

4) Severe psychiatric disease, cognitive disorder, or disturbance of consciousness not allowing the patient to cooperate with treatment.

Interventions

The patients were assigned to one of the two groups according to the patient's subjective intention (according to the suggestion by our institutional research ethics committee): the group that received the common postoperative treatments without involvement from rehabilitation clinicians (control group) or the group that received a team-based perioperative rehabilitation intervention in addition to the common postoperative treatments (trial group). And the group allocation outcomes were blinded to the research team members.

Control Group (CG)

The patients in the CG received common postoperative treatments provided by the orthopedic surgery team without any professional rehabilitation guidance.

Trial Group (TG)

The TG received both standard postoperative treatment and a team-based perioperative rehabilitation intervention. Rehabilitation clinicians, therapists, and orthopedic clinicians and nurses were included in the team responsible for the patients' diagnosis, evaluation, treatment and rehabilitation. Rehabilitation clinicians and orthopedic clinicians with knowledge of both orthopedic surgery and rehabilitation theory had key roles in the team-based approach and were in charge of the program. The supervising clinicians were leaders in the perioperative rehabilitation team meetings, conducted evaluations, formulated rehabilitation targets and clinical pathways, decided the perioperative rehabilitation programs, decided discharged exercise plans, and were responsible for the follow-up. Rehabilitation therapist was the major executor who understood both orthopedic and rehabilitation treatment principles. The therapist formulated the rehabilitation program, performed daily rehabilitation training while the patients were in-hospital, and created specific home exercise plans together with the supervising clinicians. Patients were in-hospital for 3–4 days after surgery. During perioperative rehabilitation, the intervention was custom tailored according to the evaluation results. It was the therapist's responsibility to report any changes in

illness to the clinicians in time. ▯ Nurse provided the patients with perioperative rehabilitation education and guidance, provided medical advice to the orthopedic rehabilitation team, and assisted the rehabilitation therapists in performing daily rehabilitation. The nurses in the team were required to have rehabilitation nursing knowledge and focus on perioperative care.

The tasks of the orthopedic rehabilitation team were as follows: ▯ The rehabilitation team held meetings before and after surgery to educate, evaluate, and decide on the rehabilitation program. ▯ The orthopedic rehabilitation team performed ward rounds once a day and recorded the data in the case report form. ▯ The therapists and nurses implement rehabilitation treatments according to the clinical pathway. ▯ The orthopedic rehabilitation team held a consultation prior to discharge and recorded the rehabilitation evaluation. ▯ The supervising clinicians suggested individualized at-home exercise recommendations according to the evaluation results. ▯ The team kept a record of the patients' contact information, follow-up time and follow-up doctor.

One or two days before surgery, TG patients received perioperative rehabilitation education that aimed to help patients avoid anxious emotions, encourage patients to strengthen self-management, and teach correct training methods. In the early postoperative period, TG patients received routine postoperative treatment from the therapist according to the strategy decided by the orthopedic rehabilitation team. The treatment session lasted approximately 30 minutes each day and was performed under the guidance of rehabilitation therapists. The training content was focused on preventing early postoperative complications, including deep venous thrombosis, falls, muscle hypotrophy during no weight-bearing. The training program covered the following aspects: elevation of the affected limb, ankle pump, quadriceps isometric contraction, passive hip movement, standing on the unaffected lower limb under protection, range of motion (ROM), activity of daily life, etc.

Before discharge, TG patients receiving the team-based approach received a custom-tailored rehabilitation training guidebook and learned to continue the training at home. TG patients were required to perform endurance exercises at home for the next 6 months after surgery.

Outcome Measures

General patient characteristics including age, sex, height, weight and education background were collected. The operative information (recorded by the orthopedic surgeons in the operation records) included fracture site, blood loss, quality of anatomical reduction, and the stability of fracture fixation. The outcome measures used in this study included the visual analog scale (VAS) score, Hospital for Special Surgery (HSS) knee score and Berg Balance Scale (BBS) score. The VAS is widely and easily used to evaluate the pain in the back and limbs while resting or performing activity. VAS scores were assessed at 12 and 24 weeks (± 7 days) postsurgery. The HSS knee score and BBS scores are specific functional scales of lower limb function and are widely used worldwide. A higher HSS score indicates better knee function and the higher BBS score indicate better balance function. The HSS knee score and BBS score were assessed at 12 and 24 weeks (± 7 days) post-surgery.

Data Analysis

Continuous variables were described in terms of means and standard deviations, while ordinal variables and nominal variables were described in terms of percentages. The Shapiro-Wilk test was used to determine if the data were normally distributed. ANOVAs with repeated measures were used to examine the differences in the outcomes between groups. The Mann-Whitney U test was used to compare the two groups before and after surgery. The significance level was set at 0.05. An intention-to-treat (ITT) analysis was conducted, and the multiple imputation was used to input for missing data. The data were analyzed using SPSS for Windows, version 22.0 (SPSS Inc., Chicago, IL, USA).

Results

Baseline Evaluation

668 patients met inclusion criteria during the study period, and that 636 completed follow-up and were included in the study. We found no significant differences in baseline between the 32 patients who dropped out and the 636 patients with preoperative and postoperative data (all, P > 0.05). The final analyses included 268 patients in the CG and 368 patients in the TG (Table 1, Table 2). There were no significant differences in baseline age, sex, fracture site, stability of fracture fixation, intraoperative blood loss, or reduction quality of the articular surface between the 2 groups (all P > 0.05), except for BMI, mean difference between groups (95% CI): 0.7 (0.1–1.4).

Table 1
Baseline characteristics of the study groups

Baseline	CG (n = 268)	TG (n = 368)	Mean difference between groups*	*P*
Age	48.9 ± 13.7	47.5 ± 13.6	1.3 (-0.7–3.5)	0.20
Sex (M/F)	163/105	204/164		0.18
Height (m)	1.67 ± 0.08	1.68 ± 0.08	0.0 (-0.01–0.01)	0.84
Weight (kg)	69.9 ± 14.3	68.1 ± 13.2	1.8 (-0.5–4.1)	0.12
BMI (kg/m^2)	24.9 ± 4.0	24.2 ± 4.0	0.7 (0.1–1.4)	0.03
Abbreviations: TG: trial group, CG: control group.				
Mean ± SD for continuous variables. Age, height, weight, and BMI were compared with the independent t-test to identify differences between two groups; sex was compared with the chi-square test to identify differences between the two groups.				
* Values in parentheses are 95% confidence intervals.				

Table 2
Operation situation of the study participants, stratified by group

Baseline	CG (n = 268)	TG (n = 368)	*P*
Fracture site (%)			0.49
Patellar fracture	53.7	56.8	
Distal femur fracture	5.6	4.5	
Tibial plateau fracture	40.7	38.7	
Stability of fracture fixation by CT scan (%)			0.85
Absolutely stable	60.9	60.2	
Stable	39.1	39.8	
Intraoperation blood loss			0.59
<50 ml	41.6	44.8	
50–100 ml	41.3	37.4	
>100 ml	17.1	17.8	
Reduction quality of articular surface (%)			0.33
Anatomical reattachment	77.3	78.5	
Good	20.6	21.0	
Average	2.1	0.5	
Abbreviations: TG: trial group, CG: control group.			
Categorical variables are described by frequency (%) and were compared using the chi-square test to identify differences between the two groups.			

Outcome Parameters

The VAS score of the TG was significantly lower than that of the CG at both 12 weeks and 24 weeks after surgery (both $P < 0.001$; mean difference (95% CI) at 12 weeks: 0.4 (0.1–0.6); mean difference (95% CI) at 24 weeks: 0.2 (0.06–0.11)) (Table 3).

Table 3
Results of the analysis on VAS scores

VAS	CG (n = 268)	TG (n = 368)	Mean difference between groups*	*P*
12 weeks after surgery	1.5 ± 1.4	1.2 ± 1.2	0.4 (0.1–0.6)	0.00
24 weeks after surgery	0.6 ± 0.9	0.4 ± 0.7	0.2 (0.06–0.11)	0.00
Abbreviations: TG: trial group, CG: control group. Continuous variables are described as the mean ± SD.				
* Values in parentheses are 95% confidence intervals.				

The overall HSS knee score of the TG was significantly better than that of the CG at 12 weeks after the operation ($P < 0.05$; mean (95% CI): 4.0 (0.8–7.2)) (Table 4). Moreover, patients in the TG exhibited significantly better function, ROM, and muscle strength at both 12 weeks and 24 weeks after surgery than those in the CG (all $P < 0.05$) (Table 4).

Table 4
Results of the HSS knee score analysis

Outcomes		CG (n = 268)	TG (n = 368)	Mean difference between groups*	*P*
Total HSS score	12 weeks	65.8 ± 15.1	69.8 ± 15.0	4.0 (0.8–7.2)	0.02
	24 weeks	74.0 ± 14.1	75.2 ± 13.5	1.1 (-2.2–4.3)	0.48
HSS function score	12 weeks	11.5 ± 5.3	13.5 ± 5.6	1.9 (0.5–3.3)	0.01
	24 weeks	18.0 ± 5.1	19.9 ± 4.7	1.8 (0.6–3.0)	0.00
HSS ROM score	12 weeks	13.1 ± 3.0	14.0 ± 2.5	0.8 (0.4–1.3)	0.00
	24 weeks	14.9 ± 2.3	15.9 ± 2.0	1.0 (0.7–1.4)	0.00
HSS muscle strength score	12 weeks	7.8 ± 1.7	8.1 ± 1.5	0.3 (0.05–0.6)	0.020
	24 weeks	9.0 ± 1.0	9.4 ± 0.9	0.4 (0.2–0.5)	0.000
Abbreviations: TG: trial group, CG: control group. Continuous variables are described as the mean ± SD.					
* Values in parentheses are 95% confidence intervals.					

The BBS score of the TG was superior to that of the CG at both 12 weeks and 24 weeks after surgery, and the difference was statistically significant (P < 0.001; mean (95% CI) at 12 weeks: 4.2 (2.3–6.1) ; mean (95% CI) at 24 weeks: 2.5 (1.5–3.4)) (Table 5).

Table 5
Results of the BBS score analysis

BBS	CG (n = 268)	TG (n = 368)	Mean difference between groups *	*P*
12 weeks after surgery	41.0 ± 13.2	45.2 ± 9.6	4.2 (2.3–6.1)	0.00
24 weeks after surgery	51.4 ± 6.8	53.9 ± 4.2	2.5 (1.5–3.4)	0.00
Abbreviations: TG: trial group, CG: control group. Continuous variables are described as the mean ± SD.				
* Values in parentheses are 95% confidence intervals.				

Discussion

According to previous studies, patients fail to regain ideal function and develop knee pain symptoms [6], encouraging researchers to find a better method to improve functional outcomes after knee fracture, and ensure the economic benefits of treatment. The safety of surgical treatments and postoperative exercises for such fractures has been greatly improved, making early postoperative rehabilitation intervention possible. Accelerated rehabilitation is thought to expedite the function recovery and prevent joint conglutination [8–9]. Early knee ROM exercises, quadriceps strengthening and proprioception exercises should be encouraged for a good final outcome[10, 16]. We believe that the best approach to rehabilitation after fracture is a training strategy coordinated by a multidisciplinary team for the individual to achieve the highest possible level of function. The comprehensive interdisciplinary team should provide a holistic approach tailored to different patients [17]. Surprisingly, in the literature, there is not a lot of information about these patients.

The development of clinical and surgical orthopedic techniques in China has approached or even reached the advanced international level. Nonetheless, orthopedic rehabilitation development has lagged far behind, seriously affecting the postoperative functional recovery of patients. Currently, in most Chinese hospitals, there is a dearth in the professional postoperative rehabilitation. Prolonged immobilization after surgery can lead to stiffness and impairment [18]. To the best of our knowledge, this study is the first multicenter, large sample, prospective controlled trial to test the effectiveness of a team-based perioperative rehabilitation pattern in China.

Both the 12-week and 24-week postoperative follow-up results showed that the VAS scores in the TG were significantly lower than those in the CG patients. Perioperative rehabilitation can effectively help patients control postoperative pain after surgery, dealing with the inflammatory response after surgery. Better pain relief makes it possible to continue with the exercises and adapt to daily life post-operation. This result was basically consistent with the previous studies [19–20].

In terms of functional recovery, the HSS knee scores of the TG at the 12-week follow-up were significantly better than those of the CG. And the TG had better BBS at both 12-week and 24-week follow-up. We believe that the team-based perioperative rehabilitation approach help improved the functional status of patients after knee fracture surgery and shortened the time of postoperative recovery. A recent systematic reviews demonstrated that the fucus on post-operative rehabilitation effect of tibial plateau fracture is scarce and controversial [10]. More research needs to be performed to determine a better postoperative rehabilitation pattern.

Thus, in this study, we applied a team-based perioperative orthopedic rehabilitation approach. The rehabilitation clinician, therapist, orthopedic surgeon and nurse constituted the rehabilitation treatment team and implemented the close combination of knee fracture surgery and rehabilitation. The team-based perioperative rehabilitation in this research combined comprehensive rehabilitation with home exercises, making the rehabilitation treatment feasible and effective.

One potentially in the limitations is that this was not a randomized trial. There is a risk of selection bias in this study, as the participants were allowed to choose freely their own postoperative treatment according to the suggestion of our ethics committee. Even though participants were of similar age, sex, fracture site, etc. Another limitation is that we should carry out compliance research to better understand the patient's actual demands during surgery recovery and improve the treatment plan. Further follow-up in terms of pain relief, functional improvement, and quality of life is also needed.

Conclusion

Compared to the common postoperative treatments, the TG group had better pain relief and better knee function outcomes. The low drop-out rate indicated that the rehabilitation protocol was well accepted by patients and feasible in China.

To the best of our knowledge, this study is the first multicenter, large sample, prospective controlled trial to test the effectiveness of a team-based perioperative rehabilitation pattern in China.

Declarations

Ethics approval and consent to participate: Written ethical approval was received from the ethics committees of the participating hospitals including author’s affiliation. Written informed consent was obtained from all participants before enrollment in the study.

Consent for publication: Written informed consent for publication was obtained from all authors.

Availability of data and materials: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declared no potential conflicts of interest with respect to the research, or publication of this article.

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Authors' contributions: Jingyu Liu participated in the design, carried out the study and the statistical analysis and drafted the manuscript. Mouwang Zhou conceived of the study, and participated in its overall design and coordination and helped the carry-out of the study. Yanyan Yang participated in the study design and the statistical analysis. Tao Li participated in the study design and drafted the manuscript. All authors read and approved the final manuscript.

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