



A randomized trial on the application of a nurse-led early rehabilitation program after minimally invasive lumbar internal fixation

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Background: Lumbar degenerative disease (LDD) is a narrowing of the spinal canal and intervertebral foramina caused by aging and degeneration of lumbar spine tissue. Minimally invasive internal lumbar spine fixation is emerging in the treatment of LDD. However, no standard early rehabilitation protocol for orthopedic robot-assisted minimally invasive internal lumbar spine fixation exists. To investigate the effect of a nurse-led early rehabilitation program in the postoperative recovery of patients with lumbar degenerative lesions undergoing orthopedic robot-assisted minimally invasive lumbar internal fixation.

Methods: Eighty patients with minimally invasive orthopedic robot-assisted lumbar degenerative lesions admitted to our hospital between January 2019 and January 2021 were recruited to this study. The patients were randomly allocated to a control group (n=40), involving conventional care, and an observation group (n=38; 40 initially and 2 later excluded) including a nurse-led early rehabilitation program added on the basis of the control group. The primary outcomes were the general postoperative conditions, scores of daily living ability, the degree of low back pain and functional recovery. Participants were also compared in terms of their compliance with the care regimen and the incidence of complications.

Results: Participants in the observation group had a significantly shorter first time on the floor after surgery ($P<0.001$) and shorter hospital stay ($P=0.003$). Meanwhile, participants in the observation group had higher Barthel index (BI) scores ($P=0.039$), lower visual analogue scale (VAS) scores ($P=0.028$), and Oswestry disability index (ODI) scores ($P=0.002$) at 3 days postoperatively, and there was no difference in the three scores between the two groups at 1 month postoperatively (all $P>0.05$). The compliance of participants in the observation group was significantly higher than that of the control group ($P<0.001$). Participants in the observation group were less likely to experience constipation ($P=0.043$) and bloating ($P=0.012$) within 1 month after surgery.

Conclusions: Implementation of a nurse-led early rehabilitation program in patients undergoing orthopedic robotic-assisted minimally invasive treatment of lumbar degenerative lesions can significantly improve patient compliance, significantly shorten postoperative flooring and hospitalization time, reduce the incidence of gastrointestinal adverse events, and accelerate postoperative recovery.

Trial Registration: Chinese Clinical Trial Registry ChiCTR2100048698.

Keywords: Nurse-led; orthopedic robot; lumbar degenerative disease (LDD); early rehabilitation

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Introduction

Lumbar degenerative disease (LDD) refers to the narrowing of the spinal canal and intervertebral foramina caused by aging and degeneration of the lumbar spinal tissues. It is mainly classified into lumbar disc herniation (LDH), lumbar spinal stenosis (LSS), and lumbar spondylolisthesis (LS) (1,2). Currently, the clinical treatment of LDD is mainly conservative, with the main goal of relieving low back and leg pain, restoring spinal stability, and preventing further aggravation of neurological dysfunction; when conservative treatment is ineffective, surgical treatment is required (3). The traditional procedure is pedicle screw fixation, which is effective in restoring spinal stability and improving spinal fusion rates and is the cornerstone of treatment for patients with severe LDD (4). However, pedicle screw fixation requires extensive tissue dissection, is prone to nerve and vascular damage, and has the disadvantages of poor postoperative recovery and secondary dysfunction (5). Additionally, this procedure requires a high level of skill and clinical experience of the surgeon in charge.

With the popularization of the concept of orthopedic precision treatment, the third-generation orthopedic robot “Tianguai” is gradually being incorporated into clinical practice and provides a more precise treatment solution for orthopedic diseases with its small incision, safety, precision, and fatigue resistance (6). The advantages of the “Tianguai” robot are reflected in both preoperative and intraoperative aspects. Preoperatively, it can provide personalized intelligent planning according to the patient’s specific situation; intraoperatively, it can provide precise image guidance along with the surgery, thus reducing intraoperative injuries, improving the quality of surgery, and reducing chronic back pain for the patient after surgery (7). The minimally invasive lumbar internal fixation is surgery approach with smaller incisions, less blood loss, quicker return to daily activities, and increased visualization (5). With the aid of the “Tianguai” robot, minimally invasive lumbar spinal internal fixation is gradually emerging in the treatment of LDD.

With the advancement of medical concepts and development of minimally invasive orthopedic robotic surgery, some more precise requirements for the provision of postoperative care have been stipulated. At the present stage, the traditional care model is still adopted for patients after minimally invasive lumbar internal fixation, where patients are usually first out of bed 1–7 days after surgery and after the drainage tube

is removed; however, this traditional care model can no longer match the rapid postoperative recovery enabled by minimally invasive surgery (8). Although as yet there is no standard early rehabilitation protocol for orthopedic robot-assisted minimally invasive lumbar internal fixation, early rehabilitation exercises have been reported in the literature to accelerate patients’ postoperative recovery (9). A previous randomised clinical studies of 60 patients undergoing traditional lumbar fusion for degenerative lumbar disease have revealed the integrated programme of prehabilitation and early rehabilitation in spine surgery is more cost-effective compared to standard care programme alone (10). A nurse-led early rehabilitation program on this basis combines rehabilitation therapy with nursing care, in which the charge nurse provided patients with multifaceted, comprehensive, scientific, and full rehabilitation guidance and care after implementing an individualized assessment of their condition. The functions of early rehabilitation program following surgery are to help the patients after undergoing robot-assisted minimally invasive surgery of the lumbar spine recover quickly. In this study, we analyzed the effect of a nurse-led early rehabilitation program in patients with robot-assisted minimally invasive lumbar degenerative lesions through a prospective study, and on this basis, we discussed improvement of the postoperative early rehabilitation program and nursing model. We present the following article in accordance with the CONSORT reporting checklist (available at <https://dx.doi.org/10.21037/apm-21-2294>).

Methods

Study design and participants

This is a prospective, open-label randomized clinical trial with 1:1 ratio. Participants did not know which group to be assigned to before randomization. The random numbers were generated followed the centralized allocation, using the same appearance, continuous numbered opaque envelopes. The inclusion criteria for this study were as follows: (I) patients to be treated with minimally invasive lumbar internal fixation after examination and diagnosis; (II) no other serious underlying diseases; (III) voluntary participation. The screening criteria were as follows: (I) poor postoperative general condition; (II) accompanied by severe underlying diseases; (III) osteoarthritis of the extremities resulting in walking impairment; (IV) previous history of mental illness; (V) already participated in other

Table 1 Comparison of general information between the two groups of participants ($\bar{x}\pm s$)

Group	Number of cases	Male/female	Age (y)	Intraoperative duration (min)	LDD classification		
					LDH	LSS	LS
Observation group	38	17/21	51.29±7.28	192.34±22.79	20	10	8
Control group	40	21/19	51.70±7.48	192.93±18.55	21	10	9
t/χ^2 value		0.47	-0.245	-0.124		0.032	
P value		0.493	0.807	0.902		0.984	

LDD, lumbar degenerative disease; LDH, lumbar disc herniation; LSS, lumbar spinal stenosis; LS, lumbar spondylolisthesis.

clinical trials. The exclusion criteria were the following: (I) not following the early rehabilitation program, including those patients who wanted change his/her groups; (II) cases that did not complete postoperative follow-up and data collection. A total of 80 patients who underwent orthopedic robot-assisted minimally invasive treatment of lumbar degenerative lesions at our hospital between January 2019 and January 2021 were included in this study, and after randomization, there were 40 participants in the observation group initially and 2 cases were excluded midway, and a total of 40 participants in the control group. A nurse-led early rehabilitation team provided routine care to the control group participants, while an early rehabilitation program was added to the observation group participants. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The protocol was approved by the Ethics Committee of Sichuan Provincial People's Hospital-Sichuan Academy of Medical Sciences (No. 298, 2019), and all the participants gave informed consent before taking part in the study. There was no difference in the general information between the two groups of participants ($P>0.05$), as shown in *Table 1*.

Research methodology

Control group

The routine care model after lumbar spine surgery was implemented, including preoperative fasting for 8 h, preoperative psychological guidance, postoperative assessment of general condition, postoperative guidance of patients' eating, regular axial turning, absolute rest in a flat position, and the plasma drainage tube was removed before getting out of bed.

Observation group

The early rehabilitation program was added on the basis of the control group.

Construction of early rehabilitation team

The early rehabilitation team consisted of 21 members, including 5 doctors (2 medical team leaders, 2 attending physicians, 1 anesthesiologist), 12 nurses (1 nurse leader, 1 rehabilitation specialist nurse, 2 orthopedic specialist nurses, 8 charge nurses), and in addition, the team was equipped with a rehabilitation therapist, a nutritionist and prosthetic orthopedic technician, and a psychological counselor. Among them, the medical team leader was responsible for developing and implementing the treatment plan; the nurse manager, rehabilitation specialist nurse, and orthopedic specialist nurse were jointly responsible for the implementation of the workflow of the early rehabilitation program and quality control during the implementation process; the charge nurse conducted basic and specialist patient assessments, and together with the attending physician, conducted a comprehensive patient assessment in order to implement the nurse-led early rehabilitation program in a more professional and standardized manner, and to answer patients' questions during the treatment process. The rehabilitation counselor assisted the nurse in implementing the early rehabilitation program and provided training and guidance for any identified weak links; the nutritionist conducted individualized assessment of the patient's nutritional status and selected a suitable diet for the patient; the psychological therapist was responsible for preoperative intervention to reduce patient stress and their postoperative agoraphobia. The orthopedic technician was responsible for making an individualized lumbar support, dynamically adjusting the size of the lumbar brace according to the patient's postoperative condition, and designing the outlet of the plasma drainage tube to facilitate the patient's movement out of bed with the tube *in situ*.

Nurse-led early rehabilitation program development

All members of the early rehabilitation team, except the charge nurse, discussed and made decisions based

Table 2 Nurse-led early rehabilitation program

Post-operative time	Rehabilitation programs
Day of surgery	(I) Breathing exercises (abdominal lip-reduction breathing), 5–10 sets/time, 3 times/d (II) Bedside exercises 4 times/d, 10–20 sets/time, each lasting 5–10 min (III) Clockwise abdominal massage exercises 15 movements/time, 4 times/d
Postoperative day 1	(I) Breathing exercises, bedside exercises, and abdominal massage exercises as on the day of surgery (II) Wearing lumbar support to assist with exercises from the horizontal to the telescopic position, 3 times/d, 10–20 min (III) Double assistance from bedside standing to slow indoor walking 5–10 m, 3 times/d
Postoperative day 2	(I) Breathing exercises 10–15 times/set, bedside exercises 20–30 times/set, 4 times/d, each lasting 30 min (II) Wear lumbar support and assist the patient to walk slowly indoors for 3–8 min
Postoperative day 3	(I) Breathing exercises and bedside exercises as in the 2 d postoperative period (II) Wearing lumbar support and assisting the patient to walk slowly from assistance to the independent room for 5–10 min (III) Individualized discharge rehabilitation guidance for patients who have had their drains removed
Postoperative day 4—discharge	(I) Individualized discharge rehabilitation guidance for patients who have had their drainage tubes removed (II) For patients with drainage tubes removed today and those without drainage tubes removed, the rehabilitation program is the same as at 3 days after surgery, and the above rehabilitation program is adhered to until discharge

Recumbent exercises include ankle pump exercises, straight leg raises, and functional exercises for the quadriceps.

on literature searches (11-18) to develop a nurse-led early postoperative rehabilitation program based on the advantages and characteristics of robot-assisted minimally invasive lumbar degenerative internal fixation combined with the importance of early postoperative rehabilitation exercises (*Table 2*).

Implementation of a nurse-led early rehabilitation program

(I) Quality control: first, the nurse manager, rehabilitation specialist nurse, and orthopedic specialist nurse were jointly responsible for the implementation of the workflow of the early rehabilitation program. Second, the rehabilitation therapist and the rehabilitation specialist nurse were made jointly responsible for the training and assessment of the charge nurses, and they were allowed to enter this team only after passing the grade. Third, the department used clinical cases as a template to rehearse this every month, effectively evaluated the early rehabilitation program implemented by the charge nurses, and discussed and rectified any problems to ensure homogeneous

implementation of the rehabilitation program. Fourth, the department carries out monthly tests related to the early rehabilitation program, and the charge nurses need to pass the tests.

(II) Preliminary preparation involved the production of the “Manual of rapid postoperative rehabilitation for patients undergoing robot-assisted minimally invasive surgery”, which includes the advantages of the third-generation “Tianguai” orthopedic robot, the importance of early postoperative rehabilitation exercises, and the early rehabilitation exercise program with detailed illustrations and notes after discharge from the hospital. We organized team members to shoot a video of the early rehabilitation exercises for patients to learn before and after surgery.

(III) Preoperative preparation: (i) breathing training, also known as abdominal lip retraction breathing: let the abdomen expand slowly, to the patient’s maximum tolerance, hold the breath for 3–5 s, and then retract the lips slowly exhale; (ii) through the form of brochures, videos, and on-site teaching, demonstrate and teach patients the bedside exercise movements,

and strive to standardize them; (iii) a prosthetic orthopedic technician tailor-made a lumbar support for the patient, and demonstrated the correct way to wear it, with the aim of encouraging patients to adapt to it in advance. This involved the innovative setting of a plasma drainage tube outlet on the lumbar support to avoid folding and squeezing of the drainage tube, thus enabling patients to get out of bed early.

- (IV) Pain management: patients with LDD endure long standing chronic pain and are likely to resist or refuse to accept an early rehabilitation program due to fear of pain associated with early postoperative rehabilitation exercises (19). To alleviate patients' fears, we used a combination of pre-emptive, on-time, and multimodal analgesia for each patient for the entire pain management process. Nurses and attending physicians adjusted medications according to whether patients felt pain during rehabilitation exercises, thereby improving patients' cooperation with early rehabilitation exercises and alleviating their fear of postoperative exercises.
- (V) Precautions: the nurse-led early rehabilitation program should be based on a comprehensive assessment of the patient's condition and systemic status, with the principle of gradual and consistent progress. At the same time, the patient's conditions should be dynamically evaluated, and timely communication with the attending physician and rehabilitation therapist should be made to strive to implement a case-based early rehabilitation program for each patient. At the same time, the charge nurse should know the precautions of this program during the implementation process: (i) the charge nurse performed a holistic patient assessment before implementing the early rehabilitation program and communicated with the attending physician and rehabilitation therapist before implementing the program; (ii) during implementation of the rehabilitation exercise program, the charge nurse closely monitored the patient's vital signs and vigilantly maintained safety protection to prevent the occurrence of bed falls and other adverse events caused by postural hypotension or hypoglycemia; (iii) plasma drainage tubes were properly fixed to prevent spontaneous extubation; (iv) hand hygiene was strictly adhered to during the implementation of interventions to prevent in-hospital cross-infection;

(v) communication was maintained with patients throughout the implementation process, paying full attention to their subjective feelings and pain conditions, and providing humanistic care to the greatest extent.

- (VI) Psychological guidance: the charge nurse paid attention to the psychological condition of the patient at all times, and if abnormalities were detected, she would contact the psychological therapist promptly to effectively guide the patient together. The charge nurse could use music to soothe the patient's mood and encourage them to share their exercise results with other patients to improve their compliance.
- (VII) Follow-up: after a comprehensive assessment of the patient by the charge nurse, attending physician, and rehabilitation therapist before discharge, a customized post-discharge functional exercise plan was formulated. The rehabilitation nurse followed up with the patient every week, including the patient's exercise, brace wearing, medication, wound healing, diet, stool, and so on. They also recorded the patient's individualized rehabilitation goal achievement, provided timely feedback to the patient or the patient's family, and instructed the patient to come to the outpatient clinic for review and follow-up at 1 month after surgery.

Evaluation indicators

The primary endpoints of this study were the general postoperative conditions, the scores of daily living ability, the degree of low back pain and functional recovery. (I) Postoperative time to the floor, drainage, and hospitalization; (II) assessment of daily living ability, pain, and functional recovery (3 days and 1 month postoperatively, respectively), in which the Barthel index (BI) was used to evaluate the daily living ability, the visual analogue scale (VAS) was used to evaluate the postoperative pain, and the Oswestry disability index (ODI) was used to evaluate the functional recovery; (III) the patients' compliance with the exercise program on days 1 and 4 after implementation of the exercise program in both groups; and (IV) the incidence of complications in both groups at 1 month after surgery.

Statistical analysis

Statistical analysis was performed using the software SPSS

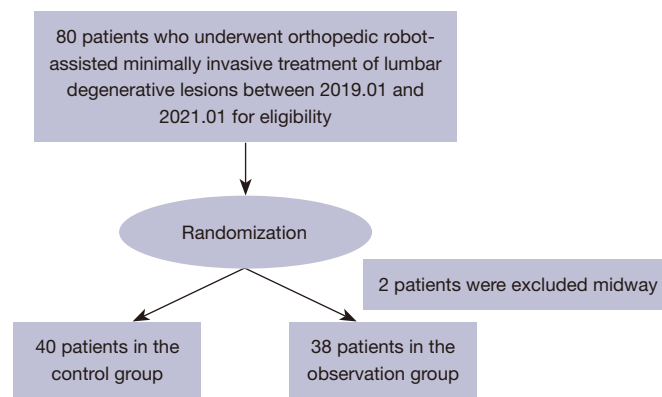


Figure 1 Flow chart.

Table 3 Comparison of postoperative conditions between the two groups of patients ($\bar{x} \pm s, d$)

Group	Example	Drainage time	Downtime	Length of hospitalization
Observation group	38	2.14±0.40	1.45±0.37	4.32±0.70
Control group	40	2.30±0.60	2.90±0.55	4.80±0.69
t value		-1.354	-13.751	-3.08
P value		0.18	<0.001	0.003

Postoperative drainage time, time from placement of surgical plasma drainage tube to its removal; postoperative first time on the floor after surgery, time from the completion of surgery to return to the ward to the time of getting out of bed and standing in lumbar support; postoperative hospitalization time, time from the completion of surgery to discharge.

22.0 IBM Corp., Armonk, NY, USA). The measurement data were expressed as mean \pm standard deviation ($\bar{x} \pm s$), compared within groups using paired *t*-test, and between groups using independent samples *t*-test; the results of clinical data were expressed as the number of cases and analyzed using the chi-square (χ^2) test or Fisher's exact test. Statistical significance was considered at $P < 0.05$.

Results

Comparison of the postoperative conditions of participants in the two groups

Eighty participants who underwent orthopedic robot-assisted minimally invasive treatment of lumbar degenerative lesions at our hospital between January 2019 and January 2021 were randomly assigned with 1:1 ratio, 40 participants in the control group without exclusion after randomization, 40 participants in the observation group but excluded 2 patients midway. Finally, 78 patients were analyzed for the primary outcome (Figure 1).

Participants in the observation group were able to

move to the floor earlier after surgery ($P < 0.001$) and their hospital stay was significantly shorter ($P = 0.003$); there was no significant difference in the postoperative drainage time between the two groups ($P = 0.18$), as shown in Table 3.

Comparison of BI, VAS, and ODI scores between two groups of participants

At 3 days after surgery, the participants in the observation group had significantly better ability to perform daily activities (BI score) than the control group ($P = 0.039$); their lumbar spine pain (VAS score, $P = 0.028$) and functional impairment (ODI score, $P = 0.002$) were significantly better than those in the control group; however, there was no significant difference in the three scores between the two groups at 1 month after surgery (all $P > 0.05$) (Tables 4-6).

Comparison of days 1 and 4 compliance after implementation of the early rehabilitation program in the two groups

The compliance at days 1 and 4 after implementation of the

early rehabilitation program was higher in the observation group than in the control group ($P < 0.001$), as shown in *Table 7*.

Table 4 Comparison of BI scores ($\bar{x} \pm s$, points)

Group	Example	Postoperative day 3	Postoperative 1 month
Observation group	38	41.05±10.54	94.34±2.89
Control group	40	34.5±16.44	90.5±14.97
t value		2.106	1.554
P value		0.039	0.124

BI, Barthel index.

Table 5 Comparison of VAS scores ($\bar{x} \pm s$, points)

Group	Example	Postoperative day 3	Postoperative 1 month
Observation group	38	2.00±0.57	1.42±0.55
Control group	40	2.30±0.61	1.65±0.66
t value		-2.247	-1.662
P value		0.028	0.101

VAS, visual analogue scale.

Table 6 Comparison of ODI scores ($\bar{x} \pm s$, points)

Group	Example	Postoperative day 3	Postoperative 1 month
Observation group	38	17.47±1.81	8.71±1.71
Control group	40	19.03±2.34	9.15±1.44
t value		-3.286	-1.230
P value		0.002	0.222

ODI, Oswestry disability index.

Table 7 Comparison of days 1 and 4 compliance after implementation of the early rehabilitation program in the two groups

Group	Number of cases	Day 1			Day 4		
		Full compliance	Part	Non-compliance	Full compliance	Part	Non-compliance
Observation group	38	25	12	1	23	12	3
Control group	40	10	20	10	6	22	12
χ^2 value			15.751			17.393	
P value			<0.001			<0.001	

Full compliance means that the patient actively completed the exercise content arranged by the charge nurse; partial compliance, supervised completion; non-compliance, unable to cooperate in completion.

Comparison of complications between the two groups of participants

The probability of constipation ($P = 0.043$) and abdominal distension ($P = 0.012$) was significantly lower in the observation group within 1 month after surgery, but there was no significant difference in the incidence of other common complications ($P > 0.05$), as shown in *Table 8*.

Discussion

The inevitability of implementing a nurse-led early rehabilitation program

In middle-aged and elderly patients, LDD is a common cause of low back pain, and when conservative treatment fails, surgical treatment is required. The traditional surgical approach has a series of problems such as the slow recovery of body function after surgery and long-term low back pain (20). In recent years, with the promotion of the “Tianguai” orthopedic robot, the implementation of minimally invasive lumbar internal fixation has widely resolved the drawbacks of the traditional surgical approach. The change of surgical modality has also presented new requirements for the corresponding postoperative care.

Rehabilitation treatment can consolidate the therapeutic effect of orthopedic surgery well and accelerate the postoperative recovery of patients. However, at present, the postoperative rehabilitation program related to orthopedic robot-assisted minimally invasive lumbar internal fixation for lumbar degenerative lesions has not been adequately addressed, and there are many problems such as difficulties in team construction, lack of unified early rehabilitation program, lack of charge nurses, and so on. Most hospital rehabilitation work is still led by clinicians and rehabilitation therapists, and nurses provide adjunct assistance (21). The nurse fulfills one of the closest roles in the medical service

Table 8 Comparison of complication rates between the two groups of participants within 1 month after surgery

Group	Example	Common complication				
		Lung infection	Urinary tract infection	Constipation	Bloating	Wound infection
Observation group	38	0	0	5	7	0
Control group	40	1	1	13	18	1
χ^2 value				4.107	6.321	
P value		0.513 ^a	0.513 ^a	0.043	0.012	0.513 ^a

^a, the expected number is less than 5. Fisher's exact test was used.

to patients. In recent years, quality holistic nursing care has been introduced into the front-line clinic, and nurses can fathom the patient's condition most intuitively. At the same time, the establishment of trust and cooperation between nurses and patients means that quality nursing care and clinical treatment have reached a new milestone. With the development of intelligent and precise medical treatment in orthopedics, alongside acceleration of the concept of surgical rehabilitation in the clinic, the theoretical knowledge and professional ability of orthopedic specialist nurses have been further enhanced, and they have assumed leading role in the early rehabilitation program team while encompassing the important duties of assessment, implementation, communication, and observation, and occupying a crucial position in the early rehabilitation program. All members of this team have relevant clinical work experience, have been professionally trained in rehabilitation therapy, and certified by the hospital, having achieved a certain level of competency to meet the particular needs of patients and hospitals regarding post-operative lumbar spine rehabilitation. Unlike the conventional model of traditional postoperative lumbar spine care, the nurse-led early rehabilitation program on this basis combines rehabilitation therapy with nursing care, enabling effective monitoring and control of the patient's condition while focusing on holistic treatment measures for those with degenerative diseases treated by orthopedic robot-assisted minimally invasive lumbar, which is in line with the concept of precision nursing and is of great significance to the patient's early recovery.

Science and feasibility of implementing a nurse-led early rehabilitation program

Previous literature has reported that early rehabilitation exercises can enhance patients' spinal stability, accelerate the repair of local muscles and blood circulation, relieve postoperative lumbar nerve root adhesions, further reduce

pain, and provide a basis for further rehabilitation exercises after discharge, enabling rapid patient recovery (12,14,22). In this study, we showed that among patients who underwent orthopedic robotic-assisted minimally invasive lumbar internal fixation surgery, the average time to start moving on the ground was 1.45 days after surgery for those who received the nurse-led early rehabilitation program, while the average time to start moving on the ground was 2.90 days after surgery for those who received conventional care, suggesting that the nurse-led early rehabilitation program accelerated patients' early postoperative movement on the ground. The postoperative hospital stay of participants in the early rehabilitation group was also significantly shorter than that of those in the conventional care group, fully confirming that implementation of the nurse-led early rehabilitation in the postoperative period was sufficient to hasten patients' postoperative recovery, which is consistent with previous reports (12). In addition, patients who undertook the early rehabilitation program had a significantly higher ability to perform daily activities 3 days after surgery than those who received conventional care, and their VAS and ODI scores were significantly lower ($P < 0.05$), indicating that the nurse-led early rehabilitation program helped to improve patients' living ability in the early postoperative period, alleviate their early postoperative pain levels, and reduce the application of postoperative analgesics and analgesic pumps. In addition, participants in the observation group were not prone to constipation and bloating, which also suggested that implementation of the nurse-led early rehabilitation program in the postoperative period could effectively reduce the occurrence of postoperative gastrointestinal complications.

Implementation of a nurse-led early recovery program can reduce patient agoraphobia

Patients with LDD experience from lasting chronic pain

and are likely to resist or reject an early rehabilitation program due to a fear of pain associated with early postoperative rehabilitation exercises (19). In this study, a nurse-led early rehabilitation program was adopted, in which the charge nurse provided patients with multifaceted, comprehensive, scientific, and full rehabilitation guidance and care after implementing an individualized assessment of their condition. In terms of compliance, that of patients in the observation group at d 1 and d 4 was higher than that of patients in the control group ($P < 0.001$), suggesting that the nurse-led aspect of early rehabilitation was instrumental in gaining patients' trust, helping patients establish confidence in early recovery, reducing patients' agoraphobia, and enhancing patients' awareness of self-exercise.

Suggestions for implementing a nurse-led early recovery program after minimally invasive lumbar internal fixation

We suggested that those who experienced minimally invasive lumbar internal fixation should receive a nurse-led early rehabilitation program as early as possible. In addition, although the nurse fulfills one of the closest roles in the medical service to patients, they should timely communication with the attending physician and each patient to dynamically assess the patient's condition and systemic status, to strive to implement a case-based early rehabilitation program for each patient.

Conclusions

The implementation of a nurse-led early rehabilitation program in patients undergoing orthopedic robot-assisted minimally invasive lumbar internal fixation not only improves patient compliance, shortens patients' postoperative time to the floor, and actively promotes rapid postoperative recovery, but also reduces the occurrence of postoperative gastrointestinal complications, bringing both immediate and long-term potential clinical benefits to patients. In addition, our study also showcased the valuable nursing experience to our colleagues, effectively enhancing the role of nurses in early rehabilitation exercises and improving their professional value. As this study was a single-center study, it is only representative of the functional rehabilitation exercises of patients undergoing robotic minimally invasive lumbar internal fixation surgery in our orthopedic department, and further studies are needed on this basis to obtain more scientific findings.

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Footnote

Reporting Checklist: The authors have completed the CONSORT guideline checklist. Available at <https://dx.doi.org/10.21037/apm-21-2294>

Trial Protocol: Available at <https://dx.doi.org/10.21037/apm-21-2294>

Data Sharing Statement: Available at <https://dx.doi.org/10.21037/apm-21-2294>

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://dx.doi.org/10.21037/apm-21-2294>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study involving human participants were in accordance with the Declaration of Helsinki (as revised in 2013). The study protocol was approved by the Medical Ethics Committee of Sichuan Provincial People's Hospital-Sichuan Academy of Medical Sciences (No. 298, 2019) and all the participants gave informed consent before taking part in the study.

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