Efficacy of a Lower Back Intensive Rehabilitation Program in Occupational Injury Patients and Characteristics of Care: A Retrospective Cohort Study

Jin Hong Kim
Ye ji Hong
Gangpyo Lee

Background: The Lower Back Intensive Rehabilitation Program (LBIRP) was developed by hospitals affiliated with the Korea Workers' Compensation and Welfare Service to support patients with lower back pain caused by occupational injuries. We studied the characteristics of patients who participated in this program to assess its efficacy and suggest areas for program quality improvement.

Material/Methods: This large-scale retrospective cohort study analyzed the electronic medical records and occupational injury insurance data of patients with lower back damage due to occupational injuries who participated in the LBIRP in hospitals affiliated with the Korea Workers Compensation and Welfare Service between April 2017 and 2020.

Results: Multidimensional analysis showed that pain, isometric strength of the hip, central muscular endurance, neuromuscular control ability, and self-questionnaire scores were significantly different among groups. Further, significant differences were observed in most multidimensional analysis items according to the cause of disease, program period, and severity of disease. There were no significant differences between the groups.

Conclusions: Based on the findings of this study, efforts must be continued to improve and standardize the LBIRP. It is expected that future studies with continuous patient follow-up comparing treatment effects among affiliated hospitals will help to expand the LBIRP for rehabilitation in private hospitals.

Keywords: Lower Back Pain • Occupational Injury • Retrospective Studies
Background

Musculoskeletal disorders are the most common cause of disability worldwide and account for a significant proportion of occupational injury claims [1]. Among them, back pain accounts for the largest proportion. Lower back pain is a significant problem in occupational medicine and public health because it limits daily and work activities, leading to substantial socioeconomic obstacles for the affected persons [2,3].

According to the 2016 Analysis of Occupational Accident Care Benefits in Korea, back pain is the most common outcome from occupational trauma [4]. Back trauma from occupational injuries causes lumbar instability, weakening of the deep muscles in the lower back, decreased reposition capacity, and defective proprioceptive functions, which synergistically lead to lower back pain. The LBIRP was designed to help people return to work following occupational injuries; this can improve the quality of life for people who had occupational injuries and improve socioeconomic stability [5,6].

Although people who had occupational injuries are provided with medical services, the Occupational Accident Insurance Medical Service in Korea is equivalent to the national health insurance service. Consequently, the available treatment service has been insufficient for patients with musculoskeletal injuries, who account for most occupational injury patients. To overcome this limitation, hospitals affiliated with the Korean Workers’ Compensation and Welfare Service have developed the Lower Back Intensive Rehabilitation Program (LBIRP) to provide effective therapeutic interventions for the recovery of physical functions.

The LBIRP consists of personalized exercise and manual therapy administered by a therapist. In a previous study, the LBIRP for occupational injury patients with lower back pain demonstrated greater therapeutic efficacy than the conventional treatment; however, there were limitations, including differences in length of treatment between groups with small sample sizes, and the treatment period was relatively short [4]. We conducted a multi-year, large-scale, retrospective cohort study to address the limitations of previous studies and provide future research perspectives. Specifically, we studied the characteristics of patients who participated in this program to assess its efficacy and suggest areas for program quality improvement.

Material and Methods

Patients and Research Procedures

This was a retrospective study in which the researchers received the necessary data for the study through the official procedure of the Korea Workers’ Compensation and Welfare Service (COMWEL). We included anonymized electronic medical records and occupational injury insurance data of patients who were hospitalized for lumbar rehabilitation treatment and participated in the LBIRP between April 2017 and 2020. Data were included for patients, regardless of sex, who were workers of Korean nationality with lower back pain due to spinal instability caused by occupational injuries, who did not have neurological damage, and who were aged between 20 and 65 years. Patients were excluded from the study if they exhibited unstable thoracic and lumbar fractures or complex morbidity in other parts of the body (excluding the lumbar spine) and those who underwent surgeries or procedures for lower back pain before the occupational injuries. A total of 486 patients were selected, and the results of 3 examinations during 12 weeks of rehabilitation were analyzed. This study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of Incheon Hospital (approval No. KCIRB-2020-0002-001).

Interventions

The LBIRP was prescribed by a specialist in rehabilitation medicine and was conducted by a physical therapist for musculoskeletal rehabilitation. A 1: 1 dedicated LBIRP treatment was conducted between the participant and an experienced physical therapist for 30 min a day, 5 times a week, for 12 weeks. Core stabilization exercises, including neuromuscular control exercises using biofeedback of visual, auditory, and tactile senses were performed. If necessary, manual therapy techniques such as soft tissue mobilization, muscle energy technique, joint mobility, and postural relaxation were conducted. Additionally, under the guidance and supervision of the therapist, the patients performed self-exercise therapy using bare hands, equipment, and instruments for 60 min a day, 5 times a week, for 12 weeks. Exercise therapy consisted of posture and movement education, flexibility exercise, joint range-of-motion exercise, cardiopulmonary endurance exercise, muscle strength exercise, muscular endurance exercise, and lower back function strengthening exercises, with and without a therapist. The intensity and order of the exercises were modified according to each patient’s condition (Table 1).

Observation Items (Multidimensional Evaluation)

Numeric Rating Scale (NRS)

An NRS was used to evaluate changes in pain during the treatment period and to assess the effects of treatment. Patients were asked to define their pain on an NRS of 0 (no pain) to 10 (severe pain) under the supervision of a therapist. NRS scores of 1-3, 4-6, and 7-10 indicated mild pain that does not interfere
with activities of daily living, moderate pain that significantly limits activities of daily living, and severe pain that prevents performing activities of daily living, respectively [7]. The severity of pain in the lower back and transmission to the lower extremities during rest and during activity were assessed.

**Muscle Strength**

Trunk and hip muscle strength was measured using a handheld digital muscle strength measurement tool, the microFET®3 Muscle Testing Dynamometer (Hoggan Scientific, Salt Lake City, USA), during isometric exercise. Isometric muscle strength during hip flexion and extension was measured 3 times, and the average value was recorded in Newtons (N). The isometric hip muscle was measured in a sitting position with the legs shoulder-width apart. The hip joint was flexed at 90°, and the knee joint was maintained at 90° flexion [8]. Both hands were placed across the trunk to measure hip flexion strength. The muscle strength meter was placed in the middle of the sternum, and the participant was asked to bend the trunk forward. The evaluator provided resistance to the participant’s hip flexion strength for 3 s, and measurements were recorded. Hip extension strength was measured in the same way as that used to measure hip flexion strength, but the strength meter was placed in the middle of the thoracic spine, and the patient was instructed to bend the trunk backward. The evaluator provided resistance to the participant’s hip flexion strength for 3 s, and measurements were recorded.

**Trunk Muscular Endurance**

The bridge posture muscular endurance test is a tool used to evaluate the stability of the core back muscles. This functional test involves many core muscles of the lower back to control the movement of the lower back by exercising proper muscle coordination. The muscular endurance of the core back muscles was measured in 3 different postures using a stopwatch: prone bridge, right-side bridge, and left-side bridge postures [9]. The patients were instructed to maintain correct positions in each posture for as long as possible, and the time until failure to maintain the posture was measured. The purpose and importance of the test were explained to the patients prior to administration, and a 3-min break was provided between each examination.

**Neuromuscular Control Ability**

In the prone position, the Chattanooga Stabilizer Pressure Biofeedback unit (Chattanooga Group Inc., Hixson, TN, USA) was used to measure the stabilized ability of core muscles. The patients were asked to place their arms at their sides. In the prone position, the center of the pressure biofeedback unit was placed on the navel of the patients. The pressure bag was maintained at 40 mmHg [10]. The test was conducted using 6 items each for the right and left sides. The items were evaluated from 0 to 5 points. The scores of each side and the sum of the 2 scores were calculated. A higher score indicated better stabilization of the core muscles.

**Self-Questionnaire Test**

The Korean Oswestry Disability Index (KODI), which was developed to assess the severity of disability in daily life due to pain and limited physical function, was used in this study [11]. The ODI is the world’s most widely used tool for the evaluation of function and quality of life in patients with spinal disorders. The questionnaire consists of several types of self-reported items on the daily lives of patients. A total of 9 items are included in the questionnaire, and each item is evaluated from 0 (no disability) to 5 (severe disability). The 9 items evaluate pain, hygiene, walking, sitting, lifting, standing, sleeping, social life, and traveling. Only the items that were answered were included in the analysis, and the total score was calculated and converted for analysis. The following formula was used to calculate% conversion score: “conversion score=[total score/(number of answered items×5)]×100.” A higher score indicated worse functional disability [12]. The reported internal

**Table 1. Lower back intensive rehabilitation program.**

| Lower back intensive rehabilitation program |
|---------------------------------------------|
| • A therapist performs 1: 1 exclusive rehabilitation therapy by selecting several manual or biofeedback techniques depending on the patient’s condition (30 min) |
| • Manual therapy is performed using muscle energy technique, joint mobilization technique, fascia release technique, proprioceptive sensory neuromuscular technique, Mulligan technique, and soft tissue technique |
| • Exercise therapy is performed selectively using various devices or equipment to suit the patient’s rehabilitation stage from among the following options (60 min) |
| • Range-of-motion and flexibility exercise, neuromuscular control exercise, back muscle strength and muscle endurance strengthening exercise, normal spine structure recovery exercise, and dynamic stabilization exercise |
| • Performed 5 times a week for 12 weeks |
| • Evaluating flexibility, strength, and endurance characteristics of the lower back: baseline, 6 weeks, and 12 weeks |
consistency reliability and test-retest reliability of the KODI are \( r=0.92 \) and \( r=0.93 \), respectively [13].

**Statistical Analysis**

Statistical analyses were conducted using SAS ver. 9.4 software (SAS Institute, Inc., Cary, NC, USA). Descriptive statistics were used to analyze the general characteristics of the patients. A mixed model for repeated measures (MMRM) was used to analyze changes in repeatedly measured multidimensional evaluation items. Because the covariance structure in MMRM does not have many repetition points, an unstructured covariance structure was used. Statistical significance was defined as \( P<0.05 \).

**Results**

**Total**

**General Characteristics of All Patients**

The mean age of the patients in the LBIRP was 54.12 years, and there were 372 men (76.5%) and 114 women (23.5%). According to the Occupational Accident Review by Korea Workers’ Compensation and Welfare Service, 379 (78%) patients had occupational back injuries, while 107 (22%) patients were diagnosed with occupational diseases. A total of 98 (20.2%), 40 (8.2%), and 348 (71.6%) patients received surgical treatment, pain intervention, and conservative treatment only, such as rehabilitation and drug treatment, respectively. The average LBIRP performance period of the patients was 95.80 days, suggesting that the patients generally participated in the program for the full 12 weeks. The average length of time from the occupational injury occurrence date to the start date of LBIRP was 134.09 days. The average recovery period of the patients was 423.75 days. The recovery period was defined as the time, in days, between the injury and return to work (Table 2).

**Frequency Analysis According to Diagnosis and Disability Classification of Patients**

The diagnosis of the disease in the patients was analyzed. The most common diagnoses were fractures of the lumbar spine and pelvis (n=212; 43.62%), followed by other intervertebral disk disorders (n=111; 22.84%), fractures of the ribs, sternum and thoracic spine, dislocations, sprains, and strains on joints and ligaments in the lumbar region and pelvis (n=57; 11.73%), and others (n=16; 3.30%) (Table 3).

| Baseline characteristic                          | M±SD or frequency (%) |
|-------------------------------------------------|------------------------|
| Age (years)                                     | 54.12±10.41            |
| Sex (male/female)                               | 372 (76.5)/114 (23.5)  |
| Weight (kg)                                     | 68.55±11.55            |
| Height (cm)                                     | 168.14±8.02            |
| Conservation                                    | 348 (71.6)             |
| Surgery                                         | 98 (20.2)              |
| Intervention                                    | 40 (8.2)               |
| Occupational accident                           | 379 (78)               |
| Occupational disease                            | 107 (22)               |
| LBIRP-execution period (day)                    | 95.80±50.90            |
| LBIRP-number of executions (time)               | 54.12±18.56            |
| OIODSD of LBIRP (day)                           | 134.09±106.07          |
| Recovery period (day)                           | 423.75±218.07          |

M±SD – mean±standard deviation; LBIRP – lower back intensive rehabilitation program; OIODSD – occupational injury occurrence date to start date.

**Multidimensional Analysis Results**

Multidimensional analysis showed significant improvement in pain, trunk muscle strength, trunk endurance, neuromuscular control ability (NCA), and KODI scores over time at baseline, 6 weeks, and 12 weeks (Table 4).

**Disease Occurrence Classification**

**General Characteristics**

The patients were divided into an occupational injury from accident group and an occupational disease group. We found significant differences in age, weight, height, recovery period, and length of time from occupational injury occurrence date to the start date of LBIRP between the occupational accident and disease groups. No significant differences were observed between the 2 groups for the LBIRP performance period and number of sessions (Table 5).

**Multidimensional Analysis Results**

LBIRP patients were divided into occupational accident and disease groups to conduct a multidimensional analysis among measurement time points. Over time, the patients demonstrated significant improvements in pain, trunk endurance, and scores for the NCA and the self-questionnaire test. However, no significant differences were found between the accident and disease groups (Tables 6-10).
### Table 3. Classification of diagnosis (n=486).

| KDCC | Diagnosis                                                                 | Frequency (%) |
|------|---------------------------------------------------------------------------|---------------|
| S32  | Fractures of the lumbar and pelvis                                       | 212 (43.62)   |
| M51  | Other intervertebral disc disorders                                       | 111 (22.84)   |
| S22  | Fractures of the ribs, sternum, and thoracic spine                        | 90 (18.52)    |
| S33  | Dislocations, sprains, and strains of joints and ligaments in the lumbar and pelvis | 57 (11.73)    |
| M48  | Other spondylosis                                                         | 7 (1.44)      |
| M43  | Other deforming dorsopathies                                               | 4 (0.82)      |
| G83  | Other paralysis syndrome                                                  | 2 (0.41)      |
| M54  | Back pain                                                                 | 2 (0.41)      |
| T09  | Other injuries to the spine and torso, unspecified areas                  | 1 (0.21)      |

KDCC – Korean Disease Classification Code.

### Table 4. Changes in multidimensional evaluation (total) (n=486).

|                      | Baseline Mean±SD | 6 weeks Mean±SD | 12 weeks Mean±SD | P     |
|----------------------|------------------|-----------------|------------------|-------|
| NRS (score)          |                  |                 |                  |       |
| NRS-Rest             | 3.71±0.09        | 3.26±0.08       | 2.99±0.08        | 0.00* |
| NRS-A                | 5.56±0.09        | 4.95±0.09       | 4.68±0.09        | 0.00* |
| Muscle strength (N)  |                  |                 |                  |       |
| Trunk flexion        | 67.45±2.51       | 82.11±2.86      | 87.91±2.88       | 0.00* |
| Trunk extension      | 70.22±2.60       | 85.49±3.03      | 91.22±3.17       | 0.00* |
| Hip flexion (R)      | 77.95±9.78       | 86.96±3.52      | 93.16±3.59       | 0.00* |
| Hip flexion (L)      | 68.00±2.84       | 84.28±3.48      | 95.23±3.67       | 0.00* |
| Hip extension (R)    | 61.71±2.70       | 77.52±3.38      | 84.55±3.37       | 0.00* |
| Hip extension (L)    | 61.52±2.71       | 81.40±5.64      | 94.57±3.66       | 0.00* |
| Hip abduction (R)    | 73.38±4.49       | 89.44±3.59      | 94.57±3.66       | 0.00* |
| Hip abduction (L)    | 69.40±3.01       | 87.30±3.62      | 95.00±3.83       | 0.00* |
| Trunk endurance (s)  |                  |                 |                  |       |
| Prone bridge         | 67.45±2.51       | 82.11±2.86      | 87.91±2.88       | 0.00* |
| Lateral bridge (R)   | 70.22±2.60       | 85.49±3.03      | 91.22±3.17       | 0.00* |
| Lateral bridge (L)   | 77.95±9.78       | 86.96±3.52      | 93.16±3.59       | 0.00* |
| NCA (score)          |                  |                 |                  |       |
| NCA (R)              | 1.68±0.07        | 2.67±0.07       | 3.13±0.07        | 0.00* |
| NCA (L)              | 1.69±0.07        | 2.63±0.07       | 3.09±0.07        | 0.00* |
| NCA (R+L)            | 3.37±0.14        | 5.31±0.14       | 6.23±0.14        | 0.00* |
| KODI (Score)         | 50.71±0.73       | 47.21±0.71      | 45.82±1.69       | 0.00* |

NRS – numeric rating scale; A – activity; NCA – neuromuscular control ability; R – right; L – left; KODI – Korean Oswestry Disability Index.

This work is licensed under Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0).
Comparative analysis was conducted on LBIRP participants by dividing them into 2 groups: <90 days and >90 days from the date of occupational injury occurrence. There were significant differences in age, weight, height, LBIRP performance period, LBIRP number of sessions, and recovery period between the 2 groups (Table 11).

### General Characteristics

Comparative analysis was conducted on LBIRP participants by dividing them into 2 groups: <90 days and >90 days from the date of occupational injury occurrence. There were significant differences in age, weight, height, LBIRP performance period, LBIRP number of sessions, and recovery period between the 2 groups (Table 11).

### Results According to LBIRP Start Date

#### General Characteristics

Comparative analysis was conducted on LBIRP participants by dividing them into 2 groups: <90 days and >90 days from the date of occupational injury occurrence. There were significant differences in age, weight, height, LBIRP performance period, LBIRP number of sessions, and recovery period between the 2 groups (Table 11).
Table 7. Changes in trunk muscle strength by group (n=486).

| Muscle strength (N) | Outcome measure | P     | P     |
|---------------------|-----------------|-------|-------|
|                     | Baseline | 6 weeks | 12 weeks |
| Occupational accident | 68.07±2.84 | 83.70±3.24 | 89.25±3.27 | 0.00* | 0.59 |
| Occupational disease | 65.33±5.36 | 76.50±6.08 | 83.13±6.14 | 0.00* |
| <90 days            | 73.62±3.99 | 88.54±4.57 | 94.74±4.60 | 0.00* | 0.95 |
| >90 days            | 63.49±3.21 | 78.02±3.65 | 83.55±3.68 | 0.00* |
| Conservation        | 68.88±2.97 | 82.74±3.39 | 89.02±3.42 | 0.00* |
| Surgery             | 62.83±5.60 | 82.58±6.38 | 85.48±6.44 | 0.00* | 0.54 |
| Intervention        | 66.67±8.82 | 75.47±9.89 | 84.15±9.94 | 0.00* |

| Trunk extension     | Occupational accident | 71.08±2.95 | 87.31±3.43 | 92.92±3.60 | 0.00* | 0.57 |
|                     | Occupational disease  | 67.26±5.55 | 79.15±6.42 | 85.26±6.73 | 0.00* |
| <90 days            | 78.10±4.14 | 95.04±4.83 | 100.91±5.05 | 0.00* | 0.73 |
| >90 days            | 65.19±3.32 | 79.43±3.85 | 85.05±4.04 | 0.00* |
| Conservation        | 70.99±3.08 | 80.98±3.59 | 92.60±3.76 | 0.00* |
| Surgery             | 68.05±5.81 | 84.53±6.76 | 87.17±7.08 | 0.00* | 0.80 |
| Intervention        | 68.86±9.13 | 83.44±10.48 | 89.23±10.96 | 0.00* |

| Hip flexion (R)     | Occupational accident | 79.68±11.08 | 86.59±4.00 | 93.35±4.08 | 0.00* | 0.83 |
|                     | Occupational disease  | 71.79±20.91 | 88.22±7.48 | 92.54±7.61 | 0.39 |
| <90 days            | 72.95±15.49 | 93.23±5.62 | 99.10±5.72 | 0.05 | 0.62 |
| >90 days            | 81.41±12.64 | 92.89±4.52 | 97.77±4.61 | 0.05 |
| Conservation        | 84.22±11.57 | 85.73±4.18 | 95.68±4.26 | 0.00* |
| Surgery             | 62.88±21.60 | 95.23±7.81 | 97.72±7.99 | 0.00* | 0.01* |
| Intervention        | 60.43±35.11 | 77.01±12.11 | 84.62±12.33 | 0.45 |

| Hip flexion (L)     | Occupational accident | 66.92±3.22 | 84.66±3.95 | 91.41±6.42 | 0.00* | 0.14 |
|                     | Occupational disease  | 71.83±6.04 | 83.00±7.37 | 108.56±12.01 | 0.00* |
| <90 days            | 71.91±4.52 | 88.10±5.56 | 96.96±9.05 | 0.00* | 0.93 |
| >90 days            | 65.43±3.65 | 81.81±4.46 | 94.16±7.28 | 0.00* |
| Conservation        | 71.77±5.28 | 91.21±4.26 | 95.38±4.34 | 0.00* |
| Surgery             | 60.20±6.29 | 83.09±7.73 | 86.25±12.70 | 0.00* | 0.57 |
| Intervention        | 59.69±9.94 | 73.94±12.01 | 82.99±19.29 | 0.11 |

| Hip extension (R)   | Occupational accident | 60.24±3.06 | 77.19±3.84 | 84.94±3.83 | 0.00* | 0.49 |
|                     | Occupational disease  | 64.80±5.70 | 78.64±7.17 | 83.20±7.15 | 0.00* |
| <90 days            | 68.60±4.28 | 82.94±5.39 | 90.02±5.37 | 0.00* | 0.73 |
| >90 days            | 56.61±3.45 | 74.02±4.34 | 81.03±4.33 | 0.00* |
| Conservation        | 63.22±3.20 | 76.87±4.02 | 85.56±4.00 | 0.00* |
| Surgery             | 55.53±5.93 | 80.90±7.50 | 81.17±7.50 | 0.00* | 0.09 |
| Intervention        | 59.45±9.40 | 74.21±11.68 | 83.86±11.58 | 0.00* |
The period of transition from the acute phase to the sub-acute phase is 90 days before the onset of lower back pain; it is clinically the most important time for rehabilitation of the lower back. After 90 days, the disease becomes chronic, which may lead to the stagnation of rehabilitation treatment. Therefore, patients were divided into 2 groups according to the length of time from the occupational injury occurrence date to the start date of LBIRP for comparison (<90-day and >90-day groups).

Significant changes were observed in pain, self-questionnaire score, trunk endurance, and NCA score; however, there were no significant differences between the 2 groups (Tables 6-10).

### According to Surgical Treatment

#### General Characteristics

Patients were divided into 3 groups according to the treatment received: conservative treatment, surgery, and spinal intervention groups. There were significant differences in age, sex, weight, length of time from occupational injury occurrence date to the start date of LBIRP, and recovery period among the 3 groups. There were no differences in the LBIRP performance period and number of LBIRP sessions among the 3 groups (Table 12).

### Multidimensional Analysis Results

Multidimensional analysis showed that trunk endurance and muscle strength significantly changed in the intervention group,
except for some items. Self-report questionnaire scores significantly changed only in the conservative treatment group. Only self-report questionnaire scores and right hip flexion in the trunk strength test were significantly different among the 3 groups. Meaningful improvement of pain and NCA scores were noted regardless of surgical treatment (Tables 6-10).

**Discussion**

A multitude of rehabilitation therapies are available for lower back pain. The LBIRP uses manual therapy and exercise therapy including supervised motor-controlled exercise. Manual therapy is conducted to reduce pain, increase joint range of motion, rapidly discharge accumulated fatigue-related substances in the body, and activate metabolism, thereby preventing and treating diseases [14-16]. Exercise therapy aims to increase muscle function and joint range of motion, reduce pain, and improve walking ability [17]. In the study, pain, isometric strength of the hip, central muscular endurance, NCA, and self-questionnaire scores were significantly improved in all groups who received LBIRP. In a study involving 30 patients with non-specific lower back pain, central trunk muscle strengthening exercises led to reduced lower back pain and increased back muscle endurance, lumbar flexibility, and gluteus maximus muscle strength [18]. Additionally, a 1:1 trunk stabilization exercise regimen consisting of stretching, equipment-based muscle strengthening, and sling-assisted sensory integration training was shown to be more effective in improving muscle strength and weight balance than conventional exercise treatment in patients with disk herniation [19]. Our observations on the effects of training on trunk stability and functional enhancement were similar to those observed in a previous study [20], suggesting that the LBIRP has positive effects on back rehabilitation in patients with lower back pain.

### Table 8. Change in trunk endurance by group (n=486).

| Trunk endurance (sec) | Outcome measure | P | p |
|-----------------------|-----------------|---|---|
|                       | Baseline | 6 weeks | 12 weeks |
| Prone bridge          |          |          |          |
| Occupational accident | 15.21±1.32 | 28.31±1.63 | 35.38±1.95 | 0.00* | 0.76 |
| Occupational disease  | 22.02±2.36 | 33.35±2.99 | 39.77±3.59 | 0.00* |          |
| ≤90 days              | 15.62±1.88 | 27.25±2.31 | 34.80±2.76 | 0.00* | 0.73 |
| >90 days              | 17.58±1.46 | 30.85±1.83 | 37.35±2.19 | 0.00* |          |
| Conservation          | 15.46±1.37 | 29.30±1.70 | 36.49±2.03 | 0.00* | 0.05 |
| Surgery               | 20.54±2.54 | 24.03±3.17 | 40.92±3.78 | 0.00* |          |
| Intervention          | 19.13±3.96 | 22.15±4.88 | 26.40±5.86 | 0.05 |
| Lateral bridge (R)    |          |          |          |
| Occupational accident | 9.41±1.04 | 15.35±1.37 | 21.11±1.76 | 0.00* | 0.48 |
| Occupational disease  | 13.21±1.28 | 18.51±1.74 | 24.07±2.25 | 0.00* |          |
| ≤90 days              | 9.41±1.04 | 15.35±1.37 | 21.11±1.76 | 0.00* | 0.54 |
| >90 days              | 10.02±0.81 | 16.85±1.08 | 21.57±1.39 | 0.00* |          |
| Conservation          | 9.35±0.76 | 16.33±1.01 | 21.69±1.29 | 0.00* | 0.40 |
| Surgery               | 11.83±1.38 | 17.56±1.85 | 23.13±2.38 | 0.00* |          |
| Intervention          | 8.19±2.18 | 12.73±2.85 | 14.91±3.67 | 0.05 |
| Lateral bridge (L)    |          |          |          |
| Occupational accident | 7.90±0.68 | 15.40±0.98 | 19.57±1.16 | 0.00* | 0.41 |
| Occupational disease  | 12.65±1.21 | 18.33±1.76 | 22.92±2.10 | 0.00* |          |
| ≤90 days              | 8.68±0.99 | 15.99±1.38 | 20.29±1.65 | 0.00* | 0.93 |
| >90 days              | 9.26±0.76 | 16.12±1.09 | 20.37±1.30 | 0.00* |          |
| Conservation          | 8.84±0.71 | 16.34±1.02 | 20.99±1.21 | 0.00* | 0.25 |
| Surgery               | 10.81±1.31 | 16.59±1.88 | 21.01±2.23 | 0.00* |          |
| Intervention          | 6.33±2.06 | 12.46±2.93 | 13.27±3.48 | 0.01* |

R – right; L – left; p – interaction term P value. * P<0.05.
Table 9. Change in neuromuscular control ability by group (n=486).

| NCA (score) | Outcome measure | Baseline | 6 weeks | 12 weeks | P     | P     |
|-------------|-----------------|----------|---------|----------|-------|-------|
|             | Occupational accident | 1.60±0.08 | 2.59±0.08 | 3.08±0.08 | 0.00* | 0.58  |
|             | Occupational disease | 1.97±0.16 | 2.98±0.16 | 3.33±0.15 | 0.00* | 0.91  |
| ≤90 days    | Occupational accident | 1.41±0.11 | 2.42±0.12 | 2.90±0.11 | 0.00* | 0.58  |
| >90 days    | Occupational disease | 1.86±0.09 | 2.84±0.09 | 3.28±0.09 | 0.00* | 0.58  |
|             | Conservation | 1.61±0.09 | 2.61±0.09 | 3.12±0.09 | 0.00* | 0.06  |
|             | Surgery | 1.90±0.16 | 3.62±0.16 | 3.32±0.16 | 0.00* | 0.06  |
|             | Intervention | 1.75±0.24 | 2.34±0.24 | 2.72±0.23 | 0.00* | 0.06  |
|             | Occupational accident | 1.60±0.08 | 2.55±0.08 | 3.03±0.08 | 0.00* | 0.63  |
|             | Occupational disease | 2.05±0.16 | 2.96±0.16 | 3.33±0.15 | 0.00* | 0.39  |
| ≤90 days    | Occupational accident | 1.38±0.12 | 2.37±0.11 | 2.90±0.11 | 0.00* | 0.63  |
| >90 days    | Occupational disease | 1.90±0.09 | 2.81±0.09 | 3.22±0.09 | 0.00* | 0.39  |
|             | Conservation | 1.61±0.09 | 2.59±0.09 | 3.13±0.08 | 0.00* | 0.39  |
|             | Surgery | 2.02±0.17 | 2.96±0.16 | 3.18±0.16 | 0.00* | 0.39  |
|             | Intervention | 1.67±0.24 | 2.29±0.24 | 2.65±0.24 | 0.00* | 0.39  |
|             | Occupational accident | 3.20±0.16 | 5.14±0.16 | 6.12±0.15 | 0.00* | 0.58  |
|             | Occupational disease | 4.02±0.31 | 5.94±0.31 | 6.65±0.30 | 0.00* | 0.58  |
| ≤90 days    | Occupational accident | 2.79±0.23 | 4.78±0.22 | 5.82±0.22 | 0.00* | 0.58  |
| >90 days    | Occupational disease | 3.76±0.18 | 5.65±0.18 | 6.51±0.18 | 0.00* | 0.58  |
|             | Conservation | 3.22±0.17 | 5.19±0.17 | 6.25±0.16 | 0.00* | 0.58  |
|             | Surgery | 3.91±0.32 | 6.03±0.32 | 6.57±0.31 | 0.00* | 0.58  |
|             | Intervention | 3.42±0.48 | 4.63±0.48 | 5.38±0.46 | 0.00* | 0.58  |

NCA – neuromuscular control ability; R – right; L – left. * P<0.05.

Table 10. Change in Korean Oswestry Disability Index by group (n=486).

| KODI (score) | Outcome measure | Baseline | 6 weeks | 12 weeks | P     | P     |
|-------------|-----------------|----------|---------|----------|-------|-------|
|             | Occupational accident | 60.13±3.08 | 76.74±6.40 | 85.34±3.96 | 0.00* | 0.31  |
|             | Occupational disease | 66.25±5.73 | 97.28±11.89 | 81.51±7.40 | 0.00* | 0.31  |
| ≤90 days    | Occupational accident | 67.47±4.31 | 81.19±9.00 | 86.63±5.55 | 0.00* | 0.39  |
| >90 days    | Occupational disease | 57.63±3.48 | 81.55±7.25 | 81.18±4.47 | 0.00* | 0.39  |
|             | Conservation | 51.54±1.38 | 47.38±1.37 | 44.29±1.37 | 0.00* | 0.39  |
|             | Surgery | 48.61±2.59 | 45.87±2.57 | 51.66±2.57 | 0.00* | 0.39  |
|             | Intervention | 48.50±4.02 | 49.39±4.05 | 44.28±4.02 | 0.00* | 0.39  |

KODI – Korean Oswestry Disability Index. * P<0.05.
Table 11. Description of patient baseline characteristics (treatment time) (n=486).

|                        | ≤90 days (n=188) | >90 days (n=298) | P     |
|------------------------|------------------|------------------|-------|
| Age (year)             | 55.43±10.26      | 53.30±10.44      | 0.02* |
| Sex (male/female)      | 138 (73.4%)      | 234 (78.5%)      | 0.59  |
| Weight                 | 68.87±12.01      | 69.63±11.13      | 0.01* |
| Height                 | 167.09±8.37      | 168.80±7.69      | 0.02* |
| Conservation           | 137 (72.9%)      | 211 (70.8%)      | 0.00* |
| Surgery                | 23 (12.2%)       | 75 (25.2%)       | 0.00* |
| Intervention           | 28 (14.9%)       | 12 (4.0%)        | 0.00* |
| Occupational accident  | 179 (95.2%)      | 200 (67.1%)      | 0.00* |
| Occupational disease   | 9 (4.8%)         | 98 (32.9%)       | 0.00* |
| LBIRP-execution period (day) | 96.70±51.24 | 93.34±49.74      | 0.04* |
| LBIRP-NE (time)        | 54.63±18.70      | 52.32±18.01      | 0.00* |
| Recovery period (day)  | 339.05±167.53    | 477.18±229.30    | 0.00* |

LBIRP – lower back intensive rehabilitation program; NE – number of executions. * p<0.05.

Table 12. Description of patient baseline characteristics (surgical treatment) (n=486).

|                        | Conservation (n=348) | Surgery (n=98) | Intervention (n=40) | P     |
|------------------------|----------------------|----------------|---------------------|-------|
| Age (year)             | 54.55±10.45          | 51.59±9.81     | 56.58±10.68         | 0.01* |
| Sex (male/female)      | 271/77               | 77/21          | 24/16               | 0.03* |
| Weight                 | 68.68±11.49          | 69.21±11.84    | 65.78±11.28         | 0.02* |
| Height                 | 168.13±8.14          | 169.34±7.49    | 165.21±7.39         | 0.28  |
| Occupational accident  | 294 (84.5%)          | 50 (51.0%)     | 35 (87.5%)          | 0.00* |
| Occupational disease   | 54 (15.5%)           | 48 (49.0%)     | 5 (12.5%)           | 0.00* |
| LBIRP-EP (day)         | 94.50±49.03          | 91.29±36.70    | 113.35±84.24        | 0.05  |
| LBIRP-NE (time)        | 53.98±18.94          | 53.30±16.98    | 57.38±19.01         | 0.48  |
| OIODSD of LBIRP (day)  | 127.67±83.62         | 192.47±159.08  | 95.58±67.15         | 0.00* |
| Recovery period (day)  | 410.09±204.66        | 499.03±253.32  | 358.15±196.94       | 0.00* |

LBIRP – lower back intensive rehabilitation program; EP – execution period; NE – number of executions; OIODSD – occupational injury occurrence date to start date. * p<0.05.

The International Labour Organization estimated the total cost of occupational injuries and occupational diseases to be 4% of the gross national product [21]. Occupational diseases are a growing problem that has only recently come into the global spotlight. Occupational diseases often have a long latency period and can be the result of occupational factors, such as working time and workload [22]. In the present study patients were divided into an occupational injury from accident group and an occupational disease group, and the MMRM was used to assess differences among time points. Most measured differences among the time points were statistically significant in the multidimensional analysis. Additionally, we compared the effects of the treatment according to the general characteristics of the patients. Among the general characteristics, the average length of time from the occupational injury occurrence date to the start date of LBIRP was 90 days greater in
the occupational disease group than that in the occupational accident group, which led to an average decrease of 80 days in the recovery period. This may be caused by the difference in time for the assessment of occupational injuries due to a disease and those caused by occupational injuries. However, further studies are required to determine the exact causes. The interaction term P value showed that there were no differences in the effects between the groups except for hip extension (L).

Patients were divided into 2 groups according to the length of time from the occupational injury occurrence date to the start date of LBIRP (≤90 and >90 days), and differences between the 2 groups at different time points were assessed. The period of transition from the acute to the sub-acute phase is 90 days before the onset of lower back pain. It is clinically the most important time for rehabilitation of the lower back; after 90 days, the disease becomes chronic, which may lead to the stagnation of rehabilitation treatment [23]. Therefore, patients were divided into a ≤90-day group and a >90-day group for comparison [24]. In the multidimensional analysis, there were significant intra-group differences between time points; however, there were no significant differences between the groups. These findings suggest that therapeutic improvements occurred in both groups and that there were no differences in the therapeutic effects between the 2 groups. Among the general characteristics, the LBIRP performance period and number of sessions were significantly different between the 2 groups. This showed that the LBIRP performance period and number of sessions were greater in the ≤90-day group than in the >90-day group. The recovery period was approximately 108 days longer in the >90-day group than in the ≤90-day group. This finding suggests that the delayed start of LBIRP tends to decrease the number of sessions, while the participation period increases significantly. Additionally, clinical improvement was observed in patients who started the LBIRP late after the occurrence of occupational injuries and were transferred to affiliated hospitals. However, if the length of hospitalization becomes problematic, despite having the same disease since the LBIRP started late from the date of occupational injury, patients must be transferred to affiliated hospitals in acute and sub-acute phases, as the rehabilitation program has a relatively constant length of time.

We analyzed the patients after dividing them into surgery, intervention, and conservative treatment groups. Multidimensional analysis showed significant change in pain, NCA, muscle strength, and central muscle endurance. Additionally, there were no differences in the effects among the groups, except for the self-report questionnaire scores. These findings suggest that the LBIRP is effective, regardless of the history of surgical treatment. Among general characteristics, the LBIRP performance period was 50 days longer, while the length of time from the occupational injury occurrence date to the start date of the LBIRP was roughly 30 days longer in the conservative treatment group with low severity of back injury than in the intervention group. This contrasts with the general tendency of increased days of care in groups with severe disease [25].

In Korea, it is impractical to offer the LBIRP to patients with lower back pain when there is only reimbursement from health insurance. Therefore, hospitals affiliated with the Korea Labor Welfare Corporation have offered a pilot LBIRP since 2017. The present study clearly demonstrates the efficacy of the LBIRP and provides an opportunity to better understand the characteristics of patients with lower back pain caused by occupational injuries. However, occupational injuries often involve multiple fractures and injuries, including those in the lower back, compared to single injuries of the lower back. In our study, the therapeutic effects on patients with injuries to multiple parts of the body, which tend to be more severe, could not be assessed. Furthermore, our study could not evaluate the reduced social costs (reduced treatment period and reduced disability) achieved by the LBIRP. In occupational injury patients, returning to work is an important prognostic variable. The lack of information on the return to work of patients limited further analysis of the recovery of job ability and employment in addition to the recovery of physical functions. Further research is needed to address these shortcomings.

**Conclusions**

Based on the findings of this study, efforts must be continued to improve and standardize the LBIRP. It is expected that future studies on continuous follow-up of patients that compare treatment effects among affiliated hospitals will help expand the LBIRP for rehabilitation in private hospitals. In patients with lower back pain due to occupational injuries, the LBIRP improves physical function, thereby decreasing the disability rate and improving the rate of return to work. As a result, at the national level, the program will significantly reduce medical expenses through systematic management of patients, increase productivity by reducing the rate of labor loss, and improve the quality of life of workers by facilitating their prompt return to daily life.
References:

1. Brooks PM. The burden of musculoskeletal disease – a global perspective. Clin Rheumatol. 2006;25(6):778-81
2. Hartvigsen J, Hancock MJ, Kongsted A, et al. What lower back pain is and why we need to pay attention. Lancet. 2018;391(10137):3356-67
3. Nelson DI, Concha-Barrientos M, Driscoll T, et al. The global burden of selected occupational diseases and injury risks: Methodology and summary. Am J Ind Med. 2005;48(6):400-18
4. Kim Y-B, Kim SW. Comparison of rehabilitation programs in traumatic lower back injuries with industrial accident. J Korean Soc Occup Environ Hgy. 2019;29:236-50
5. Lee P, Helewa A, Goldsmith CH, et al. Lower back pain: Prevalence and risk factors in an industrial setting. J Rheumatol. 2001;28(2):346-51
6. O'Sullivan PB, Mitchell T, Bulich P, et al. The relationship between posture and back muscle endurance in industrial workers with flexion-related lower back pain. Man Ther. 2006;11(4):264-71
7. Shafshak TS, Elnemr R. The visual analogue scale versus numerical rating scale in measuring pain severity and predicting disability in lower back pain. J Clin Rheumatol. 2021;27(7):282-85
8. Baschung Pfister P, De Bruin ED, et al. Manual muscle testing and hand-held dynamometry in people with inflammatory myopathy: An intra- and interrater reliability and validity study. PLoS One. 2018;13(3):e0194531
9. Brusseau TA. Preface. Res Q Exerc Sport. 2020;91(Suppl. 1):e1761751
10. Daigle FG, Léonard G, Émond M, et al. Comparison of the pressure biofeedback unit and real-time ultrasound imaging as feedback tools to contract the transversus abdominis muscle: A randomized controlled trial in healthy older adults. J Geriatr Phys Ther. 2022;45(1):25-33
11. Jeon CH, Kim DJ, Kim SK, et al. Validation in the cross-cultural adaptation of the Korean version of the Oswestry Disability Index. J Korean Med Sci. 2006;21(6):1092-97
12. Jespersen AB, Gustafsson MEAK. Correlation between the Oswestry Disability Index and objective measurements of walking capacity and performance in patients with lumbar stenosis: A systematic literature review. Eur Spine J. 2018;27(7):1604-13
13. Kim DY, Lee SH, Lee HY, et al. Validation of the Korean version of the Oswestry disability index. Spine. 2005;30(5):E123-27
14. Hemmilä HM, Keinänen-Kiukaanniemi SM, Levoska S, Puska P. Long-term effectiveness of bone-setting, light exercise therapy, and physiotherapy for prolonged back pain: A randomized controlled trial. J Manipulative Physiol Ther. 2002;25(2):99-104
15. Hsieh CY, Phillips RB, Adams AH, Pope MH. Functional outcomes of lower back pain: Comparison of four treatment groups in a randomized controlled trial. J Manipulative Physiol Ther. 1992;15(1):4-9
16. Walach H, Güthlin C, König M. Efficacy of massage therapy in chronic pain: A pragmatic randomized trial. J Altern Complement Med. 2003;9(6):837-46
17. van Tulder MW, Malmivaara A, Esmail R, Koes BW. Exercise therapy for lower back pain. Cochrane Database Syst Rev. 2000;3(2):CD000335
18. Kumar T, Kumar S, Nezamuddin M, Sharma VP. Efficacy of core muscle strengthening exercise in chronic lower back pain patients. J Back Musculoskelet Rehabil. 2015;28(4):699-707
19. Yoo Y-D, Lee Y-S. The effect of core stabilization exercises using a sling on pain and muscle strength of patients with chronic lower back pain. J Phys Ther Sci 2012;24(8):671-74
20. Airaksinen O, Brox J, Cedraschi C, et al. Chapter 4. European guidelines for the management of chronic low back pain in primary care. In: Eur Spine J; 15;2006:5192-300
21. Takala J. Introductory report: Decent work-safe work. Presented at XVIth World Congress on Safety and Health at Work. Vienna: International Labour Office; 2002 May 27
22. Hämläläinen P, Leena Saarela KL, Takala J. Global trend according to estimated number of occupational accidents and fatal work-related diseases at region and country level. J Safety Res. 2009;40(2):125-39
23. Nieminen LK, Pyysalo LM, Kankaanpää ML. Prognostic factors for pain chronicity in lower back pain: A systematic review. PAIN Rep. 2021;6(1):e919
24. Patrick N, Emanski E, Knaub MA. Acute and chronic lower back pain. Med Clin North Am. 2016;100(1):169-81
25. Horn SD, Sharkey PD, Buckle JM, et al. The relationship between severity of illness and hospital length of stay and mortality. Med Care 1991;29(4):305-17

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International [CC-BY-NC-ND 4.0]