Comparative study

THE ROLE OF CORE TRAINING DURING THE REHABILITATION OF CHRONIC LOW BACK PAIN IN FOOTBALL PLAYERS

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ABSTRACT

Management of Chronic Low Back Pain (CLBP) is often multidisciplinary and involves a combination of treatments, including instrumental physiotherapy and therapeutic exercises. Core stability exercises aim to improve pain and disability in CLBP by enhancing spinal stability, neuromuscular control, and preventing shear forces that cause damage to the lumbar spine. The objective of this study was to evaluate the effectiveness of combining instrumental physiotherapy with core stability exercises in order to reduce pain and improve limited functional capacity. This study was conducted at the "Orthomed Sport" physiotherapy clinic between January and July 2024. The participants were professional football players diagnosed with chronic lumbago, who had been prescribed instrumental physiotherapy by an orthopedic doctor for a two-week period. The participants were divided into two groups: group A and group B. Participants in group A underwent only the instrumental physiotherapy prescribed by the doctor for a two-week period. Participants in group B, in addition to the instrumental therapy, also performed core stability exercises three times a week for a period of 6 weeks. Following the study, core stability was found to be effective in improving outcomes after re-evaluation through physiotherapy. This study highlighted the reduction in CLBP in patients who incorporated core training exercises into their rehabilitation phase. This treatment effectively reduces the activation time of the stabilizing model that we aim for. Combining core stability exercises with other exercise modalities appears to lead to greater improvements in pain and disability compared to using any single treatment alone.

KEYWORDS: *core training, physiotherapy, prevention, rehabilitation, stability, posture*

INTRODUCTION

Lumbago (lower back pain) is a common neuromusculoskeletal problem affecting 40% of the global population at some point in their lives and causes significant disability in daily activities (1). The signs and symptoms include local or radicular pain, pain in the lumbar region, and spasms, which are aggravated by movement, leading to a loss of functionality (2). Physical or mechanical causes of lumbago include osteoarthritis, rheumatoid arthritis, degeneration of intervertebral discs or disc herniation, a vertebral fracture (e.g., from osteoporosis), or rarely, an infection or tumor (3).

Although the etiology of lumbago remains debated, pain is believed to arise from several factors, depending on whether they are specific or non-specific. Specific lumbago has a diagnosed pathology such as muscle strain, infection, fracture, or disease of the spinal column (4). On the other hand, non-specific lumbago does not have a clear pathology

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related to the cause of pain. Still, it is theorized to result from factors such as poor posture, reduced flexibility, previous injuries, heavy lifting, mental stress, and obesity (4, 5). Other possible causes of non-specific lumbago include common disorders identified in patients such as weakness of the deep trunk muscles, poor coordination, and muscle imbalance. The therapeutic approach to managing non-specific lumbago varies based on the tolerance of both the doctor and the patient (6). Common treatments aim to achieve similar goals, as massages are intended to promote muscle relaxation, while various modalities can be used to reduce pain levels.

Therapeutic approaches involving massage, medications, and modalities have demonstrated short-term effects in pain reduction (4, 7). Each of these management strategies requires specific equipment, repeated healthcare visits, or prescriptions.

It has been established that two-thirds of adults will be affected by or will experience non-specific lumbago at some point in their lives (8, 9). This condition limits their ability to maintain basic movement mechanics for optimal athletic performance. Lumbago can be defined as any painful stimulus in the region between the lower ribs and the gluteal areas, which can also cause muscle weakness with or without leg pain (10).

However, only about 10% of lumbago cases are specific and have a clear explanation for the pain, leaving 90% as non-specific lumbago (10).

Maintaining physical activity has positive effects on reducing non-specific lumbago (11). The use of exercises to activate and strengthen the core (i.e., Core Stability Exercises, CSE) has shown to be a promising method for treating chronic lumbago (5, 10, 12, 13). The goal of core strengthening is to improve and restore the ability to better control the spine (5). This approach focuses on re-educating the function of the deep trunk muscles and coordinating the deep and superficial trunk muscles during static and dynamic phases (10). A core program focuses on the central musculature, including the transverse and rectus abdominis, internal and external obliques, paraspinal, as well as the gluteal muscles, pelvic floor, and hip joint musculature. A core program can promote patient independence with a home exercise regimen.

Globally, lumbago is classified as the pathology with the greatest global disability, measured by Disability-Adjusted Life Years (DALY).

The diagnosis of chronic lumbago is usually made through a physical examination, physical tests, palpation, and imaging techniques such as X-rays, MRI, and CT scans. Treatment options include medication, physical therapy, and surgery, with physical therapy being tailored to the patient's condition. This includes modalities such as physical therapy, manual therapy, and patient education for home activities.

Chronic lumbago rehabilitation is carried out by a multidisciplinary team and involves a combination of physiotherapeutic treatments, pharmacological care (NSAIDs, muscle relaxants, glucocorticoids), massages, electrotherapy (laser therapy, TENS, Tecartherapy), acupuncture, and, in specific cases, the use of injections and surgical procedures (14).

The effectiveness of manual therapy and core stability exercises is evident in managing CLBP. Still, there are no single studies available in the literature on the combined effects of manual therapy and core stability exercises. Manual therapy is a common treatment for CLBP aimed at improving the mobility of the lumbar spine. These techniques involve passive mobilization performed by physiotherapists in a prone position.

Poor coordination and muscular strength (15, 16) can alter the normal stability of the spine in athletes with chronic lumbago (17, 18). The lumbar multifidus muscle is the primary stabilizer of the trunk and its effectiveness may be reduced 24 hours after the onset of acute lumbago. In patients with chronic lumbago, muscle compensation to alleviate pain may modify sensory function. Therefore, early initiation of core exercises is crucial for better recovery and prevention of chronic lumbago.

Core stability exercises strengthen the spinal muscles by improving their ability to maintain the spine in a neutral position using the abdominal, back, neck, and shoulder muscles as stabilizers rather than movers. There are two types of core stability exercises: static and dynamic exercises performed on the ground.Core stability has gained widespread popularity in recent years, with some studies observing a delayed or reduced activation of the lumbar multifidus and transversus abdominis in chronic lumbago. Dysfunction of these muscles can lead to loss of spinal stability, increased stress, and load on the spinal joints and ligaments.

The goal of core stability exercises is to establish normal muscle function to enhance spinal stability and neuromuscular control in the lumbopelvic region.

Core concept

The core concept has been a focal point in media and scientific literature since the end of the last decade (19). Core anatomy includes all structures between the scapula and gluteals. Core structures can be categorized into stabilizers, such as the internal and external oblique muscles, which control movement angles eccentrically, and mobilizers, such as the rectus abdominis and iliocostalis, which accelerate movement concentrically.

The muscles constituting the core are responsible for maintaining posture in various positions and facilitating safe and effective movement through different planes and directions. The core, represented by the coxo-lumbo-pelvic complex, is the center of the kinetic chains from which all upper and lower limb movements originate. An accurate anatomical understanding of the core region should also include the axial skeleton (coxofemoral and shoulder joints) and connective tissues (tendons, ligaments, fascia).

Researchers (20) have divided the core into three subsystems based on analogies with the "spinal stabilization system":

- passive: comprising vertebral ligaments, intervertebral discs, and articular fasciae;
- neural: this subsystem controls core muscle usage through feedforward and feedback mechanisms;
- active

The classification model proposed by researchers (21) is detailed in the following table (Table I).

Table I. *Classification of core muscles.*

LOCAL STABILIZER	GLOBAL STABILIZER	GLOBAL MOBILIZER
Transverse abdominal	External oblique muscle	Rectus abdominis
Interspinal	Internal oblique	Ileocostal
Psoas (posterior fascia)	Gluteus medius	Piriformis
Diaphragm	quadratus lumborum (deep bandage)	quadratus lumborum (ileo-costal bandage)
Pelvic muscles		Hip bi-articular muscles

The core muscles can be classified into various groups based on their anatomical location and function. The primary groups include:

1. abdominal and paraspinal muscles: these muscles are fundamental components of the core and have been extensively studied. They are divided into two main categories:
    - abdominal muscles: this group includes the rectus abdominis, external oblique, internal oblique, and transverse abdominis. These muscles are crucial for trunk flexion, rotation, and stabilization;
    - paraspinal muscles: this group consists of the spinal erectors (such as the iliocostalis and latissimus dorsi) and deeper trunk muscles like the rotatores, intertransversarii, and multifidus. These muscles are involved in extending and stabilizing the spine.

Particularly, the transverse abdominis is notable for its close anatomical relationship with the trunk and the thoracolumbar fascia. It has been the focus of many studies due to its role in core stability and is often targeted through specific exercises;

2. diaphragm: the diaphragm is considered the upper part of the core region. Its contraction, in synergy with the transverse abdominis and pelvic floor muscles, increases intra-abdominal pressure and enhances trunk stability, independent of its role in respiration;
3. coxofemoral joint and pelvic muscles: these structures form the base of support for the core. Key muscles in this region include the gluteal muscles. The gluteals are significant for stability and force production during specific sports movements. They help stabilize the trunk through closed kinetic chain movements and contribute to generating power and force for lower limb activities;
4. iliopsoas: the iliopsoas, a major muscle of the lumbar region, play a role in trunk flexion but do not contribute significantly to stabilization. Hypertonicity in this muscle can increase the load on the lumbar spine.

Methodology

This study was conducted at the “Orthomed Sport” physiotherapy clinic between January and July 2024. The participants were professional football players diagnosed with chronic lumbago who had been prescribed instrumental physiotherapy by an orthopedic doctor for a two-week period. The patients included in the study complained of back pain for 2 months and presented with a pain level of 3 or higher on the Visual Analog Scale (VAS, scale 0-10).

A total of 30 professional football players aged between 22 and 33 years were included in the study. The exclusion criteria included:

- history of spinal surgery;
- history of rheumatoid arthritis;
- spondylolisthesis or spondylolysis;
- history of pelvic fracture;
- inflammation or tumor of the spinal column;
- history of stroke;
- respiratory or cardiac pathology;
- athletes unwilling to complete the study.

The participants were divided into two groups: group A and group B. Participants in group A underwent only the instrumental physiotherapy prescribed by the doctor, which included TENS, Tecar therapy, and high-intensity laser therapy, for a two-week period. Participants in group B, in addition to the instrumental therapy, also performed core stability exercises three times a week for a period of 6 weeks. Before and after the experiment, the patients underwent the following tests:

1. measurement of pain intensity (VAS): patients were asked to indicate the subjective magnitude of their lumbar pain on a scale from 0 to 10, where 0 represents "no pain" and 10 represents "the worst possible pain" (Fig. 1);

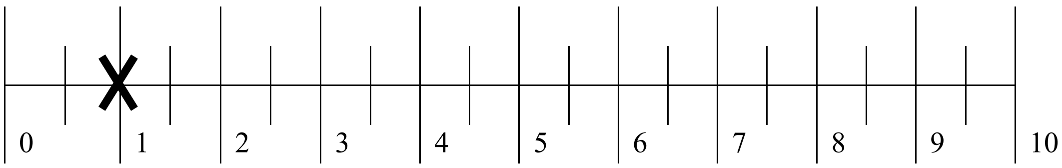

Fig. 1. *Measurement of pain intensity (VAS)*.

2. measurement of hamstring flexibility: the toe-touch test was used to assess the flexibility of the posterior thigh muscles. The patient stands with both feet together and bends forward from the hips to touch their toes with their hands. Patients were instructed to bend forward as much as possible without bending their knees;
3. measurement of iliopsoas muscle flexibility: to assess iliopsoas muscle flexibility, the Modified Thomas Test (MTT) is utilized. The patient sits on the edge of a table and lies supine. They then pull their knees toward their chest while keeping the lower back pressed against the table (to prevent compensatory movement by extending the lower back). One leg is then slowly lowered below the table. The examiner observes and palpates the thigh to ensure it is completely relaxed;
4. internal rotation test in adduction and flexion: the internal rotation test in adduction and flexion was used to measure the flexibility of the piriformis muscle. The patient is positioned supine, with the hip joint flexed to 60° and the knee joint flexed to 90°. The physical therapist performs passive adduction and internal rotation of the hip joint. The range of motion is measured with a goniometer at the point of pain during the passive test. The pain point corresponds to the sciatic and gluteal regions;
5. measurement of disability level: the Oswestry Disability Index (ODI) was used to assess disability caused by CLBP. The ODI consists of 10 questions covering pain intensity, lifting, walking, sitting, standing, sleeping, sexual activity, social life, and travel;
6. one-Legged Stance test (OLST): the test was performed by standing on one leg to measure static balance. The time is recorded until the patient places their foot on the ground and the Trunk Stability Test (TST) (Fig. 2);

Fig. 2. *Trunk stability test (TST).*

7. The Y Balance Test: the YBT test is the sum of the 3 best distances achieved in the various directions divided by length of the limbs multiplied by 100 (Fig. 3);

Fig. 3. *Y-Balance test (YBT).*

8. McGill Core test (MCG): Isometric position hold and measurement of stance duration (Fig. 4).

Fig. 4. *Core endurance tests (sit up position, trunk extension, side bridge*).

Participants in Group A and Group B underwent the aforementioned tests before the start of physiotherapy treatment. The results of these pre-treatment tests are presented in the table below (Table II).

Table II. *Initial tests before treatment.*

Patients	VAS	Flex Hams	Flex psoas	FAIRT	Trunk Stability Test (TST) left/right	MCG	YBT	OLST
Patient 1	2	7°	10°	30°	25/27 sec	20 sec	36.6 cm	1 min
Patient 2	2	8°	12°	31°	25/28 sec	18 sec	35 cm	50 sec
Patient 3	4	20°	15°	26°	18/20 sec	13 sec	26.7 cm	40 sec
Patient 4	6	22°	15°	18°	16/18 sec	10 sec	20.5 cm	35 sec
Patient 5	5	22°	18°	18°	17/20 sec	12 sec	22.6 cm	40 sec
Patient 6	5	25°	18°	19°	18/19 sec	13 sec	23 cm	40 sec
Patient 7	5	26°	18°	20°	16/21 sec	14 sec	24 cm	43 sec
Patient 8	8	30°	32°	10°	7/9 sec	6 sec	15.6 cm	10 sec
Patient 9	8	33°	34°	10°	8/10 sec	8 sec	17.3 cm	8 sec
Patient 10	5	20°	20°	15°	16/19 sec	12 sec	23 cm	37 sec
Patient 11	3	10°	31°	27°	18/21 sec	18 sec	35.3 cm	50 sec
Patient 12	3	11°	30°	26°	17/18 sec	18 sec	34 cm	47 sec
Patient 13	3	10°	32°	30°	16/16 sec	17 sec	36 cm	40 sec
Patient 14	3	8°	28°	25°	15/18 sec	16 sec	36 cm	49 sec
Patient 15	6	20°	20°	21°	13/15 sec	11 sec	21.3 cm	41 sec
Patient 16	6	20°	20°	20°	15/15 sec	10 sec	21.5 cm	40 sec
Patient 17	6	18°	22°	20°	16/17 sec	10 sec	21.5 cm	37 sec
Patient 18	7	17°	31°	22°	11/12 sec	9 sec	18.6 cm	25 sec
Patient 19	8	21°	29°	17°	10/10 sec	7 sec	15 cm	27 sec
Patient 20	7	18°	30°	20°	14/13 sec	8 sec	19.3 cm	27 sec
Patient 21	8	18°	31°	16°	11/12 sec	7 sec	14.7 cm	39 sec
Patient 22	8	20°	31°	14°	10/11 sec	6 sec	13.7 cm	38 sec
Patient 23	8	21°	32°	14°	10/14 sec	8 sec	14.8 cm	39 sec
Patient 24	8	18°	33°	15°	9/14 sec	8 sec	15.8 cm	40 sec
Patient 25	8	19°	32°	13°	10/13 sec	10 sec	15 cm	42 sec
Patient 26	7	28°	28°	17°	15/15 sec	13 sec	18.6 cm	32 sec
Patient 27	6	29°	29°	15°	16/17 sec	16 sec	22.5 cm	26 sec
Patient 28	4	24°	23°	24°	24/22 sec	18 sec	28.6 cm	47 sec
Patient 29	4	20°	25°	24°	22/21 sec	19 sec	27.8 cm	47 sec
Patient 30	9	37°	35°	8°	6/7 sec	4 sec	10 cm	6 sec

After the completion of the tests, patients in group A underwent instrumental physiotherapy for a two-week period. The procedures performed were: TENS for pain reduction=20 min, tecartherapy=25 min, high-intensity laser therapy=10 min.

Patients in group B received instrumental physiotherapy for a two-week period and, for an additional 6 weeks, performed core strengthening exercises with a frequency of three times per week. The main core exercises included:

- Push-Ups: 3 sets of 15 reps
- Dumbbell Rows: 3 sets of 10 reps (each arm)
- Overhead Press: 3 sets of 10 reps
- Plank: 3 sets of 1 minute
- Hanging Leg Raises**:** 3 sets of 10-15 reps
- Medicine Ball Slams: 3 sets of 15 reps
- Ab Wheel Rollouts: 3 sets of 10 reps
- Weighted Russian Twists: 3 sets of 20 reps on each side
- Cable Woodchoppers**:** 3 sets of 12 reps on each side
- Stability Ball Pike**:** 3 sets of 10 reps
- Russian Twists: 3 sets of 20 reps
- Leg Raises: 3 sets of 15 reps
- Bicycle Crunches: 3 sets of 20 reps. Squats: 3 sets of 10 reps
- Deadlifts: 3 sets of 8 reps
- Lunges: 3 sets of 12 reps
- TRX Body Saw: 3 sets of 15 reps
- Single-Leg Romanian Deadlift: 3 sets of 12 reps on each side
- Lateral Band Walk: 3 sets of 20 steps in each direction

Two months after the completion of treatment, patients were reassessed by the physical therapist and underwent follow-up tests. The results from the re-evaluation are presented in Table III.

Table III. *Tests after treatment.*

Patients	VAS	Flex Hams	Flex psoas	FAIR Test	TST left/right	MCG	YBT	OLST
Patient 1	0	0°	3°	40°	30/30 sec	40 sek	55 cm	2 min
Patient 2	0	0°	4°	39°	30/30 sec	38 sek	58 cm	1,7 min
Patient 3	0	1°	0°	36°	30/29 sec	31 sek	45.7 cm	1,7 min
Patient 4	1	1°	0°	30°	28/29 sec	26 sek	44.7 cm	1,2 min
Patient 5	1	1°	0°	32°	29/30 sec	28 sek	40.4 cm	1,6 min
Patient 6	1	0°	4°	31°	28/29 sec	30 sek	42 cm	1,4 min
Patient 7	1	0°	5°	33°	28/28 sec	32 sek	41 cm	1,4 min
Patient 8	2	10°	5°	27°	24/26 sec	21 sek	38.7 cm	1,8 min
Patient 9	2	8°	7°	26°	28/28 sec	20 sek	40.3 cm	48 sek
Patient 10	1	0°	0°	29°	29/29 sec	32 sek	46.5 cm	1,3 min
Patient 11	0	0°	0°	33°	30/30 sec	31 sek	56 cm	1,8 min
Patient 12	0	0°	0°	37°	30/30 sec	31 sek	57.5 cm	1;8 min
Patient 13	0	0°	0°	40°	28/29 sec	34 sek	55 cm	1,4 min
Patient 14	0	0°	2°	37°	27/28 sec	30 sek	54.6 cm	1,4 min
Patient 15	1	1°	0°	38°	27/28 sec	23 sek	46.7 cm	1,6 min
Patient 16	1	2°	0°	28°	27/29 sec	24 sek	45 cm	1,4 min
Patient 17	1	1°	0°	29°	26/30 sec	22 sek	48.5 cm	1,1 min
Patient 18	1	5°	0°	32°	27/27 sec	19 sek	43.8 cm	1,4 min
Patient 19	2	0°	5°	28°	20/20 sec	24 sek	42.3 cm	57 sek
Patient 20	2	0°	5°	32°	24/23 sec	18 sek	42.3 cm	57 sek
Patient 21	1	0°	0°	26°	25/24 sec	21 sek	46 cm	1,5 min
Patient 22	2	0°	0°	28°	20/23 sec	19 sek	40 cm	1,5 min
Patient 23	1	0°	0°	30°	30/30 sec	25 sek	50.1 cm	1,5 min
Patient 24	1	0°	0°	27°	28/29 sec	24 sek	50.3 cm	1,5 min
Patient 25	1	0°	2°	31°	26/28 sec	20 sek	49.3 cm	1,7 min
Patient 26	2	1°	0°	30°	30/29 sec	25 sek	48.5 cm	1 min
Patient 27	1	0°	5°	28°	28/28 sec	29 sek	49 cm	56 sek
Patient 28	0	0°	0°	40°	30/30 sec	38 sek	59 cm	1,7 min
Patient 29	0	0°	0°	39°	30/30 sec	37 sek	57.3 cm	1,6 min
Patient 30	2	3°	5°	26°	25/26 sec	18 sek	48 cm	45 sek

RESULTS

Core stability is closely related to the prevention and rehabilitation of lower limb injuries. The core is the primary point where the lower limbs generate or resist forces during movements. Authors have emphasized that core stability is vital for injury prevention (22). Reduced lumbo-pelvic stability has been shown to correlate with an increased risk of lower limb injuries, particularly in women. Beyond its stabilizing function and force generation, core functionality is integral to all sports involving extremities, such as athletics, football, swimming, and cycling.

Since the core connects the lower and upper limbs, controlling the strength, balance, and movement of the core can optimize the entire kinetic chain, including isolated athletic gestures of both the upper and lower limbs. Several studies have shown that excellent core stability is associated with improved physical performance in all sports. Precise transmission of forces from the lower to the upper limbs, along with good stabilization, provides a strong foundation for developing muscular strength, enhancing the effectiveness of athletic movements. A strong and stable core improves mobility, speed, and performance in athletes' lower extremities. Following the study, core stability was found to be effective in improving outcomes after re-evaluation through physiotherapy.

Two months after the completion of the therapeutic cycle, the patients were re-evaluated; from these evaluations, the following findings emerged:

- out of the 15 patients who underwent routine physiotherapeutic treatment with instrumental therapy, 8 experienced recurrent episodes of low back pain (lumbago);
- None of the 15 patients who received instrumental physiotherapeutic treatment combined with core stability exercises experienced further recurrent episodes.

This study highlighted reduced back pain from chronic lumbago in patients who incorporated core training exercises into their rehabilitation phase. This treatment effectively reduces the activation time of the stabilizing model we aim for.

DISCUSSION

In clinical practice, various therapeutic exercises are used for patients with chronic lumbago. Core stability exercises focus on activating the transverse abdominis and multifidus muscles. These muscles are connected to the thoracolumbar fascia and create a rigidity effect in the lumbar spine by increasing intra-abdominal pressure. Core stability exercises improve the muscular capacity of the local trunk muscles to achieve better neuromuscular control of spinal stability (23). These exercises can reduce pain and disability, improve proprioception, and enhance posture (24, 25).

Strength exercises are commonly used to treat patients with lumbago. Strength exercises activate the superficial trunk muscles that absorb load impacts and are suitable for patients with subacute or chronic lumbago. These exercises aim to increase the strength and control of the general trunk muscles to improve the overall stability of the vertebral column. They can reduce pain and physical disability and increase trunk muscle activity in patients with chronic lumbago.

Core strengthening through exercises can enhance the motor activity of the gamma system, improve central motor control mechanisms, or produce a combination of central and peripheral mechanisms. No previous studies have reported the effects of strengthening exercises on proprioception during subacute or chronic stages of lumbago.

In athletes with chronic lumbago, the posterior thigh muscles, iliopsoas, piriformis, and tensor fascia lata are hyperactive due to weakness in the abductors, extensors, and core muscles of the hip joint. Core stability is essential for proper pelvic, spinal, and kinetic chain balance.

CONCLUSIONS

The core is crucial in providing stability, force transmission, and preventing sports injuries. Through a comprehensive study of core anatomy, function, and clinical assessment techniques, this article provides insights for sports physical therapists. Implementing injury prevention programs for football players through core strengthening and core stability programs offers a clear, evidence-based framework for designing various effective programs. Results from several studies have shown that a single exercise is not sufficient to strengthen the entire core region; instead, a combination of exercises is needed to optimally strengthen the musculature.

Core stability can offer significant therapeutic benefits for patients with chronic non-specific low back pain. It helps reduce pain intensity and functional disability and improves quality of life by enhancing the activation and thickness of core muscles.

Core stability exercises are undeniably more effective than rest or minimal intervention. However, there is conflicting evidence regarding the superiority of core stability exercises compared to other exercises for managing chronic low back pain.

Combining core stability exercises with other exercise modalities appears to lead to greater improvements in pain and disability compared to using any single treatment alone.

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