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Original article

The effect of two lumbar belt designs on trunk repositioning sense in people with and without low back pain

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ABSTRACT

Objectives: Low back pain (LBP) has previously been associated with impaired lumbar proprioception, which may lead to and/or perpetuate joint instability as a cause of LBP. Wearing a lumbar belt (LB) may be beneficial in this regard. The primary aim was to determine the effect of 2 LB designs (extensible and non-extensible) on trunk repositioning sense in people with and without LBP. A secondary aim was to evaluate whether patients showing different clinical signs of lumbar instability differentially benefit from LBs in terms of lumbar proprioception.
Design: Within-group experimental study with a healthy control group.
Methods: In total, 38 patients with LBP and 19 healthy controls participated in this study. Lumbar proprioception (position sense) was measured with participants sitting in a device that allowed for generating movements in axial rotation. Three experimental conditions were compared: (1) no LB, (2) extensible LB, (3) non-extensible LB. Four repositioning errors were computed for each experimental condition: constant error (CE), absolute error (AE), variable error (VE) and total variability (E).
Results: CE and AE scores were higher for LBP patients than healthy controls (all $P < 0.001$), but scores did not significantly differ by condition. Additional subgroup analyses of clinical signs of instability were inconclusive, showing the same results in LBP patients with low and high instability scores (all $P < 0.001$).
Conclusions: This study confirms a significant loss of proprioception in trunk axial rotation in patients with LBP. Wearing an LB did not improve proprioception, but the contact between the LB and the skin might depend on the movement direction. Future studies should investigate the 3 planes of motion while eliminating the effect of the vestibular system.

1. Introduction

Several studies have shown impaired lumbar proprioception in patients reporting low back pain (LBP) [1–5]. This impaired proprioception may lead to and/or perpetuate joint instability as a cause of LBP [6]. Wearing a lumbar belt (LB) may be beneficial in this regard. LBs are not useful for primary prevention [7,8], but some patients with LBP may derive secondary prophylactic benefits from their use [7]. However, the exact mechanisms by which a LB may relieve pain, and possibly reduce its recurrence, remain unknown. An LB may restrict lumbar motion (increase mechanical stiffness), thus preventing loading of certain spine structures [9,10]. For example, an LB may reduce the stress on posterior viscoelastic structures [11] or the compressive loading [12] of the lumbar spine. In contrast, an LB may increase compression forces applied over the skin, thereby providing extra sensory afferents to the central nervous system by the cutaneous mechanoreceptors, which in turn would improve lumbar proprioception [13]. This situation may compensate for proprioceptive impairment and restore lumbar stability [6] or may simply serve as a reminder to avoid harmful positions.

Two studies have explored the effect of wearing an LB on lumbar proprioception [14,15]. One showed a beneficial effect in

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peoples without LBP but with poor lumbar position sense [14]. The second showed greater beneficial effects in patients with LBP than in healthy people [15]. Whether the LBP or poor lumbar proprioception explains the positive effects on position sense derived from the LB remains unknown.

These 2 studies both used an extensible LB [14,15]. However, a non-extensible LB produces a greater increase in lumbar stiffness [16] and might lead to the generation of intra-abdominal pressure. This, in turn, might change the forces exerted on the different lumbar structures that provide proprioceptive information. The effects of extensible and non-extensible LB designs should be compared.

Another element that deserves attention is a possible link between clinical signs of lumbar instability, impaired lumbar proprioception, and the benefits derived from LBs with regard to lumbar proprioception [4].

The primary aim of this study was to determine the effect of 2 LB designs – extensible and non-extensible – on lumbar proprioception, in people with and without LBP. A more exploratory (secondary) aim was to evaluate whether patients with different clinical signs of lumbar instability differentially benefit from LBs in terms of lumbar proprioception. Patients with LBP may show impaired lumbar proprioception as compared with healthy controls and hence may benefit more from wearing a LB, as may patients presenting clinical signs of lumbar instability.

2. Material and methods

2.1. Participants

We included 40 patients with LBP (20 males; 20 females) and 20 healthy controls (10 males; 10 females) between 18 and 65 years old. This sample size was based on the Newcomer et al. study [1], which reached significant statistical differences between experimental conditions with 20 patients with LBP and 20 healthy controls, without averaging measures over several trials. Considering that we averaged the scores of 10 trials per experimental condition, which increased the reliability of the averaged scores (reduced measurement error), we believe that our sample size is conservative. We recruited 40 patients with LBP to allow for subgroup analyses, as detailed below. Participants were recruited through newspaper advertisements and physiotherapy clinics in Montreal, QC, Canada.

General inclusion criteria were mastery of French or English and currently employed or, for patients, employed before the current episode of LBP. Inclusion criteria for patients with LBP were lumbar or lumbosacral pain for at least 4 weeks (non-acute phase) [17] and no radicular pain below the knees. General exclusion criteria were pelvic or spinal surgery; specific lumbar pathology (fracture, infection or tumor); scoliosis; systemic or degenerative disease; body mass index > 30 kg/m^2; high blood pressure (systolic blood pressure > 140 mmHg and/or diastolic blood pressure > 90 mmHg); history of neurological condition other than that related to back pain; receiving anxiolytic medication, anticonvulsants or anti-depressants; receiving medication that could affect neuronal excitability (antispasmodic, anti-inflammatory and analgesic medications were accepted); sacroiliac pain as identified by 5 clinical tests [18]; legal litigation related to LBP; pregnancy; and claustrophobia. Exclusion criteria for healthy controls were back pain in the preceding year or previous back pain lasting more than 1 week.

Before testing, participants were informed of all experimental procedures and gave their informed written consent. All procedures were approved by the ethics committees of the Centre for Interdisciplinary Research in Rehabilitation of Greater Montreal (CRIR) (registration n° CRIR-955-0414).

2.2. Questionnaires and assessment of lumbar instability in patients with LBP

The Roland Morris Disability Questionnaire (RMDQ) [19] was used to assess LBP-related disability. An 11-point (0 to 10) numeric rating scale (NRS) was used to assess the current, best and worst pain intensity during the last week, with the 3 ratings averaged [20].

Because of no consensus on clinical assessment for lumbar instability [17,21], we chose 2 methods with some evidence of validity. The first was the prone instability test (ProneIT) [22], a provocation test leading to a positive or negative response. The second was a questionnaire based on 15 clinical signs of lumbar instability [21], scored with a 5-level Likert scale to determine to what extent each sign was relevant for the patient. Responses for LBP patients were then dichotomized as positive (strongly agree; agree) or negative (undecided; disagree; strongly disagree), with positive items summed to obtain a lumbar instability sign score between 0 and 15 (LIS15 score).

2.3. Lumbar belts

Three experimental conditions were tested: control (no belt), extensible LB (LumboLux model, Hope Orthopedic; Carlsbad, CA, USA), and non-extensible LB (582 model, M-Brace; Italy) (Fig. 1) [23]. Different LB sizes were used to fit participants' body types based on charts offered by each company and adjusted for participant comfort. The bottom of the LB was aligned with the anterior superior iliac spine and did not touch the thighs when participants were sitting. The tension on the LB was standardized to generate a pressure of 60 mmHg (8.0 KPa) [16], measured with a thin force sensor (FSR400 model, Interlink Electronics; Shenzhen, China; Fig. 2) inserted between the LB and the participant, on the right iliac crest.

2.4. Lumbar proprioception assessment

Participants performed a lumbar repositioning task in the transverse plane (axial rotation) by use of a previously described [24], custom-built apparatus (Fig. 3). A seated position was chosen because of its functional relevance to the loading on the lumbar spine and to minimize afferent signals from the lower extremities [25].

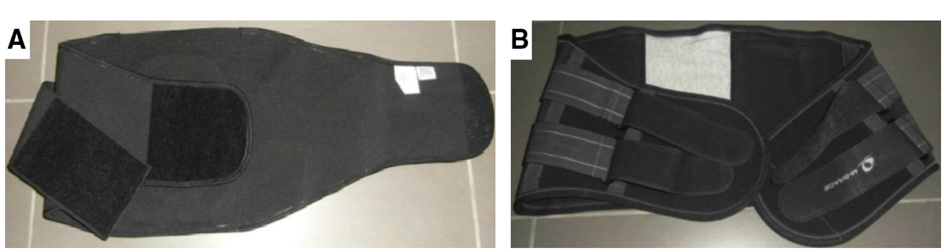

Fig. 1. (A) extensible lumbar belt (the 2 tissue layers are elastic) and (B) non-extensible lumbar belt (the 2 nylon straps prevent extensibility).