

Clinical Study

# Quantitative estimation of the high-intensity zone in the lumbar spine: comparison between the symptomatic and asymptomatic population

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Received 28 November 2012; revised 28 May 2013; accepted 24 June 2013

## Abstract

**BACKGROUND CONTEXT:** The high-intensity zone (HIZ) on magnetic resonance imaging (MRI) has been studied for more than 20 years, but its diagnostic value in low back pain (LBP) is limited by the high incidence in asymptomatic subjects. Little effort has been made to improve the objective assessment of HIZ.

**PURPOSE:** To develop quantitative measurements for HIZ and estimate intra- and interobserver reliability and to clarify different signal intensity of HIZ in patients with or without LBP.

**STUDY DESIGN:** A measurement reliability and prospective comparative study.

**PATIENT SAMPLE:** A consecutive series of patients with LBP between June 2010 and May 2011 (group A) and a successive series of asymptomatic controls during the same period (group B).

**OUTCOME MEASURES:** Incidence of HIZ; quantitative measures, including area of disc, area and signal intensity of HIZ, and magnetic resonance imaging index; and intraclass correlation coefficients (ICCs) for intra- and interobserver reliability.

**METHODS:** On the basis of HIZ criteria, a series of quantitative dimension and signal intensity measures was developed for assessing HIZ. Two experienced spine surgeons traced the region of interest twice within 4 weeks for assessment of the intra- and interobserver reliability. The quantitative variables were compared between groups A and B.

**RESULTS:** There were 72 patients with LBP and 79 asymptomatic controls enrolling in this study. The prevalence of HIZ in group A and group B was 45.8% and 20.2%, respectively. The intraobserver agreement was excellent for the quantitative measures (ICC=0.838–0.977) as well as interobserver reliability (ICC=0.809–0.935). The mean signal of HIZ in group A was significantly brighter than in group B (57.55±14.04% vs. 45.61±7.22%,  $p=.000$ ). There was no statistical difference of area of disc and HIZ between the two groups. The magnetic resonance imaging index was found to be higher in group A when compared with group B (3.94±1.71 vs. 3.06±1.50), but with a  $p$  value of .050.

**CONCLUSIONS:** A series of quantitative measurements for HIZ was established and demonstrated excellent intra- and interobserver reliability. The signal intensity of HIZ was different in patients with or without LBP, and significant brighter signal was observed in symptomatic subjects. © 2014 Elsevier Inc. All rights reserved.

## Keywords:

Disc degeneration; Magnetic resonance imaging; High intensity zone; Quantitative measurement; Reliability

FDA device/drug status: Not applicable.

Author disclosures: **CL:** Nothing to disclose. **H-XC:** Nothing to disclose. **J-FZ:** Nothing to disclose. **J-JM:** Nothing to disclose. **Y-JL:** Nothing to disclose. **S-WF:** Nothing to disclose.

This study has been approved by the institutional review board at Sir Run Run Shaw Hospital, School of Medicine, Zhejiang University. The study was sponsored by National Nature Science Fund of China (81171739, 81101378), Zhejiang Provincial Program for the Cultivation of High-level Innovative Health Talents, and Natural Science Fund of

Zhejiang Provincial (Y2110372). No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

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## EVIDENCE & METHODS

### Context

HIZs and their relationship to LBP remain unclear. The authors aimed to shed some light on this topic.

### Contribution

In this prospective MRI study, the authors found that signal intensity of HIZs differed between patients with and without LBP. Higher intensity signals on sagittal T2 imaging were observed in LBP patients. The findings showed “excellent” intra- and inter-observer reliability.

### Implications

A marker, whether biological, genetic, or radiographic, that might differentiate symptomatic versus asymptomatic disc degeneration has been elusive to date. The current findings provide a direction for further studies. However, it is unclear how the findings might guide treatment and whether they have prognostic importance.

## Introduction

The high-intensity zone (HIZ) is defined as a high intensity signal on T2-weighted magnetic resonance imaging (MRI) located in the substance of the posterior and/or posterolateral annulus fibrosus. This sign is clearly dissociated from the signal of nucleus pulposus and is appreciably brighter than that of nucleus pulposus. When first described by Aprill and Bogduk in 1992 [1], HIZ was considered a significant breakthrough in the diagnosis of low back pain (LBP), with a prevalence of 25% to 59% in patients with LBP [2–5].

However, a series of correlative studies has also been conducted to further investigate the original proposition of HIZ. Saifuddin et al. [6] suggested that the usefulness of HIZ was limited by its low sensitivity (26.7%) in detecting LBP caused by painful annular tear. Ito et al. [3] and Ricketson et al. [7] found no strong association between HIZ and a concordant pain response on discography. What is more vital is that HIZ could also be observed in patients without LBP, with a prevalence of 6% to 31% [4,8,9]. Caragee et al. [4] concluded that such a high incidence of HIZ in asymptomatic subjects was a potential limitation for meaningful clinical use.

The debate on the clinical value and the utility of HIZ is partially because of the signal intensity of HIZ. Bogduk [10] emphasized that HIZ has to be an intense signal, rather than any spot in the posterior annulus. He pointed out that a “low-intensity zone” can be found in asymptomatic population, representing annular fissures. These fissures may become painful and assume a higher intensity signal when “activated” by an inflammatory reaction [10]. Kang et al. [11] indicated that failure to distinguish HIZ and low-

intensity zones may lead to lower diagnostic value of HIZ. Obviously, comparing the signal intensity between symptomatic and asymptomatic population is important to validating the utility of HIZ. If fissures with less bright signal, instead of true HIZ, present in subjects without LBP, this would support Bogduk’s hypothesis [10] and be of enormous clinical value.

Indeed, as pointed out by Hanna et al. [12], the detection of HIZ using the naked eye is an unreliable and imprecise assessment, and may be responsible for the debate on clinical utility of HIZ. Therefore, more reliable and sophisticated measurement is strongly needed. Fortunately, because the brightness of the annular signal could be quantified by comparison with a standard tissue signal, such as cerebrospinal fluid (CSF), a rigorous investigation of HIZ is available in theory.

The current study explores these questions. In an effort to establish a series of quantitative measurements for HIZ, we seek to clarify whether relative low-signal intensity lesion present in subjects with a known propensity to lumbar disc degeneration, but who were asymptomatic for LBP completely.

## Materials and methods

This prospective study was approved by the ethical committee of our institution. All participants gave their informed consent before their inclusion in the study.

### Participants

Between June 2010 and May 2011, 271 eligible patients were referred to our tertiary spine care center. They had at least 6 months’ duration of LBP that had failed an adequate trial of conservative therapy. Those with previous spine surgery (11 patients), ongoing psychiatric illness (3), and aged  $\geq 60$  years (52) were precluded because most of the elderly patients ( $\geq 60$  years) showed abnormal findings on MRI [13,14]. All patients underwent MRI scanning of the lumbar spine. Patients were also excluded based on MRI findings that were considered to be a potential source of nondiscogenic LBP, including spondylolisthesis (37), spinal stenosis (26), degenerative scoliosis (11), disc herniation (39), spinal fracture (7), infection (8), or neoplasm (5). Thus, 72 patients with LBP were enrolled in this study as the symptomatic group (group A). There were 40 males and 32 females aged from 24 to 59 years ( $44.3 \pm 9.2$  years).

The asymptomatic controls were screened from 413 individuals presenting to our hospital because of minor extremity injuries (ie, distortion and contusion) or routine health examination during the same period. They were recruited through informational bulletins placed in the radiology department as well as through personal contacts. Subjects were considered potential controls if they had never experienced any relevant LBP or related complaints

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