

: (High - Intensity Zone: HIZ)  
(MRI) 가

: 19 , 43  
MRI  
(CT Discography: CTD) . MRI CTD

,  
grade 0, ; grade 1,  
; grade 2, . MRI T2 -  
, HIZ ,  
, CTD ,  
. MRI ,

chi - square ,  
 $p < 0.05$  .  
: Grade 1 2 43 8 (19%), 12 (28%)  
, MRI 7 . T2 -  
, HIZ

. CTD HIZ  
. HIZ 14 (33%) ,

: MRI  
MRI HIZ 가

(MRI) (7). MRI  
(1 - 3)

가 가 intensity zone: HIZ 가 (High -  
(1, 4 - 6), 가 MRI (5, 6, 8 - 10). HIZ  
MRI 가

1  
2  
3  
4

:

niation) . HIZ

가 가

2002 3 9 7 ,  
2

(1). HIZ T2 -

19 , 43 . 11 ,  
8 40.4 (21 - 72 ) .

가 (concordant

MRI ,  
(CT discography:CTD) . MRI

pain) 가 가 , ,  
(nonconcordant pain)

30.9 (3 -  
204 ) 1

grade 0, ; grade 1,  
; grade 2,

CTD

CTD

MRI 1.0 - T unit (Impact  
Expert; Siemens, Erlangen, Germany)

- T1 -

(600/12 [ msec/  
msec])

가

- T2 - , 512

1/3 ,

30 °

× 270; 280 mm × 280 mm; 4 mm;

(11).

0.4 mm; T1 - 3, T2 -

MRI

15 가

chi -

- T2 - (5100/120; 256 ×

square

210; 175 mm × 200 mm; 4 mm;

0.4 mm; 15)

가 19

MRI

grade 1 2 43

8 (19%), 12 (28%)

. MRI

(T2 -

2 - 3 2 , 3 - 4 12 , 4 - 5 15 ,

, , ) 7

5 - 1 14

. MRI T2 -

15 cm, 22 - gauge Chiba (Medical Device  
Technologies, Gainesville, FL., U.S.A.)

가 36 (84%), 28  
(65%), 23 (54%) . T2 -

5 - 1

HIZ 14 (33%) , 8 (19%)

4 (transdur -

al) . C

5 - ml

300 mg/ml iodine  
iohexol (Omnipaque 300; Nycomed Amersham, Country  
Cork, Ireland) 0.5 - 1.5 ml

**Table 1.** Comparison of Signal Intensity on T2-weighted Image and Provocative Pain to Discography

Signal Intensity on T2WI	Pain Response			p-value
	Grade 0	Grade 1	Grade 2	
Normal	7	0	0	0.014
Decrease	16	8	12	

1.5 ml

4 - 5 2

**Table 2.** Comparison of Disc Height on MR and Provocative Pain to Discography

Disc Height on MR	Pain Response			p-value
	Grade 0	Grade 1	Grade 2	
Normal	10	1	4	0.429
Decrease	13	7	8	

(annular bulging), HIZ,

MRI CTD  
T2 -  
(her -

, HIZ

(Fig. 2). 43

MRI

CTD

Table 6

MRI

Table 1 - 5

CTD

T2 -  
(Fig. 1),

. CTD

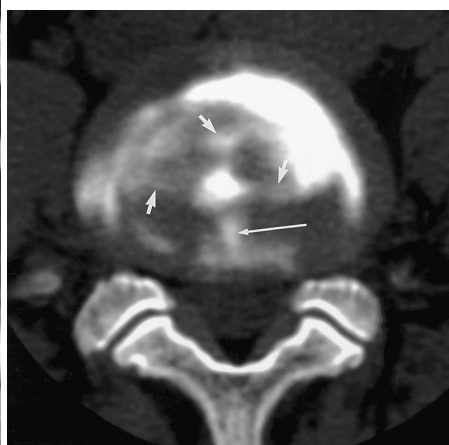
HIZ

**Table 3.** Comparison of Annular Bulging on MR and Provocative Pain to Discography

Annular Bulging on MR	Pain Response			p-value
	Grade 0	Grade 1	Grade 2	
Presence	14	3	3	0.040
Absence	9	5	9	



A



B

**Fig. 1.** A 53-year-old woman showing correlation of decreased signal intensity of disc on T2-weighted image and disc degeneration and radial tear on CT discography.

**A.** Sagittal T2-weighted image demonstrates decreased signal intensity of L4 - 5 disc (arrow). Decreased height and high-intensity zone (curved arrow) of this disc are associated.

**B.** CT discogram at L4 - 5 level shows multiple irregular annular tears (short arrows) and a radial tear (long arrow) of the disc. Discography provoked concordant pain at this level.



A



B



C

**Fig. 2.** A 26-year-old woman showing good correlation of HIZ on MR with provocative pain and radial tear on discography.

**A.** Sagittal T2-weighted image reveals high-intensity zone at L5 - S1 disc (curved arrow). The signal intensity and height of this disc are decreased. L4 - 5 disc shows normal morphology.

**B, C.** Discography provoked definite pain at L5 - S1 disc level. L4-5 disc is also normal without provoked pain. Conventional (**B**) and computed tomographic discograms (**C**) at L5-S1 level show a radial tear (arrows) combined with a concentric tear (curved arrow) at the posterior part of disc.

**Table 4.** Comparison of High Intensity Zone (HIZ) on MR and Provocative Pain to Discography

HIZ on MR	Pain Response			p-value
	Grade 0	Grade 1	Grade 2	
Presence	3	4	7	0.005
Absence	20	4	5	

**Table 5.** Comparison of Disc Herniation on MR and Provocative Pain to Discography

Disc Herniation on MR	Pain Response			p-value
	Grade 0	Grade 1	Grade 2	
Presence	4	1	3	0.639
Absence	19	7	9	

**Table 6.** Comparison of MR Imaging Findings and Disc Morphology on CT Discography

MR Imaging Findings			CT Discography								
			Degeneration			Radial tear			Extravasation		
			+	-	p-value	+	-	p-value	+	-	p-value
SI on T2WI	+	(n=36)	17	19	0.021	29	7	0.001	11	25	0.090
	-	(n=7)	0	7		1	6		0	7	
Disc Height	+	(n=28)	13	15	0.212	22	6	0.086	9	19	0.178
	-	(n=15)	4	11		8	7		2	13	
Annular Bulging	+	(n=23)	11	12	0.239	20	3	0.008	10	13	0.004
	-	(n=20)	6	14		10	10		1	19	
HIZ	+	(n=14)	4	10	0.313	13	1	0.022	5	9	0.290
	-	(n=29)	13	16		17	12		6	23	
Disc Herniation	+	(n=8)	4	4	0.507	7	1	0.226	6	2	0.000
	-	(n=35)	13	22		23	12		5	30	



**A**



**B**

**Fig. 3.** A 38-year-old man showing two levels of HIZ on MR and radial tear on discogram not associated with provocative discogenic pain.

**A.** Sagittal T2-weighted image demonstrates high-intensity zones at the L2-3, L3-4 and L5-S1 levels (curved arrows). L4-5 disc underwent discectomy 3 years ago.

**B.** Discography shows radial tear extending to the outer annulus at all of the discs of L2-3, L3-4 and L5-S1 levels (arrows). Provocative pain was only positive at L2-3 level and the pain was negative at the L3-4 and L5-S1 levels.

14),  
teoglycan

가 (13,  
pro - 가

(13).  
MRI

가

(1, 4 - 6, 15),  
(derangement) 가 MRI CTD

가 ,  
가

(16, 17).  
MRI T2 -

(5, 14, 18),  
MRI Milette

(19).  
MRI Milette

(19) MRI HIZ가

(1)  
HIZ (6, 8, 9), April Bogduk 500  
MRI T2 -  
HIZ가 86% (1).  
(10, 14, 20), Smith 55  
HIZ 40%  
(10). MRI

HIZ

Dallas  
grade가 (5,  
MRI  
HIZ

6, 18). HIZ  
HIZ 가

가 가

가 (14, 21).  
(22).  
1 Modick type

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## Internal Disc Derangement in Patients with Low Back Pain: Correlation of MR Imaging and Provocative Discography and CT Discography<sup>1</sup>

Hye Won Chung, M.D.<sup>1,2</sup>, Jung-Eun Cheon, M.D., Sung Hwan Hong, M.D.,  
Heung Sik Kang, M.D., Ji-Ho Lee, M.D.<sup>3</sup>, Joo Han Oh, M.D.<sup>3</sup>, Pyoung Jeon, M.D.<sup>4</sup>

<sup>1</sup>Department of Radiology, Seoul National University College of Medicine

<sup>2</sup>Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine

<sup>3</sup>Department of Orthopaedic Surgery, Seoul Municipal Boramae Hospital, Seoul National University College of Medicine

<sup>4</sup>Department of Diagnostic Radiology, National Health Insurance Corporation Ilsan Hospital

**Purpose:** The aim of this study was to correlate the MR imaging abnormalities of the lumbar intervertebral discs, with emphasis being placed on the high intensity zone (HIZ) with the use of discography for pain provocation and disc morphologic evaluation of the disc.

**Materials and Methods:** Consecutive patients with low back pain unresponsive to conservative treatment, and who were being considered for spinal fusion had MRI performed, and this was followed by lumbar discography. The MR imaging, discography and CT discography (CTD) were evaluated for all of the 19 patients. Forty-three lumbar discs in 19 patients were included in this study. The findings of MR and CTD images were evaluated retrospectively with the professional opinion and agreement of two radiologists. MR images were assessed for the presence or absence of decreased T2-weighted signal intensity, decreased disc height, annular bulging, HIZ on T2-weighted images and disc herniation. The results of pain provocation were graded as 0, nonconcordant pain; 1, definite pain, but only as part of the symptom complex; 2, concordant pain. The morphology of CTD was analyzed for presence or absence of disc degeneration, radial tearing and extravasation of the contrast agent. The presence of radial tearing was defined as contrast extension to the outer third of the annulus. The prevalence of all MR abnormalities was calculated, and the data were compared with disc morphologic characteristics and the pain response on provocative discography. We used the chi-square test to analyze the results.

**Results:** Grade 1 and 2 discogenic pain was observed in 8 (19%) and 12 disc levels (28%), respectively. All of the seven non-degenerated discs on MR had no pain response. The decreased SI on T2-weighted image, annular bulging and HIZ were significantly correlated with discogenic pain. Extravasation of contrast media had good correlation with annular bulging and disc herniation on MRI. Radial tearing on CT discography correlated significantly with HIZ. The HIZ was detected in 14 levels (32.6%). The HIZ on MRI correlated significantly with the pain provocation and radial tearing noted on the discograms.

**Conclusion:** Several MR imaging findings correlated significantly with the severity of pain provocation to discography. For patients with symptomatic low back pain, the HIZ observed on MR may represent a painful outer annular disruption.

**Index words :** Spine, intervertebral disks

Spine, MR

Discography

Computed tomography (CT)

Magnetic resonance (MR), comparative studies

Address reprint requests to : Hye Won Chung, M.D., Department of Radiology, Samsung Medical Center,  
Sungkyunkwan University School of Medicine, 50 Ilwon-dong, Kangnam-gu, Seoul 135-710, Korea.  
Tel. 82-2-3410-6456 Fax. 82-2-3410-0084 E-mail: hwchung@smc.samsung.co.kr