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Modic changes associated with greater pain relief following anesthetization of the adjacent lumbar intervertebral disc: A retrospective study of chronic low back pain patients

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ABSTRACT

Purpose: To assess the correlation between the degree of pain relief following discoblock and the presence and type of adjacent Modic changes (MC).
Method: We retrospectively analyzed chronic low back pain (LBP) patients whose pain was suspected to originate from a specific lumbar intervertebral disc (IVD) based on a spine orthopedist's clinical evaluation and magnetic resonance imaging (MRI). Thus, patients were selected to undergo discoblock. We calculated the degree of pain relief following discoblock on Numerical Rating Scale (ΔNRS) and analyzed the MRIs on the basis of MC presence and type on the lumbar spinal segment in question. We assessed the differences in ΔNRS between the groups with absent and present MC and the groups of MC subtypes.
Results: Forty-five patients were included in the present study, all of whom underwent discoblock at a single level. The total MC prevalence was 77.8 % (35 patients); pure or dominant MC type 1 (MC1 group) 35.6 % (16 patients); and pure or dominant MC type 2 (MC2 group) 42.2 % (19 patients). ΔNRS was significantly greater in the group with MC compared to the group without MC (median ΔNRS −5.0 vs −2.5, respectively, $P = 0.043$). In pairwise comparisons, a significant difference in ΔNRS was found between the MC1 group and the group without MC (median ΔNRS −5.0 vs −2.5, respectively, $P = 0.012$).
Conclusions: We propose that MC type 1 are associated with lumbar spinal pain, and that the pain arises at least partly from the adjacent IVD or endplate.

1. Introduction

Low back pain (LBP) affects hundreds of millions of people worldwide and has an enormous effect on the economy and public health on a global scale [1]. Intervertebral disc (IVD) is one of the major sources of LBP, and the pain is usually a consequence of IVD degeneration [2,3]. A fluoroscopy-guided injection of local anesthetic, for example, bupivacaine or lidocaine, into an IVD (discoblock) can be used to diagnose discogenic LBP. As discography, discoblock can also be used as a surgical decision-making tool. However, the predictive values of these preoperative injection procedures are controversial, as concerns regarding diagnostic accuracy have been raised and a limited number of studies have reported inconsistent postoperative results [4].

Vertebral degenerative bone marrow changes, Modic changes (MC), were first diagnosed in the 1980s. They are visible on magnetic resonance imaging (MRI) and have been reported to associate with IVD degeneration and LBP [5–7]. Depending on the signal intensity changes revealed by MRI, MC are classified into three types: type 1 (MC1) shows edematous signal changes, type 2 (MC2) fatty signal changes, and type 3 (MC3) sclerotic signal changes. Histologically, MC1 represents fibrovascular tissue proliferation, MC2 yellow bone marrow conversion, and MC3 increased bone volume fraction and trabecular thickness [7–9]. Mixed MC of different subtypes have also been reported [10].

The correlation between discoblock result and MC remains

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somewhat unexplored. Putzier et al. [11] analyzed a set of chronic LBP patients who had undergone a combined discography-discoblock procedure. The authors reported a significant correlation between positive discoblock result and the presence of adjacent MC1 or MC2. Alamin et al. [12] analyzed chronic LBP patients who had undergone discoblock after discography, and also reported a positive correlation between discoblock result and adjacent MC1, although it was not statistically significant. Notably, both studies were conducted without using a standalone discoblock and complete classification of MC subtypes in the correlation analysis. Another aspect that previous correlation assessments have not considered is the degree of pain relief (ΔNRS) following discoblock.

As the knowledge of the association between discoblock result and MC is highly limited, the present study evaluated whether certain adjacent MC are associated with a greater degree of pain relief following discoblock.

2. Methods

2.1. Hypothesis

We hypothesized that the presence of adjacent MC associates with greater pain relief following discoblock. Hypothetically, the effect is strongest in IVDs with adjacent MC1 as they are considered the most active MC [13].

2.2. Participants

We retrospectively analyzed all chronic LBP patients who underwent discoblock due to chronic LBP at a tertiary level hospital between 2011 and 2018. The patients were selected to undergo discoblock due to the suspicion that their discogenic pain originated from a specific IVD. The attending spine orthopedist made the decision patient-wise to suspect a specific IVD as the source of pain based on clinical examination and MRI. Clinical suspicion of discogenic pain arose if the pain was non-radiating, located at the midline, and followed a load-dependent pain pattern; if the nerve root, facet joint, and sacroiliac joint provocation tests did not suggest an alternative pain source; if MRI showed degenerative changes at a single level (e.g., narrowing of the IVD space, IVD bulging, or T2-weighted [T2w] signal loss), indicating the level of interest; and if there were no hints of traumatic, malignant, or inflammatory etiology.

Patients were selected for the present study if their LBP was prolonged for over six months responding suboptimally to conservative treatment including physiotherapy and pain medication; if their LBP was, in the opinion of the attending spine orthopedist, disabling enough to warrant an invasive evaluation as a candidate for surgery at a tertiary level hospital; if their MRI had been performed within one year before discoblock; if they underwent discoblock at a single level; and if adequate clinical parameters regarding discoblock were retrospectively available. Patients were excluded from the present study if their chronic LBP had any other suspected cause (e.g., an alternative IVD more likely causing the pain, facet joint pathology, fracture, malignancy, infection, rheumatic spine disease, or distinct anatomical variance); if their IVD of interest had undergone previous fusion or total disc replacement (TDR) surgery; or if they were under 18 years of age. Of the 78 patients who underwent discoblock during the timeframe, 45 (57.7 %) were selected for the present study.

The regional ethics committee of the hospital approved the study protocol. As this was a retrospective database study, it required no additional patients' informed consent. The study was conducted in accordance with the Declaration of Helsinki.

2.3. Magnetic resonance imaging

MRIs were performed using 1.5 T or 3 T units at secondary or tertiary level hospitals or at private hospitals. We analyzed sagittal T1-weighted (T1w) fast-spin echo (FSE) or fluid-attenuated inversion recovery (FLAIR); sagittal T2w FSE; and axial T2w FSE sequences in all the MRIs. When available, sagittal short tau inversion recovery (STIR) sequences were also analyzed. Owing to the use of multiple imaging units, the imaging parameters varied slightly. However, the parameters were typical of those used for spinal imaging.

2.4. Image analysis

If the MRI was performed outside the participating hospital, the images were entered into the hospital's radiology information system database for image analysis. The images were analyzed by experienced musculoskeletal radiologists (JJ and JN) who were blinded to the patients' clinical parameters. Each radiologist analyzed one half of the study sample. The analyses were conducted using clinical workstations (Neaview Radiology, v. 2.23, Neagen Corp., Helsinki, Finland) at the tertiary level hospital. Images were screened for the presence and type of MC on the intervertebral segment that had undergone discoblock. MC were categorized into MC1, MC2, and MC3 on the basis of the MRI signal intensities according to the common classification described elsewhere [7]. Endplates with mixed MC were categorized as MC1-, MC2-, or MC3-dominant by determining the most extensive subtype, which was done by comparing the proportions of the T1w and T2w signal intensities on the sagittal plane sequences in a manner described elsewhere [14]. MC volumes or other MRI findings were not reported as they were not included in the hypothesis. For the interobserver reliability assessment, 15 patients' MRIs were analyzed by both radiologists (JJ and JN), who were each blinded to the other's findings.

2.5. Discoblock procedure

All the patients underwent discoblock of the suspected pain-generating IVD. Interventions were performed in a sterile setting by an experienced interventional musculoskeletal radiologist under imaging guidance using a combined C-arm fluoroscopy and cone-beam computed tomography (CBCT) machine (Philips Allura FD 20C, Amsterdam, the Netherlands). Patients were placed in a prone position, and a local anesthetic (5 ml 10 mg/ml lidocaine) was administered into the superficial soft tissues. Discoblock was performed using a single 21-gauge Chiba needle via posterolateral approach. Correct anatomical needle placement in the inner third of the IVD was confirmed by fluoroscopy without contrast medium from two perpendicular directions, or by CBCT in any questionable situations. A normal hand-operated luer lock injection syringe and a target volume of 2 ml of lidocaine 20 mg/ml was used to perform a discoblock.

The pre-procedural Numerical Rating Scale (NRS) pain score was recorded immediately before the intervention at rest, and the post-procedural NRS pain score was recorded 45 min after the injection. We used the standard form of the NRS pain score, which ranges from zero to ten, a lower score indicating less pain [15]. Pre-procedural and post-procedural NRS pain scores were retrospectively extracted from the hospital's radiology information system database. The change in the NRS pain score (ΔNRS, post-procedural NRS pain score - pre-procedural NRS pain score) was calculated for each patient. Additionally, to compare our results with those of other studies, we calculated positive discoblock rates using a cut-off value of an NRS decrease of ≥ 3 or ≥ 80 % for a positive result. We also included patients whose discoblock results were recorded non-numerically if they did not experience any LBP relief. Procedural complications were retrospectively recorded.

2.6. Statistical analysis

First, we compared the patients with and without MC (latter, MC0 group). As the proportions of pure MC1 and MC2 lesions were low and no dominant MC3 lesions were present at the levels of interest, we further divided the patients presenting MC into two classes: patients

with pure MC1 and MC1-dominant lesions constituted the MC1 group and patients with pure MC2 and MC2-dominant lesions constituted the MC2 group.

Categorical variables were described as frequencies with percentages, and continuous variables as medians with the 1st (Q1) and 3rd (Q3) quartiles or means with standard deviations (SD). Mann–Whitney U test was used to evaluate ΔNRS between the groups with and without MC. Kruskal–Wallis and Mann–Whitney U tests were used to analyze ΔNRS between the MC1, MC2, and MC0 groups all together and pairwise, respectively. We used the Benjamini–Hochberg method with a false discovery rate of 5 % in pairwise comparisons [16]. To assess interobserver reliability, Cohen's kappa (κ) was calculated for the detection of the presence and type of MC. Statistical significance was set at $P < 0.05$. Analyses were conducted using IBM SPSS (v. 26, IBM Corp. Armonk, NY, USA).

3. Results

3.1. General characteristics

Forty-five patients participated in the present study, all of whom underwent discoblock at a single level. Fig. 1 presents a flow chart of the study including the exclusion rates and reasons, and Table 1 summarizes the patients' demographic characteristics.

3.2. Imaging results

All the patients' MRI protocols included a sagittal T1w FSE or FLAIR sequence (29 [64.4 %] and 16 [35.6 %] patients, respectively), a sagittal T2w FSE sequence, and an axial FSE sequence, whereas 37 of the 45 (82.2 %) patients had a sagittal STIR sequence available for analysis. The mean interval between MRI and discoblock was 5.0 months for all the patients combined. Table 1 presents the corresponding intervals by subgroup.

Of the 45 IVDs that underwent discoblock, 35 (77.8 %) contained adjacent MC. Of all the IVDs, 2 (4.4 %) were associated with MC1, 14 (31.1 %) with an MC1-dominant lesion, 3 (6.7 %) with MC2, 16 (35.6 %) with an MC2-dominant lesion, and 10 (22.2 %) with no MC lesions. Hence, the MC0 group consisted of 10 (22.2 %) patients, the MC1 group of 16 (35.6 %) patients, and the MC2 group of 19 (42.2 %) patients. Table 2 presents MC locations by subgroup.

The interobserver reliabilities for the detection of the presence and type of MC ($\kappa = 0.727$ and $\kappa = 0.610$, respectively) were substantial.

3.3. Discoblock results

Complete NRS pain score records were available for 41 (91.1 %) patients, and the remaining four (8.9 %) had a non-numerical result recorded and therefore included only ΔNRS. Thirty-six (80.0 %) patients experienced pain relief following discoblock but seven (15.6 %) patients

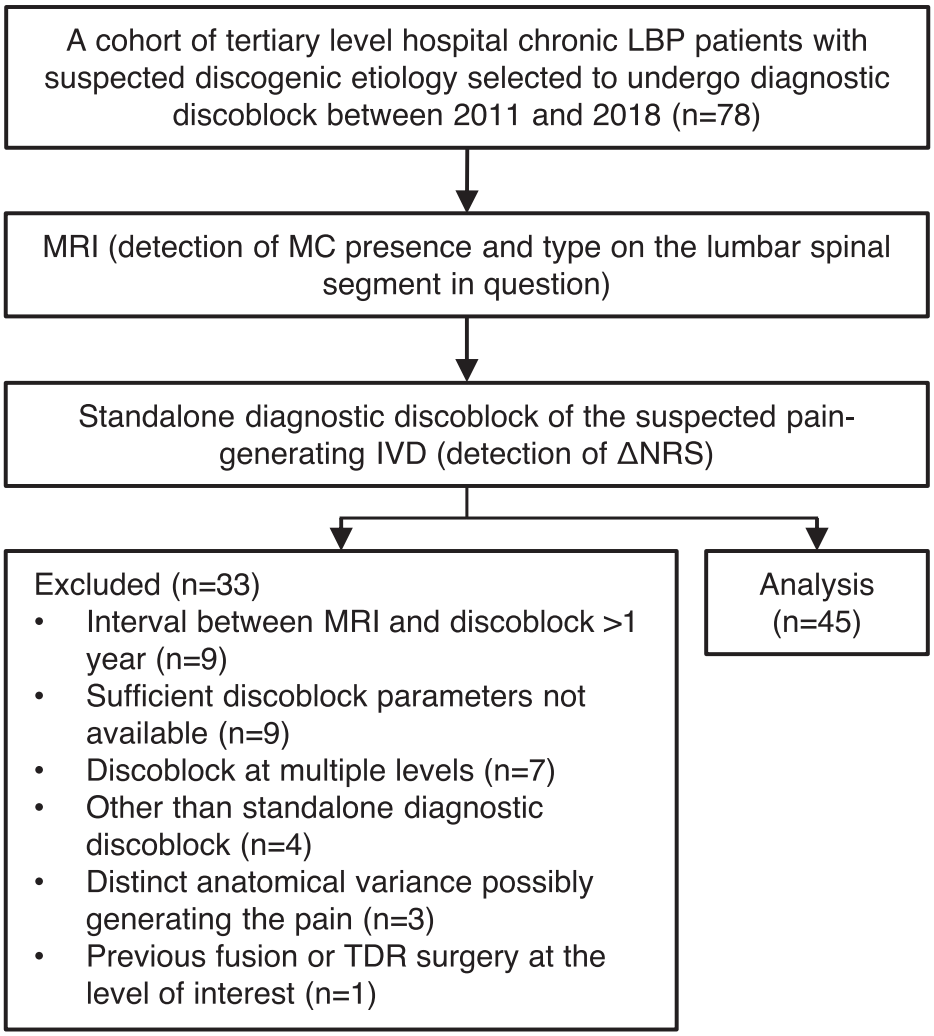

Fig. 1. A flow chart of the study including the exclusion rates and reasons. *LBP* low back pain, *MRI* magnetic resonance imaging, Modic changes, *IVD* intervertebral disc, *ΔNRS* the degree of pain relief following discoblock, *TDR* total disc replacement.

Table 1
Demographic characteristics and intervals between imaging and discoblock.

	Total	Any MC	No MC	MC1 or MC1-dominant	MC2 or MC2-dominant
No. of patients (%)[a]	45 (100.0 %)	35 (77.8 %)	10 (22.2 %)	16 (35.6 %)	19 (42.2 %)
No. of male sex (%)	23 (51.1 %)[a]	17 (48.6 %)[b]	6 (13.3 %)[a]	8 (50.0 %)[c]	9 (47.4 %)[c]
Age range (mean ± SD), yr	31.2–72.6 (46.7 ± 9.9)	31.2–72.6 (47.7 ± 10.3)	31.2–56.8 (43.5 ± 8.1)	34.3–72.6 (46.8 ± 11.0)	31.2–64.7 (48.4 ± 9.9)
Interval between MRI and discoblock (mean ± SD), mo	5.0 ± 3.5	4.9 ± 3.4	5.4 ± 4.0	5.5 ± 4.2	4.3 ± 2.7
No. of non-mixed lesions (%)[b]	–	5 (14.3 %)	–	2 (5.7 %)	3 (8.6 %)

MC Modic changes, *MC1* Modic changes type 1, *MC2* Modic changes type 2, *SD* standard deviation, *yr* years, *MRI* magnetic resonance imaging, *mo* months.
[a] of all the patients.
[b] of the group with present MC.
[c] of the subgroup in question.

Table 2
Discoblock parameters.

	Total	Any MC	No MC	MC1 or MC1-dominant	MC2 or MC2-dominant
Intervention level[a]					
L2-L3 (%)	1 (2.2 %)[b]	1 (2.9 %)[c]	0 (0 %)[b]	1 (6.3 %)[d]	0 (0 %)[d]
L3-L4 (%)	3 (6.7 %)[b]	3 (8.6 %)[c]	0 (0 %)[b]	1 (6.3 %)[d]	2 (10.5%)[d]
L4-L5 (%)	18 (40.0 %)[b]	11 (31.4 %)[c]	7 (15.6 %)[b]	4 (25.0 %)[d]	7 (36.8 %)[d]
L5-S1 (%)	23 (51.1 %)[b]	20 (57.1 %)[c]	3 (6.7 %)[b]	10 (62.5 %)[d]	10 (52.6 %)[d]
Pre-procedural NRS median (Q1; Q3)	7.0 (6.0; 8.0)	7.0 (6.0; 8.0)	7.5 (5.4; 9.8)	7.0 (5.3; 7.0)	7.0 (6.0; 8.0)
Post-procedural NRS median (Q1; Q3)	2.0 (1.0; 3.5)	1.5 (0.5; 3.0)	4.0 (2.1; 6.8)	1.8 (0.0; 2.0)	1.0 (1.0; 4.5)
ΔNRS median (Q1; Q3)	−4.0 (−5.5; −2.0)	−5.0 (−6.0; −3.0)	−2.5 (−4.0; 0.0)	−5.0 (−5.9; −3.3)	−4.0 (−6.0; 0.0)

MC Modic changes, *MC1* Modic changes type 1, *MC2* Modic changes type 2, *NRS* Numerical Rating Scale, *Q1* 1st quartile, *Q3* 3rd quartile, *ΔNRS* the degree of pain relief following discoblock.
[a] i.e. MC location.
[b] of all the patients.
[c] of the group with present MC.
[d] of the subgroup in question.

did not experience any pain relief and two (4.4 %) patients' LBP worsened. Discoblocks were positive in 32 (71.1 %) and 14 (31.1 %) IVDs when judged in a binary manner using NRS decrease cut-off values of ≥ 3 or ≥ 80 %, respectively. Table 3 presents positive discoblock rates of other similar studies. No complications were noted.

The median pre-procedural and post-procedural NRS pain scores were 7.0 (Q1 6.0; Q3 8.0) and 2.0 (Q1 1.0; Q3 3.5), respectively, for all the patients combined. The median ΔNRS was −4.0 (Q1 −5.5; Q3 −2.0) for all the patients combined. Table 2 shows the discoblock parameters by subgroup.

3.4. Correlation analysis

ΔNRS was significantly greater in the group with MC compared to the MC0 group (median ΔNRS −5.0 vs −2.5, respectively, P = 0.043). We found no significant differences in ΔNRS between the MC1, MC2, and MC0 groups when analyzed all together (P = 0.079). However, pairwise comparisons revealed a significant difference in ΔNRS between the MC1 and MC0 groups (median ΔNRS −5.0 vs −2.5, respectively, P = 0.012). Fig. 2 illustrates the differences between the ΔNRS values of the subgroups.

4. Discussion

To the best of our knowledge, no study has previously compared the degree of pain relief following discoblock with the presence of adjacent MC. We observed significantly higher ΔNRS values in the group with any adjacent MC than in the MC0 group (median ΔNRS −5.0 vs −2.5, respectively). Furthermore, pairwise comparisons revealed a significant difference in ΔNRS between the MC1 and MC0 groups (median ΔNRS −5.0 vs −2.5, respectively). Thus, we propose that MC1 are associated with lumbar spinal pain, and that the pain arises at least partly from the adjacent IVD or endplate. Our findings are consistent with those of previous studies that assessed the correlation between discoblock result and MC. Putzier et al. [11] reported that a positive discoblock result of a combined discography-discoblock procedure correlated with the presence of adjacent MC1 or MC2. Although not statistically significant, Alamin et al. [12] also showed that discoblock result positively correlated with the presence of MC1.

In a large study of 2457 IVDs in a very similar setting, Thompson et al. [21] reported that MC1 strongly predicted concordant pain reproduction in discography, which is one of the diagnostic criteria for discogenic LBP [22]. Notably, we found a matching relationship for discoblock. The tendency of MC1-containing lumbar spinal segments to react more often concordantly in discography and more strongly in discoblock might be explained by immunohistochemical findings. It is known that endplates adjacent to MC1 express higher rates of proinflammatory cytokine TNF and contain greater nerve density than endplates without adjacent pathology [23,24], hypothetically sensitizing the endplates for irritation and anesthetization.

Alternatively, a connection between MC and IVD pathology has been demonstrated in various aspects, and histological studies suggest increased innervation in degenerated IVDs [13,25]. Thus, in our study, it remains debatable whether the enhanced pain relief following discoblock in the groups with present MC and MC1 was mainly caused by anesthetization of the IVD, the endplates, or both. Furthermore, a morphological study showed increased endplate porosity with pronounced IVD degeneration [26], which may allow the anesthetic to diffuse somewhat into the MC-containing vertebral body.

Several studies have suggested that MC1 have the strongest correlation with LBP of all the MC subtypes [27–30]. Moreover, LBP associated with MC has been proposed to differ clinically from LBP without MC, as the presence of MC correlated with more frequent and disabling LBP in patients with IVD degeneration [6]. Although degenerative, biomechanical, infectious, and autoimmune etiologies have been suggested, the exact pathophysiology of MC remains unknown. Consequently, there is no consensus on the treatment of such bone marrow changes [13,31]. As IVDs with adjacent MC seem to react more

Table 3
A non-systematic review of previous studies that utilized lumbar discoblock as a diagnostic tool.

Authors (publication year)	Purpose	Sample size (n), study population	Mean age in years (males-%)	Discoblock method	Positive discoblock prevalence[a/b]	Positive discoblock cut-off value	Conclusion	Association between discoblock result and MC
Ohtori et al. (2009) [17]	To compare ALIF surgery results between the groups of positive preoperative discography and discoblock	42 patients (15 patients in standalone discoblock group), clinical study population of chronic LBP patients	36 (66.7 %)	Standalone discoblock	Not specified	Any pain relief	Superior ALIF outcomes in the group with discoblock-confirmed LBP compared to the discography group	Not compared
Alamin et al. (2011) [12]	To assess the concordance between discography and discoblock results	52 patients, clinical study population of chronic LBP patients with suspected discogenic etiology	45 (46.2 %)	Standalone discoblock after a positive discography or extensive MC type 1	57.4 %[b]	≥2/10 NRS decrease during a provocative position or activity 5–20 min after the injection	46 % disagreement rate between discography and discoblock results patient-wise	MC type 1 were non-significantly more common in positive discoblock segments (OR 6.0 [95 % CI 0.7–51.6])
Derby et al. (2012) [18]	To compare the positive result rates of standalone discography, combined discography-discoblock, discoblock after discography and standalone discoblock procedures	223 patients (28 patients in standalone discoblock group)[c], clinical study population of chronic LBP patients	40.6 (57.1 %)	Standalone discoblock 45 min after discography via discography catheter	80.0 %[a] (≥50 % pain relief)/ 25.7 %[a] (≥80 % pain relief)	≥50 % and ≥ 80 % subjective pain relief compared to preoperative NRS score	No significant differences in the positive result rates between standalone discoblock and discoblock after discography procedures with ≥ 80 % cut-off value for discoblock	Not compared
Putzier et al. (2013) [11]	To compare discography and discoblock results to each other and to clinical and MRI parameters	26 patients (31 IVDs), clinical study population of chronic LBP patients with IVD degeneration	42.2 (53.8 %)	Combined discography-discoblock (a mixture of local anesthetic and contrast medium)	64.5 %[a]	≥3/10 NRS decrease 60 min after the injection	Discoblock is a feasible additional surgery decision-making tool, as its result correlates with discography results and with the presence of MC type 1 or 2	Discoblock result positively correlated with the presence of MC (type 1 or 2)
Liu et al. (2020) [19]	To assess the effectiveness of OLIF on suspected discogenic LBP confirmed by discography and discoblock	108 patients (28 patients left at one year follow-up), clinical study population of chronic LBP patients with suspected discogenic etiology	50.8 (42.6 %)	Discoblock after positive discography	Not specified	Reoccurring LBP after discoblock	Reoccurring LBP after discoblock in the setting of a previous positive discography is a viable selection criterion for OLIF	Not compared
Korhonen et al. (2022) [20]	To evaluate how well the degree of pain relief following discoblock predicts short-term surgical disability outcome of fusion and TDR surgeries	15 patients, clinical study population of chronic LBP patients with suspected discogenic etiology	44.9 (53.3 %)	Standalone discoblock	Not specified	Not specified, discoblock was utilized non-binarily	Discoblock has predictive value on disability outcome of lumbar fusion surgery with > 4/10 NRS decrease cut-off value for a positive discoblock result	Not compared

MC Modic changes, *ALIF* anterior lumbar interbody fusion, *LBP* low back pain, *NRS* Numerical Rating Scale, *OR* odds ratio, *CI* confidence interval, *MRI magnetic resonance imaging, IVD* intervertebral disc, *OLIF* oblique lumbar interbody fusion, *TDR* total disc replacement.

[a] per IVD.

[b] per patient.

[c] An another group of standalone discoblock patients was also analyzed with a requirement of pain reproduction to an intensity of ≥ 6/10 to assess the anesthetization effect. With ≥ 50 % and ≥ 80 % pain reliefs as positive result cut-off values positive prevalence rates were 40.0 % and 20.0 %, respectively, per patient.

favorably to temporary anesthetization, long-term elimination of MC-associated IVD by fusion or TDR surgery could be proposed as a valid treatment for chronic discogenic LBP. A few studies have assessed the effect of preoperative MC on the outcome of fusion and TDR surgeries, the results of which are summarized in a review by Laustsen et al. [32]. Although some studies have reported superior operative outcomes when preoperative MC are present, firm conclusions cannot be drawn on the subject due to the lack of large sample sizes with less risk of selection bias. Alternatively, conflicting results have been reported regarding MC1-related LBP's response to conservative treatment [33–35].

We found a total MC prevalence of 77.8 %, which is in accordance with a Spanish study that reported 80.9 % total MC prevalence among chronic LBP patients [36]. Conversely, a literature review concluded a median prevalence of 43 % in clinical populations of non-specific LBP

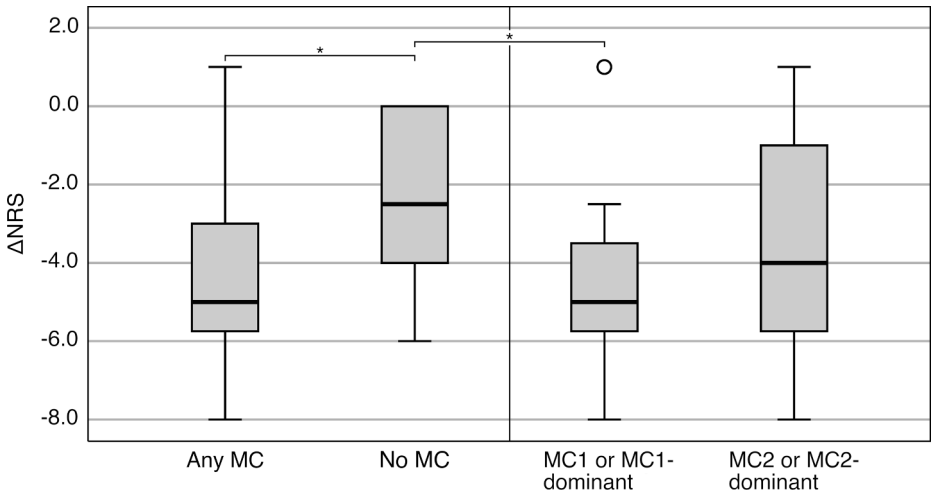

Fig. 2. Boxplot illustrating the differences between the ΔNRS values of the subgroups *ΔNRS* the degree of pain relief following discoblock, *MC* Modic changes, *MC1* Modic changes type 1, *MC2* Modic changes type 2. *P < 0.05.

patients [5]. Our higher MC prevalence rate might be explained by the findings of previous studies that the presence of MC correlated with IVD degeneration and its severity [6,37]: We only examined IVDs that were suspected to be the source of LBP based on clinical examination and MRI. Moreover, the study population consisted of tertiary level hospital patients whose LBP and IVD degeneration might have been more severe.

The higher MC prevalence rate might also be explained by the fact that we focused solely on suspected pain-generating IVDs and left healthy-appearing IVDs with supposedly fewer MC intact. Our practice is in contrast to most previously established discogenic LBP diagnostic guidelines, as control injections to neighboring IVDs were usually recommended in discography, although they do not necessarily improve diagnostic accuracy [22,38]. Discography has been reported to accelerate long-term degenerative changes, including MC, in painless lumbar segments [38]. Subsequently, these changes were correlated with poorer clinical outcomes in terms of more pronounced LBP and an increased need for lumbar imaging and surgery compared to the non-injected control group [39]. The etiology of iatrogenic IVD degeneration after discography is likely multifactorial, including annular puncture, IVD pressurization, and contrast medium toxicity, of which the first two directly concern discoblock as well [39]. In addition, a recent in vivo study added to the body of evidence on local anesthetics' IVD cell toxicity [40]. Considering the long-term degenerative changes after discography, we minimized the number of examined IVDs by avoiding control IVD injections.

In the literature, positive discoblock rates have ranged from 25.7 % to 71.4 % per IVD, most rates being reported in the upper part of the range (Table 3). It should be noted that concordant criteria for a positive discoblock result have not been used, as the NRS decrease cut-off value has ranged from > 0 to ≥ 3 and ≥ 80 %. With a cut-off level set at an NRS decrease of ≥ 3, our positive result rate of 71.1 % per IVD is comparable to that of previous studies. Intriguingly, the positive result prevalence of discography has also been approximately 60–70 % in several previous studies of chronic LBP patient samples [41–43], although lower rates have also been reported [21,44]. Furthermore, we found a positive discoblock rate of 31.1 % using ≥ 80 % NRS decrease cut-off value. The same cut-off value for a positive discoblock was used in Derby et al.'s study [18], in which the authors found no significant differences in positive result rates per IVD between standalone discography and discoblock procedures. The prevalence rates were 33.7 % and 25.7 %, respectively, with which our positive rate of 31.1 % is concordant. Interestingly, the estimated prevalence of IVD-generated pain in chronic non-radicular LBP patients has also been approximately 30 % [45,46].

The need for further validation studies on discoblock is underlined by previous findings of varying discordance rates between discography and discoblock results. In the setting of discoblock after a positive discography, Alamin et al. [12] reported that approximately 50 % of the discoblocks were positive, and Derby et al. [18] showed 45.7% and 29.8% of discoblocks (with ≥ 50 % and ≥ 80 % subjective pain relief cut-off values, respectively) to confirm a positive discography result. In contrast, DePalma et al. [47] concluded an 80 % confirmatory rate for discoblock in a similar study setting. No study has assessed the concordance of the tests using discoblock as the primary procedure.

The present study has some limitations. The study design was retrospective, the sample size was somewhat limited decreasing the statistical power, and there was no control group. Although we used common spinal imaging protocols and no low-field MRI equipment, the usage of several MRI units may have caused variation in the patients' MC diagnostics. Further, selection bias may have occurred, as the patients undergoing discoblock might have expressed a higher number of certain MC adjacent to the suspected pain-generating IVD or more complicated LBP with possible discrepancies in their diagnostics. Overall, proving an IVD as the source of pain and further determining the level of the painful IVD may be challenging. Therefore, the examined lumbar segment may not have been the pain generator in some cases. We did not analyze the effect of the pre-procedural NRS pain score on the results, as this might have limited the magnitude of ΔNRS in some patients. The proportions of pure MC were low, and due to the small group sizes, we had to combine groups of pure and mixed MC.

In conclusion, we found significantly higher ΔNRS values in the group with adjacent MC than in the group without MC. Furthermore, pairwise comparisons revealed a significant difference in ΔNRS between the MC1 and MC0 groups. Thus, we propose that MC1 are associated with lumbar spinal pain, and that the pain arises at least partly from the adjacent IVD or endplate.

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The datasets analyzed during the current study are available from the corresponding author on reasonable request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability:

The datasets analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Patient Consents: The study protocol was approved by the Oulu University Hospital Ethics Committee (REC# 174/2019). We conducted a retrospective database study and therefore additional patients' informed consents were not required. The study was conducted in accordance with the Declaration of Helsinki.

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