

## Review article

# The course of *Modic* vertebral body changes after posterolateral lumbar fusion on fused and adjacent levels: A systematic review of the literature



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## ABSTRACT

According to the original description by Modic et al., the natural course of bone marrow signal abnormalities is an inexorable, progressive one, however recent evidence has demonstrated in healthy individuals and those suffering from lumbar disc herniation that the course of endplate degenerative changes is rather dynamic and sometimes regressive. The evolution of such changes in lumbar fused segments and adjacent levels is largely unknown. The literature relevant to the course of *Modic* changes on fused and adjacent levels, as well as its clinical correspondence in patients undergoing posterolateral lumbar fusion was collected. Two studies met the criteria. Of 38 patients with *Modic* type I signals preoperatively, 6 regressed to type 0, 22 progressed to type 2, and 10 remained the same postoperatively. Of 12 patients with *Modic* type 2 signals preoperatively, 2 regressed to type 0 and 10 remained the same postoperatively. None of the articles described the *Modic* changes in adjacent levels. Clinical and functional outcomes were significantly improved at follow-up regardless of the endplate signal changes. The best available evidence points out to a reduction in *Modic* type I frequency on fused segments, either regressive or progressive. There was a predominance of new type II changes in postoperative images, which might represent improvement of instability. This study calls into attention the controversial role of *Modic* changes as an indicator of clinical significance, since clinical and functional outcomes significantly improved regardless of the endplate signal changes.

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## 1. Introduction

The evolution of the degenerative changes of the spine, and in this case, the lumbosacral segment, is regarded as multifactorial. Disc degeneration begins early in life and the rate of progression depends on several factors such as familiar predisposition, ageing, mechanical stress, nutritional factors, and physical loading [1,2]. It is worth noting that the clinical presentation does not always correspond to the degree of spinal degeneration found in each patient [3], in such a way that mildly symptomatic patients may present significant degenerative changes, while highly symptomatic ones may demonstrate few spondylotic changes in imaging [4,5].

Degenerative disc disease (DDD) is one of the most common causes of chronic back pain, which negatively affects patients quality of life because of the disability and functional limitations. In

1988, Modic et al., [6] studied 474 patients with chronic low back pain and classified the degenerative changes of the vertebral endplates into two main types according to the findings observed in the magnetic resonance imaging (MRI). Type I is characterized by hypointense or iso-signal on T1-weighted sequences and hyperintense signal on T2-weighted sequences. It is attributed to bone marrow edema and hypervascularity. Type II demonstrates hyperintense signal on T1 and T2-weighted sequences, which is believed to represent bone marrow replacement by fatty tissue. Later, type III lesions were described (hypointense on T1 and T2-weighted images), suggesting an advanced process of reactive subchondral bone sclerosis [7].

According to the original description by Modic et al. [6], the natural course of bone marrow signal abnormalities is an inexorable, progressive one, in such a way that five of the six Type I lesions were substituted by Type 2 signals over 14–36 months. Conversely, all Type 2 lesions remained stable for a long time (over 2–3 years of follow-up). However, recent evidence has demonstrated in healthy individuals and those suffering from lumbar disc herniation that

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the course of endplate degenerative changes is rather dynamic and sometimes regressive [3–5,8,9], which might represent the current state of bone marrow pathological changes. The evolution of such changes in lumbar fused segments and adjacent levels is largely unknown. Thus, the aim of this study was to perform a systematic review of the literature, aiming at a better understanding of the course of Modic changes on fused and adjacent levels, as well as its clinical correspondence in patients undergoing posterolateral lumbar fusion.

## 2. Methods

### 2.1. Search strategy

The articles were searched in the electronic database of the Virtual Health Library (VHL), using references of the US National Library of Medicine and The National Institutes of Health (PubMed) and Latin American and Caribbean Database in Health Sciences (LILACS). In addition, reviews and reference lists of selected articles were evaluated in order to identify relevant studies. The selection of studies was restricted to research in humans published until April, 2015.

The descriptors used were in accordance with Descriptors in Health Sciences (DeCS) and the Medical Subject Headings (MeSH), namely “Modic changes” OR “MRI” OR “endplate” OR “lumbar fusion” AND “adjacent level”.

We found 387 articles in the VHL database, of which 244 were excluded by title, 115 were excluded by abstracts and 28 had full text reviewed (Fig. 1).

### 2.2. Inclusion and exclusion criteria

Articles related to degenerative disease of the lumbar spine and published in Portuguese, English or Spanish, in which patients underwent posterolateral lumbar fusion or 360° fusion by a posterior approach were included. Data collected from the articles included the number of patients, the study design (prospective or

retrospective), pre- and postoperative Modic changes on fused and/or adjacent levels and, also, follow-up clinical information.

Articles related to *in vitro* or animals studies, those including spinal diseases other than DDD, comparative studies on surgical techniques, and those presenting surgical results by an anterior approach were excluded by title.

### 2.3. Selection and quality assessment

Based on the titles found in the databases and the abstracts, the selection of articles was performed by one evaluator (STP), observing the inclusion and exclusion criteria. The evaluation of the quality of the articles was based on the criteria adapted from Downs & Black Scale [10]. Of the twenty-seven questions originally described, thirteen were considered in this study (Table 1). The articles selected for evaluation as quality, are related to the fusion of the vertebral segment and postoperative follow-up with clinical and imaging data. Of 28 articles analyzed were considered only positive responses.

## 3. Results

Of the 28 articles reviewed, only two described the course of Modic changes postoperatively and reported some association with the clinical panorama. A total of 50 patients were included in this review. The interpretation of our results is limited by the unquantified level of bias, and makes our systematic review a synthesis of Level 3 evidence only.

### 3.1. Study characteristics

Both studies, all prospective, reported the course of bone marrow changes after posterolateral lumbar fusion with pedicle screws, rods and bone grafting. No intervertebral body fusion was added.

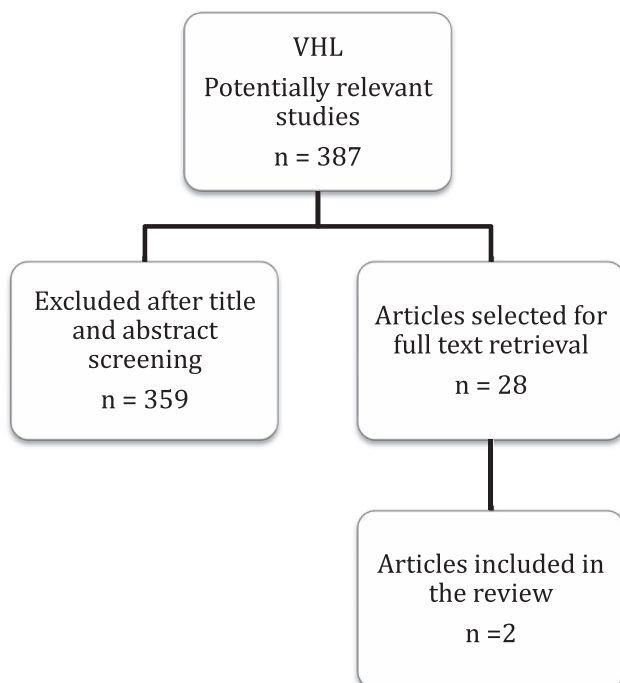


Fig. 1. Flowchart of the systematic review. \*VHL – Virtual Health Library database.

Table 1  
Quality assessment of published studies.

Questions	Positive answers (%)
1 Is the hypothesis/aim/objective of the study clearly described?	27 (96.4%)
2 Are the main outcomes to be measured clearly described in the Introduction or Methods section?	25 (89.3%)
3 Are the characteristics of the patients included in the study clearly described?	14 (50%)
4 Are the main findings of the study clearly described?	22 (78.6%)
5 Have the characteristics of patients lost to follow-up been described?	15 (53.6%)
6 Have actual probability values been reported ( $p < 0.05$ ) for the main outcomes except where the probability value is less than 0.001?	19 (67.8%)
7 Were the subjects asked to participate in the study representative of the entire population from which they were recruited?	27 (96.4%)
8 Were those subjects who were prepared to participate representative of the entire population from which they were recruited?	20 (71.4%)
9 Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?	28 (100%)
10 Were the statistical tests used to assess the main outcomes appropriate?	23 (82.1%)
11 Was compliance with the intervention/s reliable?	28 (100%)
12 Were the main outcome measures used accurate (valid and reliable)?	25 (89.3%)
13 Were losses of patients to follow-up taken into account?	11 (39.3%)

Adapted from Downs & Black Check-list [10].

Total of articles selected for full text retrieval: 28.

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