Chronic low back pain: Relevance of a new classification based on the injury pattern

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Review article

Chronic Low Back Pain: Relevance of a New Classification Based on the Injury Pattern

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ABSTRACT

Background: The objectives of this study were to define the role for surgery in the treatment of chronic low back pain (cLBP) and to develop a new classification of cLBP based on the pattern of injury.

Hypothesis: Surgery may benefit patients with cLBP, and a new classification based on the injury pattern may be of interest.

Method: A systematic literature review was performed by searching Medline, the Cochrane Library, the French public health database (*Banque de Données en Santé Publique*), Science Direct, and the National Guideline Clearinghouse. The main search terms were 'back pain' OR 'lumbar' OR 'intervertebral disc replacement' OR 'vertebrae' OR 'spinal' AND 'surgery' OR 'surgical' OR 'fusion' OR 'laminectomy' OR 'discectomy'.

Results: Surgical techniques available for treating cLBP consist of fusion, disc replacement, dynamic stabilisation, and inter-spinous posterior devices. Compared to non-operative management including intensive rehabilitation therapy and cognitive behavioural therapy, fusion is not better in terms of either function (evaluated using the Oswestry Disability Index [ODI]) or pain (level 2). Fusion is better than non-operative management without intensive rehabilitation therapy (level 2). There is no evidence to date that one fusion technique is superior over the others regarding the clinical outcomes (assessed using the ODI). Compared to fusion or multidisciplinary rehabilitation therapy, disc replacement can produce better function and less pain, although the differences are not clinically significant (level 2). The available evidence does not support the use of dynamic stabilisation or interspinous posterior devices to treat cLBP due to degenerative disease (professional consensus within the French Society for Spinal Surgery). The following recommendations can be made: non-operative treatment must be provided for at least 1 year before considering surgery in patients with

cLBP due to degenerative disease; patients must be fully informed about alternative treatment options and the risks associated with surgery; standing radiographs must be obtained to assess sagittal spinal alignment and a magnetic resonance imaging scan to determine the mechanism of injury; and, if fusion is performed, the lumbar lordotic curvature must be restored.

Discussion: This work establishes the need for a new classification of cLBP based on the presumptive mechanism responsible for the pain. Three categories should be distinguished: non-degenerative cLBP (previously known as symptomatic cLBP), in which the cause of pain is a trauma, spondylolysis, a tumour, an infection, or an inflammatory process; degenerative cLBP (previously known as non-specific cLBP) characterised by variable combinations of degenerative alterations in one or more discs, facet joints, and/or ligaments, with or without regional and/or global alterations in spinal alignment (which must be assessed using specific parameters); and cLBP of unknown mechanism, in which the pain seems to bear no relation to the anatomical abnormalities (and the Fear-Avoidance Beliefs Questionnaire and Hospital Anxiety and Depression Scale may be helpful in this situation). This classification should prove useful in the future for constituting well-defined patient groups, thereby improving the assessment of treatment options.

Level of evidence: II, systematic review of level II studies

Key words: Low back pain. Spine surgery. Fusion. Disc prosthesis. Lumbar spine. Classification. Degenerative disc disease. Sagittal balance.

Introduction

Chronic low back pain (cLBP) is a well-recognised public health burden whose costs have increased steadily over the past four decades. In France, the agency responsible for defining healthcare targets (*Groupe technique national de définition des objectifs*, GTNDO) reported the following epidemiological data in 2003 [**1**]: with 6 million physician visits (including 90% to general practitioners), cLBP was the third most common reason for physician visits in males and the sixth in females, accounting for 6% of all physician visits; nearly a third of physiotherapist sessions, 2.5% of drug prescriptions, and 5% to 10% of imaging studies were for cLBP; and cLBP was the reason for 13% of work-related injury claims, the leading cause of disability in individuals younger than 45 years, and the leading reason for sick leaves, whose mean duration was 33 days, resulting in 3 600 000 days of work lost per year. Importantly, 70% to 80% of costs related to cLBP were incurred by only 5% to 10% of patients with cLBP. Thus, cLBP is clearly a public health challenge due not only to the financial burden it imposes, but also to its psychological and social consequences.

Here, we conducted a systematic literature review with the objective of defining cLBP; reviewing the available surgical techniques and specifying the efficacy of each in the light of the outcome measures used and of the type of cLBP considered; and developing a new classification of cLBP that is based on the pattern of injury, takes spinal alignment into consideration, and helps to guide treatment decisions. The working hypothesis was that surgery may benefit patients with cLBP, and that a new classification based on the injury pattern may be of interest.

Methods

The recommendations put forward here are based on findings from a systematic literature review performed in 2014-2015 by a task force that was convened by the French national authority for health (*Haute Autorité de Santé*, HAS) to assess the relevance of surgery in cLBP. The following databases were searched: Medline, the Cochrane Library, the French public health database (*Banque de Données en Santé Publique*, BDSP), Science Direct, and the National Guideline Clearinghouse. The search terms were 'back pain' OR 'lumbar' OR 'intervertebral disc replacement' OR 'vertebrae' OR 'spinal' AND 'surgery' OR 'surgical' OR 'fusion' OR 'laminectomy' OR 'discectomy'. The reference lists of publications retrieved by the search were systematically reviewed.

The first selection step based on the title and abstract identified 1533 potentially relevant publications. Recommendations, randomised trials, systematic literature reviews, and meta-analyses of randomised trials were then identified. Studies providing lower levels of evidence were selected only when no better evidence was available. The articles were selected by an independent project manager employed by the French ministry of health. Any disagreements were resolved by consensus among healthcare professionals who had no conflicts of interest relevant to this work. Selected articles were then reviewed in detail by the project manager, who identified those of sufficient methodological quality to be included in the study. The grading system developed by the HAS was applied to determine the level of evidence supplied by each article. When no evidence was available, agreement among experts was used to develop recommendations.

Results

Defining chronic low back pain (cLBP)

In four sets of recommendations, whose methodological grades are shown in **Table 1,** a variety of definitions of cLBP were used. In 2000, the French agency for healthcare evaluations (*Agence NAtionale d'Évaluation en Santé,* ANAES) defined cLBP as inveterate pain in the lumbar region for longer than 3 months. The pain may radiate to the buttock, iliac crest, or even thigh but only very rarely extends beyond the knee (professional consensus) [**2**]. The recommendations about the early management of persistent non-specific low back pain issued by the Royal College of General Practitioners (RCGP) adopted the 1987 definition by Spitzer et Leblanc of acute, sub-acute, and chronic low back pain as having durations of less than 6 weeks, 6 to 12 weeks, and more than 12 weeks, respectively. The RCGP pointed out that this classification was not always appropriate for patients whose symptoms fluctuated over time [**3**]. The American Society of Interventional Pain Physicians (ASIPP) issued comprehensive evidence-based guidelines for interventional techniques in the management of chronic spinal pain, in which chronic is defined as a duration of at least 6 months [**4,5**]. Finally, in the clinical practice guidelines for the management of non-specific low back pain developed by a Mexican group, low back pain is defined as a syndrome encompassing severe types of pain or discomfort that arise between the 12th rib and the buttock (i.e., at the lumbo-sacral junction), may extend to the back or legs, and may occur concomitantly with other clinical manifestations. This syndrome is classified as chronic if it lasts more than 12 weeks or occurs repeatedly over a period longer than 6 months [**6**]. In addition to three of these four clinical practice guidelines [**2,3,6**], three systematic literature reviews also define chronicity of low back pain as a duration of 3 months or longer [**7-9**].

The HAS task force elected to use the definition put forward by the ANAES [**2**], i.e., inveterate pain in the lumbar region for longer than 3 months. Severely incapacitating flares of pain may occur. The pain may radiate to the buttock, iliac crest, or even thigh, but only

very rarely extends below the knee. This clinical definition lacks discrimination and makes no reference to the mechanism responsible for the pain.

In published studies, non-specific cLBP is usually distinguished from symptomatic cLBP due to a trauma, tumour, infection, or inflammatory process. This distinction is not entirely satisfactory, as it implies that non-specific cLBP is not a symptom. Furthermore, the term 'non-specific' has been used to indicate that no anatomical lesions capable of causing the clinical manifestations were identified. However, recent advances in clinical semiology, imaging techniques, and the elucidation of spinal biomechanics have shed new light on this category of cLBP [**10-12**]. Patients classified as having 'non-specific' cLBP are now recognised to constitute an extremely heterogeneous population of patients in whom neither the causal anatomical lesions nor the abnormalities in spinal alignment were taken into account (**Figure 1**). Using a group of patients with widely varying diseases states for purposes of comparison inevitably results in confusion. We therefore suggest that LBP may be best classified into three categories (**Figure 2**): non-degenerative, degenerative, and undetermined. Non-degenerative LBP (formerly known as symptomatic LBP) is due to a trauma, spondylolysis, a tumour, an infection, or an inflammatory process. Degenerative LBP (formerly known as non-specific LBP) is caused by variable combinations of abnormalities in one or more intervertebral discs, facet joints, and/or ligaments, with or without regional and/or global alterations in spinal alignment (as assessed by measuring spinal balance parameters). Regional alterations in spinal alignment are defined as abnormalities in lumbar lordosis distribution that do not adversely affect overall spinal alignment. Finally, undetermined LBP is defined as LBP that does not correlate with any abnormalities detectable using currently available imaging studies.

In the degenerative LBP category, pain due to disc disease may be caused by any of the following lesions: isolated degenerative disc disease (DDD), DDD with Modic type 2 or

3 modifications, inflammatory disc disease with Modic type 1 modifications, or L5-S1 disc disease due to abnormalities of the lumbo-sacral junction (including L5-S1 retrolisthesis).

This new classification should prove useful for future studies of treatment efficacy, as it will allow the constitution of uniform patient groups defined based on objective and well-defined anatomical abnormalities documented by imaging studies.

Available surgical techniques -- efficacy depending on outcome measures and type of chronic low back pain (cLBP)

The main surgical techniques available for treating cLBP are fusion, prostheses, and stabilisation devices [**13-26**]. Fusion techniques include postero-lateral fusion (PLF) with or without instrumentation, posterior lumbar inter-body fusion (PLIF), trans-foraminal inter-body fusion (TLIF), anterior lumbar inter-body fusion (ALIF), and circumferential lumbar fusion via a dual anterior and posterior approach. Prostheses can be used to replace part of the functional spinal unit, i.e., either a disc or a facet joint. Finally, dynamic stabilisation devices can be implanted using either pedicle screws or inter-spinous systems.

Fusion techniques

Of five identified studies comparing fusion to non-operative treatment, two were systematic literature reviews**[27-29] (Table 2**), one was a meta-analysis**[30] (Table 3**), and two were randomised trials **[31,32] (Table 4**). In patients with cLBP and DDD but no nerve root pain, only low-level evidence is available to suggest that fusion may be effective compared to non-operative treatment [**27,28,33**]. In two randomised trials, outcomes were better with fusion than with standard non-operative treatment (i.e., not including intensive rehabilitation therapy) [**34,35**] (level 2 evidence). No differences in outcomes were found between fusion and intensive rehabilitation therapy including cognitive behavioural therapy

in three randomised trials [**27,28**] (level 2 evidence). Importantly, in none of these studies was spinal alignment assessed pre-operatively, despite the key impact of this factor on functional outcomes. In sum, fusion has not unequivocally demonstrated superiority over non-operative treatment including intensive rehabilitation therapy and cognitive behavioural therapy (level 2 evidence).

Fusion can be offered to patients with cLBP who have failed to respond to at least 1 year of non-operative treatment and who have been informed of the other treatment options, notably intensive rehabilitation therapy with cognitive behavioural therapy, whose functional outcomes as assessed by the Oswestry Disability Index (ODI) may be similar to those of fusion (level 2 evidence). Before treatment initiation, long-spine radiographs must be obtained to look for sagittal spinal malalignment **[36].** Magnetic resonance imaging (MRI) is also crucial to identify disc inflammation and changes due to degenerative disease.

Comparisons of fusion techniques

Four studies comparing different fusion techniques were identified including two systematic literature reviews [**37,38**] (**Table 5**), a meta-analysis [**39**] (**Table 6**), and a randomised trial [**40**]. The findings from these studies do not allow definite conclusions about whether any fusion technique is superior over the others in terms of the clinical outcome as assessed by the ODI. However, the patients were selected based on the former clinical definitions of LBP, which do not allow the constitution of patient groups based on objective anatomical criteria. The level of evidence from these studies is consequently very low, and no significant differences were found across fusion techniques. These limitations highlight the usefulness of the new classification suggested here.

Disc replacement

Retrieved publications about disc replacement by a prosthesis included a clinical practice guideline **[27,28]**, two systematic literature reviews **[28,41]** (**Table 7**), two meta-analyses **[42,43]** (**Table 8**), and three randomised controlled trials **[44-46]** (**Table 9**). The study patients, who had pain in the low back and/or leg together with DDD, had failed to respond to 3-6 months of non-operative treatment. According to the two meta-analyses, although disc replacement can provide patients with cLBP with gains in function and pain compared to fusion, these gains are not clinically significant after 2 years (level 2 evidence). However, ongoing longitudinal studies suggest possible differences after 5 and 10 years, notably at L4-L5 [**47**] (level 3 evidence).

Dynamic stabilisation

No randomised trials have compared dynamic stabilisation devices to other surgical techniques (fusion and disc replacement) and/or to non-operative treatments for cLBP. Dynamic stabilisation was assessed in two non-systematic literature reviews [**48,49**], one prospective and retrospective study [**50**], and four retrospective studies [**51-54**]. In addition, a retrospective study [**55**] and a non-systematic literature review [**56**] evaluated the frequency of screw loosening after implantation of a posterior dynamic stabilisation device. Thus, overall, few evaluations of dynamic stabilisation are available, and those identified by the literature search provided only level 4 evidence. Most of these studies were done in heterogeneous populations of patients with cLBP due to a variety of causes including lumbar spinal stenosis, spondylolisthesis, disc herniation, and DDD. Consequently, they do not allow definitive conclusions. No data are available on the long-term outcomes of dynamic stabilisation devices. Similarly, dynamic stabilisation has not been compared to the natural history of cLBP, to other surgical techniques, or to non-operative treatments. Additional studies are needed to determine the potential role for dynamic stabilisation in the treatment

of degenerative cLBP. Given the inadequate evaluation to date of dynamic stabilisation devices, these are not recommended for the management of cLBP (professional consensus).

DISCUSSION

Once non-degenerative causes have been ruled out, analgesic therapy remains the recommended first-line strategy in patients with cLBP. However, the optimal duration of non-operative treatment before surgery is considered has not been determined. The only available guidance comes from recommendations on fusion techniques based on expert opinion. For instance, for patients with cLBP but no nerve root pain, the American Pain Society [**2,3,16,17**] has stated that surgery can be considered a treatment option if degenerative lesions have been documented and the symptoms are both persistent and incapacitating, provided the risks and benefits of the procedure are discussed openly. More specifically, the patient must be informed that multidisciplinary management including intensive rehabilitation therapy provides similar efficacy to surgery, but that surgery may be more effective than a non-operative treatment programme that does not include multidisciplinary management with intensive rehabilitation therapy. However, in their systematic literature review, Philips et al. [**57**] criticised comparisons of fusion versus non-operative treatments as spurious since, in clinical practice, these two treatment methods are generally used one after the other instead of being viewed as mutually exclusive alternatives. Thus, surgery is usually reserved for patients who have failed non-operative therapy. This point limits the value of comparing fusion to non-operative treatments.

Compared to non-operative treatment programmes that include intensive rehabilitation therapy and cognitive behavioural therapy, fusion has not been proven superior in terms of functional outcomes as assessed by the ODI or of pain relief (level 2 evidence). The

outcomes of fusion are better than those of non-operative treatment without intensive rehabilitation therapy (level 2 evidence). Published data have not established whether any fusion technique is superior over the others regarding the clinical outcome assessed by the ODI. Finally, compared to fusion or multidisciplinary rehabilitation therapy, disc replacement provides gains in function and pain that are not of substantial clinical relevance (level 2 evidence).

Our literature review establishes that no specific fusion technique has been proven superior over the others. However, the diagnoses in the included patients covered such a broad range that relevant conclusions are difficult to draw. In randomised trials, detailed evaluations of lumbar disc replacement indicate some efficacy when the disc lesions involve one or two levels. Dynamic stabilisation systems, although widely used, have not been evaluated in any well-designed randomised trial whose results might support their use in patients with cLBP.

Importantly, restoring proper spinal sagittal balance and, more specifically, restoring the lumbar lordotic curvature at the instrumented levels, is directly related to achieving a good clinical outcome [**10,11,36**].

In sum, the task force, after obtaining a consensus via an anonymous vote during the annual meeting of the French Society of Spine Surgery attended by a substantial proportion of members, suggests the following seven recommendations for the management of degenerative cLBP (Figure 2).

(1) Psychological and social factors must be evaluated routinely using tools such as the Hospital Anxiety and Depression Scale and the Fear-Avoidance Beliefs Questionnaire. This evaluation is particularly relevant when the patient's history suggests a high risk of such factors being present. Patients with strong psychological and/or social factors whose

radiographs and MRI scan after 6 months show no other cause of pain should be classified as having indeterminate cLBP.

(2) A non-operative treatment programme must be followed for at least 1 year before considering surgery in patients with degenerative cLBP and no nerve root pain.

(3) After 1 year of rehabilitation therapy, the patient must be re-evaluated to confirm the diagnosis of degenerative cLBP and to consider surgical options.

(4) The patient must be informed of all available treatment options. More specifically, the patient must be informed that multidisciplinary management with intensive rehabilitation therapy and cognitive behavioural therapy is effective.

(5) The patient must be informed of the risks associated with surgical treatment.

(6) Imaging studies must be obtained routinely before surgical treatment is performed. The imaging studies must include weight-bearing long-spine radiographs or EOS imaging to assess sagittal spinal alignment and MRI to classify the patient in the new classification developed by the expert panel and approved by professional consensus during the 2014 annual meeting of the French Society for Orthopaedic and Trauma Surgery (*Société Française de Chirurgie Orthopédique et Traumatologique*, SoFCOT).

(7) When fusion is performed, spinal alignment must be restored, with special attention to lumbar lordosis.

CONCLUSION

In addition to the development by the expert panel of recommendations validated by the French Society for Spinal Surgery, this work establishes the need for a new classification of cLBP based on the presumptive source of pain. This new classification distinguishes the following three categories of cLBP: non-degenerative cLBP (formerly known as

symptomatic cLBP) due to a trauma, a spondylolysis, a tumour, infection, or an inflammatory process; degenerative cLBP (formerly known as non-specific cLBP) due to degenerative alterations of one or more discs, facet joints, and/or ligaments with or without regional and/or global abnormalities of spinal alignment (as assessed by measurements of spinal balance parameters); and indeterminate cLBP with no identifiable anatomical lesions that correlate with the pain. Evaluating psychological and social factors using the HADS and FABQ is useful in all patients with LBP.

Disclosure of interest

None of the authors has any conflicts of interest to declare.

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Table 1. Methodological quality of the recommendations

Authors, Country, Years (reference #)	Title Design	Systematic literature review	Main focus	Levels of evidence	Multidisciplinary panel of experts	Revision External validation
ANAES, France, 2000 [1]	Clinical practice guideline	Yes	Management of cLBP	Yes	Yes	Yes
Guevara-Lopez, Mexico, 2011 [24]	Consensus	Yes	Management of LBP	Yes	Yes	No
RCGP, UK, 2009 [43]	Clinical practice guideline	Yes	Management of persistent non-specific LBP	Yes	Yes	Yes
ASIPP, USA, 2009-2013 [2,3,16,17]	Clinical practice guideline	Yes	Management of chronic spinal pain	Yes	Yes	Yes

cLBP, chronic low back pain; LBP, low back pain

Table 2. Systematic literature reviews comparing fusion to non-operative treatments

Authors Year (reference #)	Systematic review	Criteria for including articles	Criteria for excluding articles	Analysis of the articles explained in detail	Number of articles included Study design (number of patients)	Level of evidence	Conclusions of the authors consistent with previously published data
Phillips *et al.*, 2013 [46]	Yes	Yes	Yes	Yes	2 RCTs (547 patients) 12 RCTs (1420 patients) 5 non-randomised retrospective studies (491 patients)	Yes	Fusion is a treatment option for relieving pain and improving function
Chou *et al.*, 2009 [16,17]	Yes	Yes	Yes	Yes	4 RCTs (767 patients) 2 RCTs (596 patients)	Yes	Fusion is better than standard non-operative treatment (1 RCT). Fusion is not different from intensive rehabilitation therapy (3 RCTs) Fusion is not different from disc replacement (1 RCT)

RCT, randomised controlled trial

Table 3. Meta-analysis comparing fusion and non-operative treatment

Authors Years (reference #)	Population (follow-up)	N articles (N patients)	Surgical outcomes
Ibrahim *et al.*, 2008 [28]	Patients with cLBP managed by fusion (2 years)	3 RCTs (634 patients)	Surgery vs. non-operative: mean ODI difference = 4.13, p=0.10

cLBP, chronic low back pain; RCT, randomised controlled trial; ODI, Oswestry Disability Index

Table 4. Randomised controlled trials comparing fusion and non-operative treatment

Authors Years (reference #)	Study design (follow-up)	N patients	Type of fusion (N patients)	Surgical outcomes
Brox *et al.*, 2010 [11]	RCT (4 years)	124 patients with cLBP and DDD for >1 year with or without disc herniation surgery	PLF + pedicle screw	Surgery vs. non-operative: mean ODI difference =1.1
Froholdt *et al.*, 2012 [21]	RCT (9 years)	99 patients with cLBP and DDD for >1 year	PLF + pedicle screw	Surgery vs. non-operative: mean ODI difference =1.9

RCT, randomised controlled trial; cLBP, chronic low back pain; DDD, degenerative disc disease; PLF, postero-lateral fusion

Table 5. Systematic literature reviews comparing different fusion techniques

Authors Year (reference #)	Systematic review	Criteria for including articles	Criteria for excluding articles	Analysis of the articles explained in detail	Number of articles included Study design (number of patients)	Level of evidence	Conclusions of the authors
Carreon *et al.*, 2008 [14]	Yes	Yes	Yes	Yes	23 RCTs (2007 patients)	Yes	All three types of fusion (anterior, posterior, and combined) produce similar ODI improvements
Lee *et al.*, 2011 [40]	Yes	Yes	Yes	Yes	6 RCTs (526 patients)	Yes	Conflicting findings: no proof that any technique is superior over the others in terms of fusion rates among ALIF, PLF, PLIF, and circumferential fusion

RCT, randomised controlled trial; ODI, Oswestry Disability Index; ALIF, anterior lumbar inter-body fusion; PLF, postero-lateral fusion, PLIF, posterior lumbar inter-body fusion

Table 6. Meta-analysis comparing different fusion techniques

Authors Year (reference #)	Population (follow-up)	N articles (N patients)	Surgical outcomes
Han *et al.*, 2009 [27]	Patients with degenerative disease (2 years)	4 RCTs (437 patients)	Compared to instrumented PLF, circumferential fusion may increase the fusion rate and decrease the surgical revision rate. The two groups were not significantly different regarding the overall assessment of the clinical outcome.

RCT, randomised controlled trial; PLF, postero-lateral fusion

Table 7. Systematic literature review evaluating disc replacement in patients with chronic low back pain

Authors Year (reference #)	Systematic literature review	Criteria for including articles	Criteria for excluding articles	Analysis of the articles explained in detail	Number of articles included Study design (number of patients)	Level of evidence	Conclusions of the authors consistent with previously published data
Chou *et al.*, 2009 [16,17]	Yes	Yes	Yes	Yes	2 RCTs (596 patients)	Yes	No difference vs. fusion
Van den Eerenbeemt *et al.*, 2010 [48]	Yes	Yes	Yes	Yes	4 RCTs	No	Yes

RCT, randomised controlled trial

Table 8. Meta-analysis evaluating disc replacement

Authors Year (reference #)	Population (follow-up)	N articles (N patients)	Surgical outcomes
Yajun *et al.*, 2010 [51]	Patients with DDD managed with disc replacement or fusion (ALIF, PLF, PLIF) (2 years)	5 RCTs (837 patients)	Disc replacement was slightly better in terms of function and pain, but the difference was not clinically significant; patient satisfaction was significantly higher. Significant improvements in the ODI and VAS score occurred in both the disc replacement group and the ALIF group, with no superiority of one group over the other
Jacobs *et al.*, 2012 [29]	DDD managed by disc replacement	7 RCTs (676 patients)	Total disc replacement seemed effective in treating LBP in the selected patients and was at least as good as fusion in the short term.

DDD, degenerative disc disease; ALIF, anterior lumbar inter-body fusion; PLF, postero-lateral fusion, PLIF, posterior lumbar inter-body fusion; LBP, low back pain; VAS, visual analogue scale for pain

Table 9. Randomised controlled trials evaluating disc replacement

Authors Year (reference #)	Study design (Follow-up)	N of patients	Type of surgery (N of patients)	Outcomes
Gornet *et al.*, 2011 [22]	Multicentre RCT (2 years)	577 patients aged 18-70 years with DDD between L_4 and S_1 and no improvement after at least 6 months of non-operative treatment; ODI ≥30	Disc replacement (405) vs. ALIF (172)	Statistically significant differences in favour of disc replacement for the ODI, pain, SF36 Physical Component Summary score, satisfaction, and return to work
Johnsen *et al.*, 2013 [31]	Multicentre RCT (2 years)	173 patients with LBP and DDD	Disc replacement vs. multidisciplinary rehabilitation therapy	No significant differences in sagittal mobility between segments with vs. without artificial discs or between disc replacement and multidisciplinary rehabilitation therapy
Berg *et al.*, 2011 [8]	RCT (2 years)	152 patients with cLBP due to DDD	Disc replacement (72) vs. instrumented posterior fusion (80)	Mobile segments in 85% of patients after disc replacement vs. 30% after fusion

DDD, degenerative disc disease; LBP, low back pain; cLBP, chronic low back pain; ALIF, anterior lumbar inter-body fusion; ODI, Oswestry Disability Index; SF36, 36-item Short Form Survey

FIGURE LEGENDS

Figure 1

Limitations of current definitions of chronic low back pain: with the current definitions, both patients are classified as having non-specific low back pain

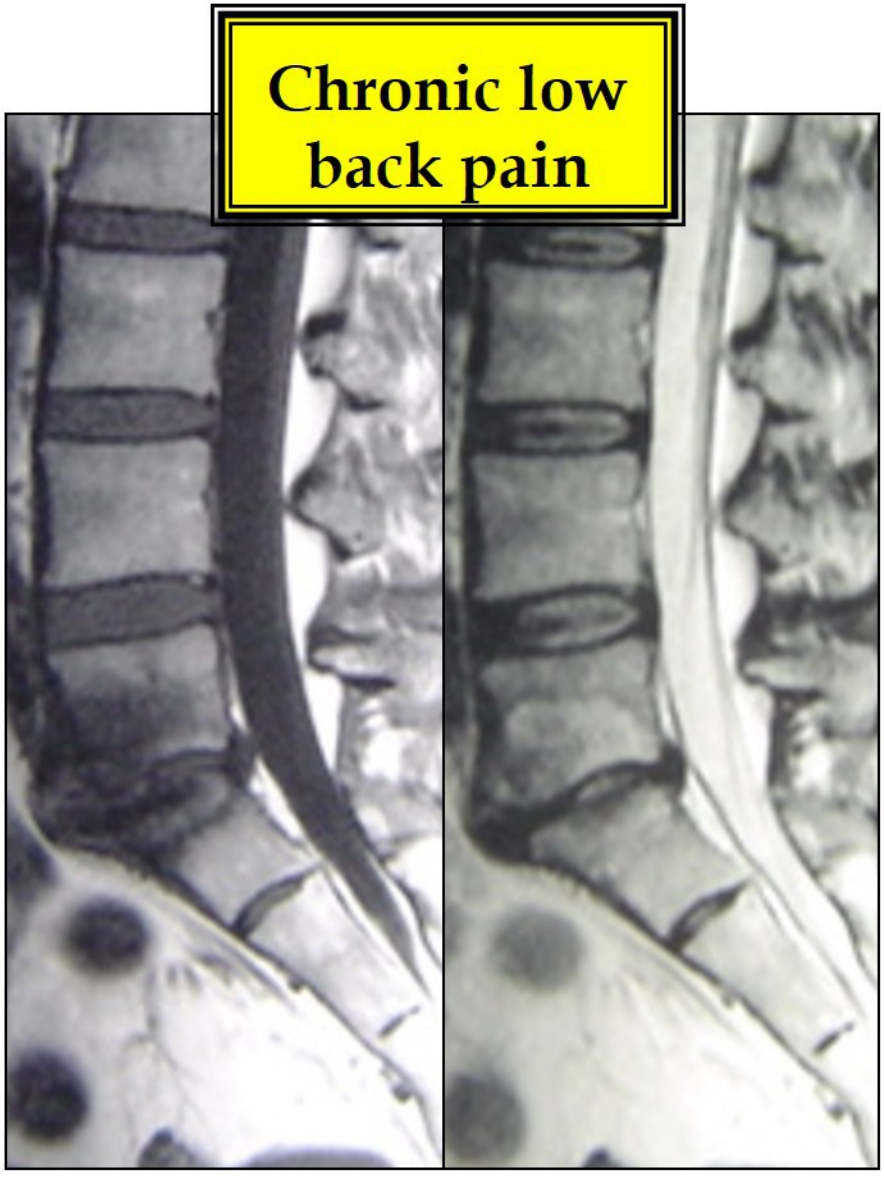
(A) On the left, young female with isolated inflammatory L5-S1 disc disease, normal lordosis, and normal spinal alignment

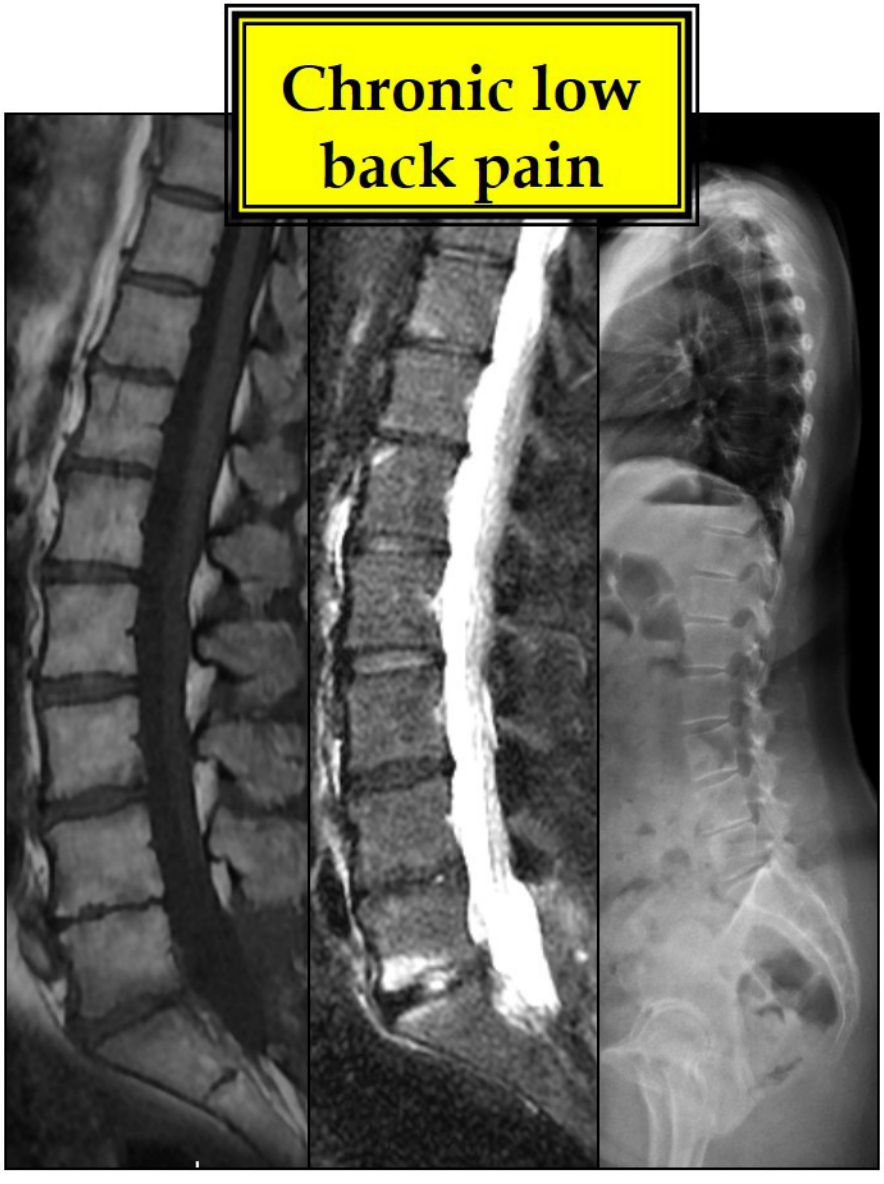
(B) On the right, elderly female with inflammatory L5-S1 disc disease combined with multi-level degenerative disc disease, loss of L3-S1 lordosis, and regional spinal malalignment.

Figure 2

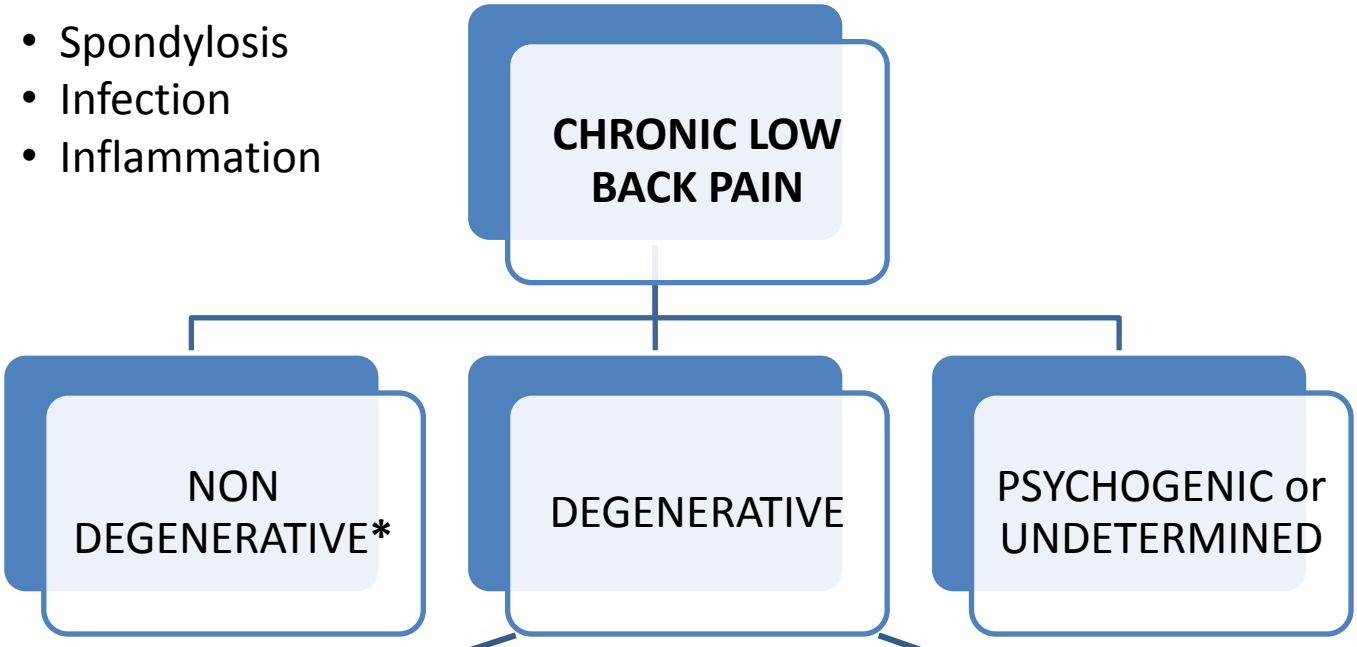
The suggested new classification of chronic low back pain is based on the presumptive source of pain and takes spinal alignment into account.

DDD, degenerative disc disease


Chronic low
back pain


Chronic low
back pain

* • Tumor
  - Trauma
  - Spondylosis
  - Infection
  - Inflammation



1- Discogenic
- Isolated degenerative disc disease (DDD)
- DDD with MODIC 2 or 3
- Inflammatory DDD (MODIC 1)
- L5-S1 retrolisthesis by lumbo-sacral mismatch

2- Facet lesions (isolated facet arthritis)

3- Mixed (degenerative disc and facet-joint disease)

4- Ligament lesions with segmental instability

5- Regional disorder of spinal balance
- Multilevel DDD with loss of lordosis
- Compensatory DDD (in extension) adjacent to a kyphotic segment
- Hyperlordosis

6- Global disorder of spinal balance
- Lumbar degenerative kyphosis
- Spinal deformity with global malalignment