

Review

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Review

Conservative Versus Surgical Treatment of Lumbar Radiculopathy: A Structured Review Within a Biopsychosocial Framework

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Abstract

Background: Lumbar radiculopathies are common and cause significant pain and functional limitations. The optimal strategy between conservative physiotherapeutic and surgical approaches remains debated. **Objective:** Evidence-based comparison of conservative and surgical strategies regarding pain reduction and functional improvement within a biopsychosocial framework. **Methods:** Structured narrative review with systematic searches in PubMed/MEDLINE, Cochrane Library, and PEDro using a PICO-based strategy, focusing on studies published between 2020 and 2025, with two key references from 2018 additionally retained from a 10 year database sweep because of their contextual relevance; predefined eligibility criteria (peer reviewed human studies in English or German); thematic synthesis. Single reviewer screening without duplicate screening or formal risk of bias assessment; no protocol registered; no systematic search of grey literature or trial registries; last search November 5, 2025. **Results:** Physiotherapeutic approaches, including exercise with targeted multifidus activation and cognition-oriented motor control, show relevant improvements. Epidural injections and, if needed, gabapentin may provide short-term relief. Surgical procedures, particularly microdecompression or microdiscectomy, yield faster early gains but converge with conservative outcomes in the medium and long term. Reoperation rates and functional outcomes show no consistent superiority. Psychosocial factors such as distress and catastrophizing affect recovery and should be screened. **Conclusion:** In the absence of red flags or severe deficits, conservative therapy addressing psychosocial factors should be prioritized within shared decision-making. Surgery is reserved for significant symptom burden, progressive deficits, or failed conservative care.

Keywords: lumbar radiculopathy; sciatica; herniated disc; microdiscectomy; decompression surgery; exercise therapy; cognition-targeted motor control; multifidus activation; epidural injection; biopsychosocial approach; return to work

1. Introduction

In Austria, musculoskeletal disorders are among the most common causes of sick leave and thus represent a significant burden on the healthcare system [1]. In Germany as well, the Robert Koch Institute (RKI) [2] describes this group of disorders on its website as one of the most frequent health impairments. The lower back is the primary localization of such complaints. Although the symptoms in this region can be diverse, pain symptomatology is considered the most important limitation in these disorders. This often leads to a considerable loss of quality of life and to functional impairments of the musculoskeletal system [2]. Due to demographic changes, such health-related problems are expected to increase further in the future, which was already evident in 2023 through an increase in the sickness absence rate of 0.13% compared to 2022 [1].

In the case of pain-dominant disorders of the lumbar spine region, radiculopathies, that is, irritations or lesions of the spinal nerve root, are particularly noteworthy, as they are often associated with high pain intensity [3]. Radicular symptoms are a common consequence of intervertebral disc

degeneration. Although there are many possible causes of these complaints, such as spinal stenosis, the intervertebral disc is most frequently associated with radiculopathy [4]. This is also confirmed by the current version of the S2k guideline on rehabilitative care for herniated discs with radicular symptomatology [3].

1.1. *Relevance and Problem Statement*

The relevance of radiculopathy becomes evident when considering its point prevalence, which is approximately 5% among adults over the age of 30. Although its occurrence is possible in any section of the spine, the lumbar spine accounts for about 95% of all cases, making it by far the most frequent localization [5]. Despite being a condition of high epidemiological relevance, optimal care strategies within the healthcare system remain difficult to implement, as it represents a complex interaction of biological, psychological, and social factors. This multifactorial nature of the disorder explains both the development and persistence of the respective symptoms. Hincapié et al. [5] describe, in this context, not only mechanical causes such as space-occupying lesions within the spinal canal due to disc pathology or bony narrowing as seen in spinal stenosis, but also pathological changes of the nerve structure itself. Psychosocial factors, on the other hand, play a major role in pain intensity and pain duration. The importance of interdisciplinary collaboration is often underestimated, and healthcare professionals tend to focus too narrowly on their own field of expertise, neglecting factors that lie outside their domain [6]. In addition to pain-related limitations, further symptoms such as numbness, paresthesia, and even severe motor impairments may occur, which can potentially lead to long-term restrictions for patients and thus to high costs for the healthcare system [3].

The decision between conservative and surgical treatment is not one to be made lightly. Here as well, many factors influence the actual improvement in function and the reduction of pain [7]. Consequently, there is still a lack of appropriate recommendations on how to best manage a radiculopathy.

1.2. *Central Research Question*

In formulating the research question, the focus is placed both on the comparison between conservative and surgical treatment and on the improvement of pain and function. This leads to the following research question:

How do conservative physiotherapeutic treatment strategies, compared to surgical interventions, influence pain reduction and functional improvement in patients with lumbar radiculopathy?

1.3. *Objective*

The aim is to create a scientifically grounded comparison between both approaches with regard to pain reduction and functional improvement, in order to simplify decision-making processes and optimize treatment. In doing so, biopsychosocial factors as well as the interdisciplinary approach are taken into account. Research findings can thus be compared across the respective domains to enable comprehensive conclusions. Furthermore, this paper focuses on physiotherapeutic and surgical interventions as the primary treatment strategies. Pharmacological and interventional pain management, including modalities such as gabapentin and epidural injections, are considered only insofar as they form part of conservative treatment protocols in the included studies and are not evaluated as independent therapeutic domains, while psychotherapeutic approaches are acknowledged but not analysed in depth and are therefore not a primary focus of the comparative synthesis.

2. Theory

For a comprehensive understanding of lumbar radiculopathy, this chapter describes the fundamental mechanisms of the disorder. The basis is formed by the anatomy and the function of the affected structures, in order to subsequently present the pathophysiological processes in a more comprehensible way. Factors that are decisive for the onset and intensity of the condition illustrate the complexity of a radiculopathy.

2.1. Anatomical and Biomechanical Foundations

The lumbar spine consists of five vertebral bodies that are separated by intervertebral discs. The lowest disc connects the lumbar spine to the sacrum. A natural lordosis extends along the entire section from L1 to the sacrum, with 60–66% of this curvature found in the lower segments starting from L4 [8].

Spinal stability is ensured primarily by strong ligaments, namely the anterior longitudinal ligament anteriorly and the posterior longitudinal ligament posteriorly. In addition, the ligamentum flavum lies between the laminae of adjacent vertebrae, thereby preventing excessive flexion. This movement is also limited by the interspinous and supraspinous ligaments, which connect the spinous processes. Alongside the intervertebral discs, the facet joints positioned on the left and right sides connect the vertebral bodies; these joints are oriented approximately 50° coronally and 90° sagittally. Within the vertebral canal runs the spinal cord, which connects the central and peripheral nervous systems via the nerve roots [8].

The muscles of the spine provide not only movement of the individual vertebral segments but also additional stability. In particular, the transversus abdominis, psoas major, and multifidus muscles are crucial both for controlled curvature and for maintaining mechanical stability. Local stabilization is primarily provided by the multifidus muscle [9].

The intervertebral disc, as the fibrous connective structure between the vertebral bodies, is responsible for the mobility of the spine. In addition, its flexible shape enables the distribution of loads that occur during movement. In everyday life, this results in highly variable and sometimes extreme stresses [10].

The anatomy of the intervertebral disc distinguishes between two fundamental structures. On the one hand, the disc is formed by the outer annulus fibrosus, and on the other hand, by the inner nucleus pulposus. The outer fibrous ring consists of concentric layers that are arranged in alternating directions. These layers of collagenous connective tissue provide the disc with stability. In addition, they are interconnected by translaminar elastin bridges, which result in high shear strength. The inner core, by contrast, behaves more like a fluid-filled cushion and responds to applied forces with changes in pressure direction [10].

Radiculopathy refers to an alteration or injury of the nerve root. It involves the root of the spinal nerves, which exit between the vertebral bodies through the intervertebral foramen beneath the pedicle of the respective vertebra, and are therefore located in close proximity to the intervertebral discs [8]. Each spinal nerve arises from several small rootlets that join to form an anterior ventral motor root and a posterior dorsal sensory root. Distal to the dorsal root ganglion these roots unite to form a mixed spinal nerve that conducts afferent and efferent impulses between the spinal cord and the periphery. The sensory neuronal cell bodies are clustered in the dorsal spinal ganglion on the posterior root close to the intervertebral foramen [11].

2.2. Pathophysiology of Lumbar Radiculopathy

In radicular disorders, the underlying cause is often an inflammatory reaction in the spinal canal [3]. As mentioned in the introduction, a herniated disc is the most common cause of this condition [4], although it does not necessarily have to involve compression by the disc or other structures. Greitemann and Schmidt [3] describe the mere presence of disc material in the spinal canal as a possible trigger for symptomatic radiculopathy.

Degenerative processes that lead to disc fibrosis at a very early stage significantly alter the range of motion. In particular, a rapid limitation of flexion can be expected [10]. This restriction of

movement results in altered shear forces between the lamellae, thereby increasing susceptibility to injury. Repeated peak loads in such less mobile segments of the disc subsequently lead to a herniated disc, with the endplates, rather than the annulus fibrosus, often being the structures that ultimately fail [10].

In addition, spinal stenosis represents the second most common cause of this condition. It primarily occurs with increasing age due to hypertrophy of the ligamentum flavum and is often accompanied by facet joint arthrosis. A spondylolisthesis may further narrow the intervertebral foramen [8].

A lumbar radiculopathy is characterized, in addition to radiating pain in the dermatome area, by further neurological symptoms. Paresthesia and numbness may occur in the same region. Motor symptoms include weakness or, in severe cases, complete paralysis of the key muscles. A major complication is nerve root necrosis, as this event cannot be reversed. Particular attention must be paid to the so-called cauda equina syndrome, in which bladder and/or bowel dysfunction occurs [3]. The causes of these symptoms include not only direct compression but also inflammation-related changes in the nerve root. These include intraneural ischemia, that is, reduced oxygen supply due to edema formation in the affected area. This is followed by neural fibrosis, which is typical of this condition [12]. Regarding pain symptomatology, neuroinflammation plays a crucial role in both the development and maintenance of the disorder. It leads to disrupted retrograde and anterograde axonal transport, which is associated with increased neural mechanosensitivity [12]. Ectopic discharges originating from the ganglion or the dorsal root then give rise to the characteristic radicular pain syndrome [12].

From a muscular perspective, there is a strong correlation between weakness or atrophy of the lumbar multifidus muscle, functional limitation, and the occurrence of degenerative disc processes. In addition, a dose-dependent relationship can be observed: the greater the degree of degenerative changes, the greater the loss of multifidus muscle mass [9,13,14].

The risk factors that contribute to the development of radiculopathy are as diverse as the mechanisms underlying its symptoms. For a long time, improper movement behavior was considered the primary cause. However, several additional factors have since been identified. In addition to repetitive loads on the lumbar spine, such as those resulting from manual lifting and carrying of heavy objects in occupational contexts, lifestyle factors also play a role in degenerative processes and the associated increase in injury risk. A high BMI and regular smoking are likewise regarded as significant risk factors that promote the occurrence of radiculopathy [5].

A reliable diagnosis is crucial and should be established using specific tests such as neural tension tests, assessment of strength in the corresponding key muscles, and specific reflex tests [3]. Imaging techniques may also be used for evaluation. Magnetic resonance imaging (MRI) is particularly important; however, Greitemann and Schmidt [3] recommend not using imaging procedures as a primary diagnostic tool within the first two weeks but rather reserving them for special indications and the presence of red flags. Furthermore, other possible causes of the symptoms must be ruled out. Differential diagnoses may include inflammatory rheumatic diseases, fractures, infections, or tumors and metastases [3].

2.3. Psychosocial Influencing Factors

In the management of musculoskeletal disorders, clinical attention is often directed primarily or even exclusively toward the structural level. However, in the development and maintenance of symptoms associated with lumbar radiculopathy, psychosocial factors also play a decisive role [6]. Depressive symptoms and distress, that is, stress perceived as negative, are common influencing factors that can have adverse effects on symptom severity [3]. Patients with depressive symptoms generally exhibit greater pain intensity and disability both before and after lumbar spine surgery compared with those without depression, yet still achieve substantial postoperative improvements in pain, function, and overall recovery, underscoring the need for systematic mental health assessment and support in perioperative spine care [15]. Pain-related cognition refers to the primary

symptom of pain, whereby both catastrophizing and fear-avoidance behavior affect pain modulation, potentially leading to a generalized or condition-specific overreactive pain response. A tendency toward somatization further amplifies these processes [3]. The association between mental stress and symptomatic radiculopathy is also described by Hincapié et al. [5]. The definition of the biopsychosocial system illustrates that these factors should not be viewed in isolation but rather as complementary and functionally integrated components. In this context, Schmid et al. [12] even describe it as inevitable that peripheral nerve lesions induce central nervous changes, which may contribute to central sensitization.

To identify psychosocial factors influencing symptomatology, the use of questionnaires is recommended, as they can be evaluated using standardized scoring systems and therefore applied in an interdisciplinary manner without requiring prior expertise in the respective field. Examples include the Örebro questionnaire and the RISC-R questionnaire [3].

In summary, psychological and psychosomatic factors receive insufficient attention in the management of radiculopathies, resulting in existing treatment concepts often remaining ineffective [6].

3. Methodology

This review used a structured narrative methodology covering the search, predefined eligibility criteria, and a narrative synthesis focused on conservative versus surgical care for lumbar radiculopathy.

3.1. Literature Search

The literature review approach makes it possible to capture the current state of scientific knowledge. This method is well suited to answering the research question, as studies were identified on both conservative and surgical treatments, as well as scientific papers that directly compare the two.

Books were consulted exclusively for anatomical, biomechanical, and basic pathophysiological context and did not inform study selection, data extraction, or comparative efficacy judgments, consistent with Ritschl et al. [16]. Instead, the focus was placed on databases recommended for medical research. These are:

- PubMed/MEDLINE,
- Cochrane Library and
- PEDro

While PubMed represents one of the largest and most important databases in this field, the Cochrane Library provides fewer results, although these are of high quality. Similarly, the PEDro database is structured to provide a numerical indication of study quality based on the PEDro scale [16].

The search strategy within the databases was conducted using the PICO strategy. This framework refers to the components **P**opulation, **I**ntervention, **C**omparison, and **O**utcome. The strategy is also recommended by Blümle et al. [17]. With regard to the research question, the following categorization applies to the comparison between conservative and surgical approaches:

Table 1. PICO scheme. Own illustration adapted from Blümle et al. [17].

P	Patients with lumbar radiculopathy
I	Conservative physiotherapeutic treatment
C	Surgical interventions
O	Pain reduction and functional improvement

Derived from this framework, the following search terms were used:

Table 2. Search terms. Own illustration adapted from Blümle et al. [17].

P	Lumbar radiculopathy, Sciatica, Herniated disc, Low back pain
I	Conservative, Physiotherapy, Exercise therapy
C	Operative, Surgical, Discectomy, Microdiscectomy, Spinal fusion
O	Pain reduction, Functional improvement, Disability evaluation, Return to work, Patient satisfaction

Using the Boolean operators AND, OR, and NOT, the search terms were combined, ensuring that word endings were neutralized by using an asterisk and related terms were connected with quotation marks. This approach allows the search to be conducted more effectively [16].

With this approach, various word combinations could be covered, while the search terms, combined with MeSH terms (Medical Subject Headings) as described by Ritschl et al. [16], further contributed to a more specific search. Core search strings included: (“lumbar radiculopathy” OR sciatica) AND (conservative OR physiotherapy OR “exercise therapy”) AND (surgery OR discectomy OR microdiscectomy) AND (pain OR function).

Searches were conducted from March 1, 2024, through November 5, 2025, with the last search update on November 5, 2025. No systematic search of grey literature databases or trial registries was performed. However, one current S2k clinical practice guideline and selected health reports were used to contextualize and interpret the findings and to derive practice recommendations.

3.2. Criteria for Study Selection

This paper is based on current data, which is why specific inclusion and exclusion criteria were defined in the following. Primarily, studies published no earlier than 2020 were included, corresponding to the time frame recommended in the literature for medical research findings [16]. However, the database filter function was set to 10 years to ensure that relevant literature was not overlooked in areas with limited available data.

The level of evidence represented another important criterion for the inclusion or exclusion of certain studies. In general, meta-analyses and systematic reviews were given the highest weighting. According to Ritschl et al. [16], these studies, classified as Level 1, provide the highest evidential strength, followed by randomized controlled trials, which were also highly weighted. Studies ranked lower in the evidence pyramid, such as non-randomized experimental or non-experimental studies, were considered in part but assigned a lower weight accordingly.

As a limitation, it must be noted that although the selected studies were retrieved from high-quality databases and therefore, in part, underwent quality assessment through the databases themselves (Cochrane and PEDro), no additional systematic quality evaluation was conducted using standardized instruments such as the PEDro scale, as recommended by Cashin and McAuley [18]. Consequently, potential variations in the methodological quality of the studies cannot be entirely ruled out.

Study selection was conducted by a single reviewer (PH) in two stages (title/abstract screening followed by full-text assessment) using a reference manager. Predefined eligibility criteria guided inclusion and exclusion; uncertainties were resolved by returning to these prespecified criteria. No independent duplicate screening was performed. Database filters were restricted to the last 10 years to avoid missing earlier but relevant evidence. For the actual synthesis, only studies published between 2020 and 2025 were included, with the exception of two references from 2018 (a randomized trial on pain neuroscience education and an S2k guideline on lumbar radiculopathy) that were retained because of their specific relevance. Eligible records were limited to human studies in English or German. Records were deduplicated in the reference manager using matching on author, title, year, and DOI/PMID where available.

3.3. Analysis and Synthesis of Results

After completion of the literature search, the included studies were analyzed and their results synthesized. This process was carried out using a reference management program, in which the studies were assigned to the relevant sections of the table of contents. Information on conservative and surgical procedures and their effects was subsequently extracted, and key statements as well as essential findings were systematically organized as knowledge elements. During this step, duplicates could also be removed. The use of reference management programs for optimal structuring and clear presentation of key findings is also recommended by Ritschl et al. [16].

The following table shows the number and distribution of included references across the respective subject areas:

Table 3. Distribution of references across the respective subject areas (Own illustration).

References	Category	IDs
5	Description of conservative approaches and their effects	[20], [21], [22], [29], [32]
3	Description of surgical approaches and their effects	[25], [26], [30]
6	Comparative or combined conservative and surgical care	[3], [4], [7], [27], [28], [31]
3	Psychosocial context factors	[6], [15], [24]
11	Other relevant areas (pharmacological therapy, pathophysiology, etc.)	[1], [2], [5], [8], [9], [10], [11], [12], [13], [14], [23]

This review followed a structured narrative approach without duplicate screening and without a formal risk-of-bias assessment. Consequently, findings should be interpreted with caution due to methodological heterogeneity across included studies and the absence of a formal appraisal using tools such as RoB 2 or AMSTAR 2. Results were summarized without meta-analysis and organized by conservative, surgical, and direct comparison sections, with pain and function as primary endpoints and return to work reported where available.

This structured narrative review was planned and reported in accordance with the SANRA (Scale for the Assessment of Narrative Review Articles) criteria [19]. The full SANRA scale is provided in Appendix A.

3.4. Use of AI tools

A language-based AI tool (ChatGPT) was used only for English-language editing (grammar, clarity, and style). No AI tools were used for evidence selection, data analysis, or the creation of figures or tables. The author reviewed all content and takes full responsibility for the work.

4. Results

This chapter summarizes the results of the literature review. It presents the findings on conservative and surgical therapy for lumbar radiculopathy with regard to pain reduction and functional improvement.

4.1. Conservative Therapy

In conservative treatment, as in diagnosis, there is no single approach that appears to be the best for all patients. Rather, it involves a combination of various areas of physiotherapy and pharmacological therapy [20]. Regarding the effectiveness of these treatment modalities, their efficacy remained unclear for a long time. A meta-analysis from 2023 concluded that the effectiveness of physiotherapeutic interventions in terms of pain intensity is not clearly established [20]. It should be noted that many older RCTs were included in this study, and the physiotherapeutic interventions examined were often outdated. More recent findings tend to indicate that physiotherapy demonstrates good effects in lumbar radiculopathy. Jäntschi-Rieckert et al. [21] concluded that this type of therapy, at least when combined with pharmacological treatment using gabapentin and

epidural injections, leads to significant improvements in both pain intensity and function. Physiotherapists are not only important in treatment but also play a role in the early detection of neuropathic pain in this condition [22].

When considering exercise therapy alone, it becomes evident how profound the structural changes induced by targeted loading are. Laube [23] demonstrates that connective tissue can lose 30–40% of its load-bearing capacity in the absence of physical activity, which is highly relevant given that both the intervertebral discs and the stabilizing ligaments of the spine are composed of this tissue type. In contrast, physical loading or training activates anabolic hormonal systems and promotes tissue-specific repair, adaptation, and regeneration processes. Regular exercise therefore leads to a more resilient and anti-inflammatory body structure [23]. Conversely, visceral fat produces pro-inflammatory signaling molecules, resulting in a silent, chronic inflammation that in turn promotes degenerative diseases [23]. Age also plays an important role. Over time, neuronal connectivity decreases, and muscle effectiveness declines accordingly, leading to reduced pain inhibition. The loss of muscle mass is accompanied by an increase in adipose tissue, further accelerating degenerative processes [23]. A more specific examination highlights the significance of local muscle groups, particularly the multifidus muscle. As mentioned in section 2.2, the degree of degeneration correlates with the degree of weakness in this muscle. Three of the included studies concluded that both processes influence each other. Targeted activation could therefore lead to positive effects in the treatment of radiculopathy [9,13,14].

Physiotherapy, however, does not refer solely to exercise therapy. Malfliet et al. [24] demonstrated that the combination of pain neuroscience education, meaning targeted education about the neurophysiological mechanisms of pain stimuli, and cognition-oriented motor control training can achieve significantly better outcomes than exercise alone by improving various domains such as pain, central sensitization, functional limitations, mental functions, and pain-related cognition.

In summary, reported outcomes indicate a success rate of about 90% and an average time to return to work of approximately 5.8 weeks for conservative management of lumbar radiculopathy [21].

4.2. Surgical Therapy

In addition to conservative treatment options, surgical methods are also frequently discussed in clinical practice. Microsurgical techniques are considered the gold standard and are therefore the most commonly performed. According to Greitemann and Schmidt [3], these are standard procedures, and the outcomes are generally good. In most cases, removal of the intervertebral disc material is avoided, and motion-preserving decompression techniques are the method of choice both initially and in revision surgery [3]. Discectomy is most commonly performed microsurgically; it can also be performed endoscopically and, according to Greitemann and Schmidt [3], is comparable in technique to arthroscopic procedures. It is also a widely used technique that is increasingly applied worldwide [3].

Particularly in cases of acute radiculopathy-related leg pain and functional impairment, this surgical technique shows a good effect immediately after the procedure. Subsequently, back pain often improves significantly as well [25]. Other minimally invasive procedures, such as laser discectomy, chemonucleolysis, where injected enzymes are used to achieve disc volume reduction, or radiofrequency ablation, are not described in greater detail in this chapter, as no conclusive evidence is currently available [3].

Spinal fusion, on the other hand, is considered an established surgical technique, primarily used when minimally invasive procedures are either unlikely to succeed or have already been exhausted [3]. By means of pedicle screw-rod systems or through the implantation of so-called interbody cages, vertebrae are connected, thereby preventing movement in the intervertebral space [10]. Segmental instability as a possible complication in disc-related lumbar radiculopathy often represents the indication for fusion of the respective spinal segments. Although a rapid improvement in both pain

symptomatology and functional limitation can also be expected after such surgery, this type of operation often requires a longer rehabilitation period [3]. Fusion in certain spinal segments results in a drastic change in biomechanics, which may subsequently cause adjacent systems, that is, both the discs above and below and the vertebral bodies themselves, to be exposed to disproportionate stress. Deformities as well as renewed degeneration, the so-called adjacent segment degeneration, may be the consequence [10]. A possible alternative that could circumvent such problems would be the implantation of artificial discs. However, the exact kinematics of the respective segment must be taken into account in order to ensure relief of the passive structures. So far, the evidence base is heterogeneous and a precise statement about the long-term consequences is difficult to make [10].

The complexity of lumbar radiculopathy means that the decision for or against surgery depends on many factors. This decision can be made based on the symptomatology, intensity, or duration of symptoms. As part of the current S2k guideline for rehabilitative care in herniated discs with radicular symptoms, an interdisciplinary group of experts was formed, consisting of physicians, physiotherapists, psychologists, sports scientists, and representatives of pension insurance institutions [3]. Within this expert group, 93% recommend surgery after prior conservative therapy lasting 6 to 12 weeks if the desired effects fail to appear [3]. One hundred percent recommend surgical intervention if radicular pain symptomatology is severe and the affected person explicitly wishes to achieve rapid pain relief through surgical procedures [3]. In the case of neurological symptoms leading to a muscle strength value of 3 or less in the key muscles, consensus is lower. Here, 79% of experts recommend surgical treatment [3]. In contrast, surgical intervention within 48 hours in the presence of a cauda equina syndrome receives unanimous approval [3]. When one of the described surgical techniques is applied, occupational reintegration is generally possible after 8 to 12 weeks on average [3].

In the medium term, that is, within the first few years, surgical treatment shows good benefit. However, there are few data available regarding long-term effects. At least one study by Hermansen et al. [26] demonstrates, for the same pathology but in the cervical region, complete recovery in 88% of operated patients even after 20 years.

In summary, it can be stated that surgical treatment of disc-related radiculopathies in the lumbar region shows good effectiveness, although the multifactorial nature of this condition does not always lead to complete patient satisfaction, since biopsychosocial factors continue to play a major role [3].

4.3. Comparison of Treatment Outcomes

The comparison between conservative and surgical therapy in lumbar radiculopathies shows that various approaches can achieve significant improvements in pain reduction and functional limitations. Although surgical procedures, especially minimally invasive techniques, can often provide very rapid and pronounced pain relief and functional improvement in the short term, this advantage diminishes again in the medium term [27]. A systematic comparison of the intervention methods presented in this paper, both conservative and surgical, shows that with regard to pain, functional limitation, and reoperation rate, no method can be identified as the preferred intervention, as the effects are similarly strong [28]. Even the rapid pain-relieving effect of surgical procedures can be achieved with similar effectiveness through conservative techniques such as epidural injections [29]. The administration of oral pain medication such as gabapentin further enhances the effect in addition to exercise therapy measures [21]. Nevertheless, surgical intervention shows a clear advantage in terms of rapid functional improvement. However, this difference is statistically significant only in the early phase [30].

Özden and Koçyiğit [31] point out that a combination of surgical techniques and conservative care can lead to better outcomes than physiotherapeutic interventions alone. On the other hand, Kim et al. [32] conclude that, in the case of a normal course, surgery should be avoided if patients prefer so. In this context, attention must be paid to the principle of shared decision-making. This becomes particularly important when considering the psychosocial components that can influence both the symptomatology itself and the decision regarding the appropriate type of treatment [3].

The timing of return to work varies in the literature. A period of 5.8 to 12 weeks is reported for both treatment approaches [3,21], although Clark et al. [30] conclude that there are no significant differences in the restoration of work ability between conservative and surgical treatment.

5. Discussion

A closer examination of the results reveals several contradictions as well as limitations, which necessitate a nuanced consideration and critical appraisal.

One essential aspect that should be viewed critically concerns the primarily medium-term equivalence of both treatment approaches. Although surgical procedures lead to rapid improvements in pain and function, they are also associated with greater risks. When considering the combination of conservative physiotherapeutic interventions together with epidural injections, this advantage is usually relativized. The remaining question is whether the risks of surgery should be accepted when conservative therapy shows equivalent effects in many cases [28,29,32].

Furthermore, it must be noted that psychosocial factors receive less attention in surgical procedures, which may explain why successful surgical treatments can still lead to unsatisfactory outcomes in some cases [3]. On the other hand, Eich et al. [6] show that such psychosocial factors are also often underestimated or even disregarded within physiotherapy. Thus, the question remains to what extent established treatment strategies could lead to better outcomes if these factors were given greater consideration.

According to Jäntsch-Rieckert et al. [21], specific physiotherapeutic approaches show clearly positive effects, yet Dove et al. [20] point out that the effectiveness of physiotherapeutic interventions should be viewed critically due to methodological weaknesses in older studies and the inconsistency of therapeutic measures. This raises the question of the extent to which older evidence can still contribute to current decision-making in this field. Another controversy concerns the surgical technique of spinal fusion. Although the fusion of spinal segments is critically assessed by Welke et al. [10], insufficient data likewise do not allow for clear conclusions or recommendations for or against the implantation of artificial discs.

A multimodal approach is essential, yet there is a risk that experts may tend to focus on their own discipline, causing the interdisciplinary concept to be lost. This, in turn, reinforces the need for stronger integration of patient preferences, as these can serve as a focal point for interdisciplinary expertise [32].

As a limitation of this paper, it must be emphasized that the research primarily focuses on the comparison between conservative and surgical treatment, whereas combinations of both approaches could lead to better outcomes, as also recommended by Özden and Koçyiğit [31]. Furthermore, the significance of this work is limited, as the research mainly concentrates on the most common cause of lumbar radiculopathy, namely lumbar disc herniation in a non-chronic stage. Other mechanisms such as spinal stenosis, malignant diseases, or fractures would exceed the scope of this paper and are therefore only minimally considered. The distinction from specific medical-pharmacological therapies as well as psychological interventions must also be mentioned, as these are significant influencing factors that can substantially alter the decision between conservative and surgical treatment.

5.1. Answer to the Research Question

Conservative physiotherapeutic and surgical treatment strategies show comparable effects in lumbar radiculopathies with regard to pain reduction and functional improvement, although they differ in their temporal course. Surgical methods lead to a significant improvement in both areas immediately, but this advantage diminishes in the medium to long term. Specifically, exercise therapy with targeted activation of the multifidus muscle and cognition-targeted motor control approaches in combination with educational measures promote not only structural but also psychosocial recovery, with screening procedures for psychosocial involvement being considered part of physiotherapy. More complex surgical methods, such as spinal fusion, on the other hand,

carry the risk of biomechanical sequelae but may be necessary in individual cases. Overall, the evidence shows that neither treatment approach is clearly superior.

5.2. Implications for Clinical Practice

Comprehensive diagnostics covering the entire biopsychosocial spectrum are crucial. Physical examinations such as nerve tension, muscle strength, or reflex tests, as well as imaging procedures where appropriate, should be applied alongside evidence-based and standardized screening of psychosocial factors using questionnaires such as the RISC-R questionnaire or the Örebro questionnaire [3]. In this way, red flags can be detected at an early stage, and necessary steps, such as surgical decompression of neural structures, can be initiated [3].

Regarding decision-making between conservative and surgical therapy, there is a need for thorough patient education about the advantages and disadvantages of each approach. Furthermore, particular attention should be given during counseling to the neurophysiological mechanisms of pain generation as described by Malfliet et al. [24]. Good education can potentially reduce psychological barriers, which in turn may have a positive effect on the overall healing process.

The results of this paper generally suggest that conservative therapy should be used first whenever possible, with individual patient preference playing a major role. This is consistent with the recommendation by Hammed et al. [7] regarding the management of radicular symptoms. Exercise therapy represents the most important intervention, which can already be applied in the subacute phase [3]. Particular attention should be paid to the function of the multifidus muscle, as a direct relationship between its function and degenerative processes of the spine can be observed [13].

Even if patients decide in favor of surgical therapy, it should be clearly communicated that exercise therapy plays an indispensable role both in the short and long term [3]. Accordingly, in the decision-making process, it is essential to maintain a long-term perspective from both the professionals' and the patients' point of view.

In summary, according to Greitemann and Schmidt [3], the following recommendations can be derived for clinical practice:

- Comprehensive diagnostics including standardized psychosocial screening tests with special attention to red flags and differential diagnoses
- Education about therapy options and neurophysiological pain mechanisms, including long-term consequences
- Decision-making processes prioritizing conservative treatment options and patient preferences
- Development of long-term therapy strategies

6. Conclusion

In conclusion, it can be stated that both conservative and surgical therapies have legitimate applications in the treatment of lumbar radiculopathy, although their weighting should vary depending on the individual situation. Due to the comparable long-term effectiveness and lower risk, conservative treatment should be attempted and optimized first whenever possible. Biopsychosocial factors require specific measures that must also take place within an interdisciplinary framework, combining physical-structural exercise approaches with psychosocial components. Surgical procedures remain appropriate, particularly in cases of severe neurological symptoms or insufficient success of conservative measures and should be performed promptly in such cases. Patient preferences play a decisive role in the decision-making process, and a treatment plan must always be individually tailored in the short, medium, and long term. Future studies should increasingly focus on examining combined therapeutic approaches as well as on the long-term evaluation of effectiveness and patient satisfaction.

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List of Abbreviations.

AMSTAR	A measurement tool to assess systematic reviews
BMI	Body mass index
MeSH	Medical Subject Headings
MRI	Magnetic Resonance Imaging
PEDro	Physiotherapy Evidence Database
PICO	Population, Intervention, Comparison, Outcome
RCT	Randomized Controlled Trial
RoB	Risk of Bias
SANRA	Scale for the Assessment of Narrative Review Articles

Appendix A

Table A1. SANRA scale for the assessment of narrative review articles. Reproduced from Baethge et al. [19] with permission (granted November 16, 2025).

SANRA - Scale for the Assessment of Narrative Review Articles		
1. Justification of the article's importance for the readership		Score
–	The importance is not justified	0
–	The importance is alluded to, but not explicitly justified	1
–	The importance is explicitly justified	2
2. Statement of concrete aims or formulation of questions		
–	No aims or questions are formulated	0
–	Aims are formulated generally but not concretely or in terms of clear questions	1
–	One or more concrete aims or questions are formulated	2
3. Description of the literature search		
–	The search strategy is not presented	0
–	The literature search is described briefly	1
–	The literature search is described in detail, including search terms and inclusion criteria	2
4. Referencing		
–	Key statements are not supported by references	0
–	The referencing of key statements is inconsistent	1
–	Key statements are supported by references	2
5. Scientific reasoning		
–	The article's point is not based on appropriate arguments	0
–	Appropriate evidence is introduced selectively	1
–	Appropriate evidence is generally present	2
6. Appropriate presentation of data		
–	Data are presented inadequately	0
–	Data are often not presented in the most appropriate way	1

– Relevant outcome data are generally presented appropriately	2	
Sumscore	12	10

References

1. Bittschi B, Mayrhuber C. Fehlzeitenreport 2024. Krankheits- und unfallbedingte Fehlzeiten in Österreich: Österreichisches Institut für Wirtschaftsforschung; 2024 [cited 2025 March 13] Available from: URL: <https://www.sozialversicherung.at/cdscontent/load?contentid=10008.789000&version=1719902096>.
2. Robert Koch-Institut. Muskulo-skelettale Erkrankung; 2023 [cited 2025 March 9] Available from: URL: <https://www.rki.de/DE/Themen/Nichtuebertragbare-Krankheiten/Koerperliche-Gesundheit/Muskuloskelettale-Erkrankungen/muskuloskelettale-erkrankungen-node.html>.
3. Greitemann B, Schmidt R. S2k-Leitlinie: Konservative, operative und rehabilitative Versorgung bei Bandscheibenvorfällen mit radikulärer Symptomatik: Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF); 2021 [cited 2025 March 9] Available from: URL: https://register.awmf.org/assets/guidelines/033-0481_S2k_Konservative-operative_rehabilitative-Versorgung-Bandscheibenvorfall-radikulae_2021-06_01.pdf.
4. Glocker F. S2k-Leitlinie: Lumbale Radikulopathie: Leitlinien für Diagnostik und Therapie in der Neurologie: Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften (AWMF); 2018 [cited 2025 March 9] Available from: URL: https://dnvp9c1uo2095.cloudfront.net/cms-content/030058_LL_Lumbale_Radikulopathie_2018_archiviert_1726228804828.pdf.
5. Hincapié C, Kroismayr D, Hofstetter L, et al. Incidence of and risk factors for lumbar disc herniation with radiculopathy in adults: a systematic review. *European spine journal* 2025; 34(1): 263–94[<https://doi.org/10.1007/s00586-024-08528-8>][PMID: 39453541]
6. Eich W, Diezemann-Prößdorf A, Hasenbring M, et al. Psychosoziale Faktoren bei Schmerz und Schmerzbehandlung: Eine Positionsbestimmung. *Schmerz* 2023; 37(3): 159–67[<https://doi.org/10.1007/s00482-022-00633-1>][PMID: 35303149]
7. Hamed A, Al-Qiami A, Alsalhi H, et al. Surgical vs. Conservative Management of Chronic Sciatica (3 Months) Due to Lumbar Disc Herniation: Systematic Review and Meta-Analysis. *Cureus* 2024; 16(5): e59617[<https://doi.org/10.7759/cureus.59617>][PMID: 38832179]
8. Farshad M, Wanivenhaus F, Spirig J, Betz M, Unterfrauner I. Wirbelsäule: Anatomie. In: Farshad M, editor. *Lehrbuch Orthopädie: Was man wissen muss*. 2. Auflage. Berlin, Heidelberg: Springer 2023; 7–42.
9. Liu C, Xue J, Liu J, et al. Is there a correlation between upper lumbar disc herniation and multifidus muscle degeneration? A retrospective study of MRI morphology. *BMC Musculoskelet Disord* 2021; 22(1): 92[<https://doi.org/10.1186/s12891-021-03970-x>][PMID: 33468108]
10. Welke B, Daentzer D, Neidlinger-Wilke C, Liebsch C. Biomechanik der Bandscheibe: Bedeutung degenerativer Veränderungen. *Orthopädie* 2024; 53(12): 912–7[<https://doi.org/10.1007/s00132-024-04578-4>][PMID: 39499289]
11. Dalley AF, Agur AMR, Moore KL. *Moore's clinically oriented anatomy*. 9th ed. Philadelphia: Wolters Kluwer 2024.
12. Schmid A, Fundaun J, Tampin B. Nervenkompressionssyndrome – eine aktuelle Betrachtung von Pathophysiologie, klinischer Untersuchung und Management: Deutsche Fassung. *Schmerz* 2021; 35(6): 419–33[<https://doi.org/10.1007/s00482-021-00584-z>][PMID: 34505948]
13. Cooley J, Jensen T, Kjaer P, Jacques A, Theroux J, Hebert J. Spinal degeneration is associated with lumbar multifidus morphology in secondary care patients with low back or leg pain. *Sci Rep* 2022; 12(1): 14676[<https://doi.org/10.1038/s41598-022-18984-1>][PMID: 36038653]
14. Naghdi N, Mohseni-Bandpei M, Taghipour M, Rahmani N, Gonil F. Lumbar Multifidus Muscle Morphology Changes in Patient with Different Degrees of Lumbar Disc Herniation: An Ultrasonographic Study. *Medicina (Kaunas)* 2021; 57(7): 688[<https://doi.org/10.3390/medicina57070699>][PMID: 34356981]
15. Javeed S, Benedict B, Yakdan S, et al. Implications of Preoperative Depression for Lumbar Spine Surgery Outcomes: A Systematic Review and Meta-Analysis. *JAMA Netw Open* 2024; 7(1): e2348565[<https://doi.org/10.1001/jamanetworkopen.2023.48565>][PMID: 38277149]

16. Ritschl V, Weigl R, Stamm T, editors. *Wissenschaftliches Arbeiten und Schreiben: Verstehen, Anwenden, Nutzen für die Praxis*. 2. Auflage. Berlin, Heidelberg: Springer; 2023.
17. Blümle A, Sow D, Nothacker M, et al. *Manual Systematische Recherche für Evidenzsynthesen und Leitlinien: Cochrane Deutschland Stiftung, Institut für Evidenz in der Medizin, Institut für Medizinische Biometrie und Statistik, Freiburg, Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften - Institut für Medizinisches Wissensmanagement, Ärztliches Zentrum für Qualität in der Medizin; 2020 [cited 2025 March 11] Available from: URL: <https://www.cochrane.de/de/literaturrecherche>.*
18. Cashin A, McAuley J. Clinimetrics: Physiotherapy Evidence Database (PEDro) Scale. *J Physiother* 2020; 66(1): 59[<https://doi.org/10.1016/j.jphys.2019.08.005>][PMID: 31521549]
19. Baethge C, Goldbeck-Wood S, Mertens S. SANRA-a scale for the quality assessment of narrative review articles. *Res Integr Peer Rev* 2019; 4: 5.
20. Dove L, Jones G, Kelsey L, Cairns M, Schmid A. How effective are physiotherapy interventions in treating people with sciatica? A systematic review and meta-analysis. *European spine journal* 2023; 32(2): 517–33[<https://doi.org/10.1007/s00586-022-07356-y>][PMID: 36580149]
21. Jäntschi-Rieckert M, Rommel O, Kästner V, Maercklin-Rommel L, Jäger G. Konservative Kombinationstherapie beim lumbalen Bandscheibenvorfall mit Nervenwurzelreizsyndrom mit mechanischer Physiotherapie (McKenzie), Gabapentin und transforaminalen epiduralen Infiltrationen. *Schmerz* 2024[<https://doi.org/10.1007/s00482-024-00824-y>][PMID: 39134776]
22. Taxer B. Die Rolle der Physiotherapie bei neuropathischen Schmerzen. *Schmerz Nachrichten* 2024; 24(2): 84–7[<https://doi.org/10.1007/s44180-024-00177-z>]
23. Laube W. Neuroanatomie und Neurophysiologie der Motorik: Wechselwirkungen des sensomotorischen Systems. In: Strobl W, Abel C, Pitz E, Schikora N, editors. *Therapeutisches Arbeiten in der Neuroorthopädie: Multiprofessionelle Teamarbeit und transdisziplinäres Denken*. Berlin, Heidelberg: Springer 2021; 10–5.
24. Malfliet A, Kregel J, Coppieters I, et al. Effect of Pain Neuroscience Education Combined With Cognition-Targeted Motor Control Training on Chronic Spinal Pain: A Randomized Clinical Trial. *JAMA Neurol* 2018; 75(7): 808–17[<https://doi.org/10.1001/jamaneurol.2018.0492>][PMID: 29710099]
25. Rushton A, Heneghan N, Heymans M, Staal J, Goodwin P. Clinical course of pain and disability following primary lumbar discectomy: systematic review and meta-analysis. *European spine journal* 2020; 29(7): 1660–70[<https://doi.org/10.1007/s00586-019-06272-y>][PMID: 31916000]
26. Hermansen A, Hedlund R, Zsigmond P, Peolsson A. A more than 20-year follow-up of pain and disability after anterior cervical decompression and fusion surgery for degenerative disc disease and comparisons between two surgical techniques. *BMC Musculoskelet Disord* 2023; 24(1): 406[<https://doi.org/10.1186/s12891-023-06503-w>][PMID: 37217867]
27. Liu C, Ferreira G, Abdel S, et al. Surgical versus non-surgical treatment for sciatica: systematic review and meta-analysis of randomised controlled trials. *BMJ* 2023; 381: e070730[<https://doi.org/10.1136/bmj-2022-070730>][PMID: 37076169]
28. Rickers K, Pedersen P, Tvedebrink T, Eiskjær S. Comparison of interventions for lumbar disc herniation: a systematic review with network meta-analysis. *The spine journal* 2021; 21(10): 1750–62[<https://doi.org/10.1016/j.spinee.2021.02.022>][PMID: 33667683]
29. Manchikanti L, Knezevic E, Knezevic N, et al. Epidural Injections for Lumbar Radiculopathy or Sciatica: A Comparative Systematic Review and Meta-Analysis of Cochrane Review. *Pain Physician* 2021; 24(5): 539–554[PMID: 34323441]
30. Clark R, Weber RP, Kahwati L. Surgical Management of Lumbar Radiculopathy: a Systematic Review. *J Gen Intern Med* 2020; 35(3): 855–64[<https://doi.org/10.1007/s11606-019-05476-8>][PMID: 31713029]
31. Özden F, Koçyiğit GZ. The effect of early rehabilitation after lumbar spine surgery: a systematic review and meta-analysis. *Egypt J Neurosurg* 2024; 39(1): 8[<https://doi.org/10.1186/s41984-024-00270-z>]
32. Kim C, Choi Y, Chung C, et al. Nonsurgical treatment outcomes for surgical candidates with lumbar disc herniation: a comprehensive cohort study. *Sci Rep* 2021; 11(1): 3931 [<https://doi.org/10.1038/s41598-021-83471-y>][PMID: 33594185]

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