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Complete spontaneous resorption of a symptomatic L5–S1 lumbar disc herniation following conservative management despite an initial indication for surgery: a case report with a review of immunobiological mechanisms

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Case Report

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Abstract

Background

Lumbar disc herniation (LDH) is among the leading causes of low back pain and lumbar radiculopathy. Although surgical discectomy is considered the standard treatment for patients with persistent disabling symptoms or neurological deficits, increasing evidence indicates that spontaneous regression of lumbar disc herniation may occur following conservative management, particularly in extruded and sequestrated discs. This phenomenon is believed to result from a coordinated inflammatory response involving macrophage infiltration, angiogenesis, cytokine release, extracellular matrix degradation, and phagocytosis of the herniated fragment. We report a case of complete spontaneous resorption of a symptomatic L5–S1 lumbar disc herniation and discuss the biological mechanisms underlying this remarkable process.

Case presentation

A 48-year-old woman presented with a three-month history of mechanical low back pain that progressively evolved into severe right-sided lumbosciatica associated with L5–S1 paresthesia and painful intermittent claudication. Pain intensity was 9/10 on the visual analogue scale. Neurological examination demonstrated a positive straight-leg-raising test at 30° and a diminished right Achilles tendon reflex without motor deficit or sphincter dysfunction. Lumbar magnetic resonance imaging revealed a right paramedian and foraminal L5–S1 disc herniation causing significant narrowing of the right neural foramen. Initial conservative management consisted of oral corticosteroids, analgesics, and muscle relaxants. Owing to persistent disabling pain, surgery was proposed. However, the patient declined surgical intervention and elected to continue conservative treatment. After gradual pain relief, a structured physiotherapy program was initiated. Follow-up magnetic resonance imaging performed eight months later demonstrated complete spontaneous disappearance of the herniated disc with restoration of the neural foramen, accompanied by marked clinical recovery.

Conclusion

This case highlights that spontaneous lumbar disc regression is an active immunobiological process rather than passive dehydration, supporting individualized treatment strategies in neurologically stable patients. In the absence of progressive neurological deficit or cauda equina syndrome, carefully selected patients may benefit from continued conservative treatment. Current evidence supports an active biological process driven by inflammation, neovascularization, macrophage-mediated phagocytosis, and extracellular matrix remodeling.

Introduction

Lumbar disc herniation is one of the leading causes of lumbar radiculopathy and disability worldwide, accounting for a substantial proportion of spine consultations and surgical procedures.The lifetime

prevalence of symptomatic lumbar disc herniation has been estimated at approximately 2–3%, most commonly affecting adults between the fourth and sixth decades of life. The L4–L5 and L5–S1 levels account for nearly 90% of symptomatic lumbar disc herniations owing to their greater biomechanical stress. Although surgery provides rapid symptom relief in selected patients, spontaneous regression of lumbar disc herniation has increasingly been recognized as part of its natural history.

The natural history of lumbar disc herniation is generally favorable. Most patients experience substantial improvement within several weeks under conservative treatment, including analgesics, nonsteroidal anti-inflammatory drugs, activity modification, and physical rehabilitation. Nevertheless, patients presenting with persistent disabling radiculopathy, progressive motor deficit, or cauda equina syndrome are usually considered candidates for surgical decompression.

During the last three decades, magnetic resonance imaging (MRI) studies have increasingly documented spontaneous regression of lumbar disc herniations. This phenomenon was initially regarded as exceptional but is now recognized as relatively common, particularly in extruded and sequestrated herniations. A large meta-analysis demonstrated that spontaneous regression occurs in the majority of sequestrated discs, followed by extruded discs, whereas protrusions exhibit substantially lower regression rates.

Although spontaneous regression has been well documented radiologically, its biological basis has only recently become clearer. Current evidence suggests that disc resorption is not merely a consequence of dehydration but rather an active immunological process initiated by exposure of the nucleus pulposus to the epidural space. This exposure disrupts the immune privilege of the intervertebral disc and triggers an inflammatory cascade characterized by macrophage recruitment, angiogenesis, cytokine production, matrix metalloproteinase activation, and progressive degradation of the extracellular matrix.

Understanding these mechanisms has important clinical implications because it may help identify patients who can safely undergo prolonged conservative treatment despite severe radiological findings. We report a patient with complete MRI-confirmed spontaneous resorption of an L5–S1 lumbar disc herniation initially considered for surgery and review the current understanding of the biological mechanisms responsible for spontaneous disc regression.

Case Presentation

A 48-year-old woman with no significant medical history presented to our department with a three-month history of mechanical low back pain. Over time, her symptoms progressively evolved into severe right-sided lumbosciatica radiating along the posterior aspect of the lower limb, accompanied by paresthesia in the L5–S1 dermatome and painful intermittent claudication that considerably limited walking distance and daily activities.

Pain intensity was rated 9/10 on the Visual Analogue Scale (VAS). The patient reported marked functional impairment requiring repeated periods of sick leave.

Physical examination revealed lumbar stiffness with marked limitation of lumbar flexion. A right straight-leg-raising test was positive at 30°, reproducing the patient's radicular pain. Neurological examination demonstrated a diminished right Achilles tendon reflex. No motor weakness was detected in the lower limbs, and muscle strength was graded 5/5 according to the Medical Research Council scale. Sensory examination confirmed paresthesia in the L5–S1 distribution. No bladder or bowel dysfunction was present, and there were no clinical features suggestive of cauda equina syndrome.

Lumbar magnetic resonance imaging (MRI) demonstrated a large right paramedian and foraminal L5–S1 disc herniation causing significant narrowing of the right neural foramen and compression of the corresponding nerve root (Fig. 1).

Conservative treatment consisted of oral prednisolone at an initial dose of 1 mg/kg/day, gradually tapered over three weeks, with a new three-week course administered every three months. Additional symptomatic treatment included paracetamol 500 mg combined with codeine 30 mg (Dafalgan Codéiné), one tablet orally four times daily (2 g/day of paracetamol and 120 mg/day of codeine), and pregabalin 50 mg orally twice daily (100 mg/day). These symptomatic medications were maintained throughout the conservative treatment period. Despite this treatment, severe radicular pain initially persisted and substantially impaired the patient’s quality of life. After multidisciplinary discussion, lumbar discectomy was recommended. However, the patient declined surgery, preferring to continue conservative management.

Over the following months, progressive improvement in pain intensity and walking capacity was observed. Once acute symptoms had subsided, the patient underwent a structured physiotherapy program emphasizing lumbar stabilization, stretching exercises, progressive muscle strengthening, and functional rehabilitation.

Eight months after the initial MRI, follow-up imaging demonstrated complete spontaneous disappearance of the L5–S1 herniated disc with restoration of the right neural foramen and resolution of nerve root compression (Fig. 2). This radiological finding correlated with marked clinical improvement, complete resolution of radicular pain, and return to normal daily activities without surgical intervention.

Discussion

Spontaneous regression of lumbar disc herniation (LDH) has evolved from being considered an anecdotal radiological observation to becoming a well-recognized component of the natural history of lumbar disc disease (1–5). The present case illustrates complete MRI-confirmed regression of a symptomatic L5–S1 disc herniation despite an initial indication for surgery, emphasizing that radiological severity alone should not dictate therapeutic decisions (2–5). Instead, the clinical course supports the concept that spontaneous disc resorption represents an active immunobiological phenomenon driven by a complex interplay between inflammation, angiogenesis, extracellular matrix remodeling, and innate immune activation.

The sequential radiological evolution observed in our patient is consistent with the currently accepted biological model of spontaneous lumbar disc resorption (Fig. 3).

From a Mechanical Disorder to an Immunological Disease

Following annular rupture, extrusion of nucleus pulposus into the epidural space disrupts the immune privilege of the intervertebral disc and initiates a cascade of inflammatory and reparative events leading to spontaneous disc resorption (Fig. 4).

Traditionally, lumbar disc herniation was viewed as a purely mechanical disorder in which nerve root compression explained both pain and neurological dysfunction. Although mechanical compression undoubtedly contributes to radicular symptoms, increasing experimental evidence indicates that biochemical inflammation is equally important.

The intervertebral disc is an immune-privileged structure (6,7). The nucleus pulposus is normally isolated from systemic immune surveillance by the annulus fibrosus and cartilaginous endplates, a concept referred to as the blood-disc barrier **(6,8)**. During disc extrusion, rupture of the annulus disrupts this barrier and exposes nucleus pulposus antigens to the epidural immune environment. Immune cells therefore recognize the extruded disc fragment as foreign tissue, initiating an inflammatory response that paradoxically promotes its elimination rather than its persistence.

Exposure of nucleus pulposus tissue following annular rupture initiates an inflammatory cascade responsible for spontaneous regression **(7–10)**.

This concept fundamentally changes the understanding of spontaneous regression. Rather than representing passive degeneration, disc disappearance should be regarded as an organized process of immune-mediated tissue clearance.

The Inflammatory Cascade: The First Step Toward Resorption

Exposure of nucleus pulposus tissue activates resident macrophages, dendritic cells, and endothelial cells, leading to rapid secretion of pro-inflammatory cytokines including TNF-α, IL-1β, IL-6, IL-8, prostaglandin E2, nitric oxide, and cyclooxygenase-2 **(9–12)**.

These mediators have a dual role. Initially, they contribute to radicular pain by sensitizing nerve roots and increasing vascular permeability. Simultaneously, they orchestrate recruitment of inflammatory cells that ultimately degrade the herniated fragment.

Activation of the NF-κB signaling pathway appears central to this response. Once activated, NF-κB induces transcription of cytokines, chemokines, adhesion molecules, and matrix metalloproteinases, thereby amplifying both inflammation and tissue remodeling. This duality explains why the same inflammatory response responsible for severe pain may ultimately favor spontaneous healing **(11–14)**.

Macrophages: The Principal Effectors of Disc Resorption

Macrophages represent the principal effector cells responsible for spontaneous disc resorption through coordinated phagocytosis, extracellular matrix degradation, and regulation of angiogenesis, as summarized in Fig. 4.

Among inflammatory cells, macrophages appear to be the dominant mediators of spontaneous regression. Histopathological studies consistently demonstrate abundant macrophage infiltration surrounding regressing disc fragments **(4,10,15,16)**.

Current evidence suggests that macrophage polarization determines the outcome of the inflammatory response. Classically activated M1 macrophages predominate during the early phase, secreting TNF-α, IL-1β, IL-6, reactive oxygen species, and inducible nitric oxide synthase, thereby amplifying inflammation and promoting recruitment of additional immune cells.

As tissue degradation progresses, macrophages gradually acquire an M2 phenotype characterized by secretion of IL-10, transforming growth factor-β (TGF-β), and arginase-1. These reparative macrophages promote phagocytosis of disc debris, resolution of inflammation, extracellular matrix remodeling, and tissue repair (10).

The balance between M1 and M2 polarization may therefore determine whether inflammation becomes chronic or evolves toward complete disc resorption. Identifying factors that promote this phenotypic switch may represent a future therapeutic strategy.

Angiogenesis: Opening the Door to Immune Cell Recruitment

Healthy intervertebral discs are among the largest avascular tissues in the human body. Consequently, spontaneous regression cannot occur unless immune cells gain access to the extruded fragment.

Angiogenesis represents the critical link between inflammation and tissue clearance. Cytokine-induced expression of vascular endothelial growth factor (VEGF), fibroblast growth factor (FGF), and platelet-derived growth factor (PDGF) stimulates formation of new capillaries around the herniated fragment (10,11). These vessels allow continuous recruitment of circulating monocytes and macrophages while facilitating delivery of oxygen and proteolytic enzymes.

Contrast-enhanced MRI frequently demonstrates peripheral enhancement around extruded herniations, a finding believed to reflect neovascularization. Several studies have suggested that rim enhancement may predict subsequent spontaneous regression, making it a potentially valuable imaging biomarker for conservative management (12).

Extracellular Matrix Remodeling

Successful resorption requires degradation of the dense extracellular matrix that characterizes nucleus pulposus tissue.

This process is mediated primarily by matrix metalloproteinases (MMP-3, MMP-7, MMP-9, and MMP-13), whose expression increases markedly following disc extrusion. These enzymes digest collagen, aggrecan, laminin, fibronectin, and proteoglycans, progressively fragmenting the disc matrix (10,14).

Their activity is regulated by tissue inhibitors of metalloproteinases (TIMPs). The dynamic balance between MMPs and TIMPs determines whether extracellular matrix degradation predominates or whether the disc fragment persists (10,14). Future pharmacological modulation of this balance could theoretically accelerate spontaneous resorption.

Beyond Inflammation: Emerging Molecular Mechanisms

Recent studies suggest that additional molecular pathways participate in spontaneous regression.

Toll-like receptors (TLR2 and TLR4) expressed by disc cells recognize damage-associated molecular patterns released after annular rupture, amplifying innate immune activation through NF-κB signaling.

MicroRNAs also appear to regulate inflammatory responses and extracellular matrix metabolism. Several microRNAs influence macrophage polarization, cytokine production, and MMP expression, suggesting that post-transcriptional regulation may partly explain why some herniations regress whereas others persist (15).

Extracellular vesicles and exosomes released by disc cells represent another emerging field of investigation. These vesicles transport proteins, cytokines, and regulatory RNAs capable of modulating macrophage behavior and angiogenesis, raising the possibility of future cell-free biological therapies.

Clinical Implications and Future Perspectives

The present case illustrates that severe pain and an initial surgical indication do not necessarily preclude spontaneous healing when neurological function remains preserved. Careful patient selection, repeated neurological examination, and shared decision-making remain fundamental.

Importantly, conservative management should never delay surgery in patients with progressive motor deficit or cauda equina syndrome (2,3,5).. However, in neurologically stable patients, MRI characteristics —particularly extrusion, sequestration, and peripheral contrast enhancement—may help identify individuals with a high probability of spontaneous regression.

A better understanding of disc immunobiology opens exciting therapeutic perspectives. Rather than removing the herniated fragment surgically, future treatments may aim to enhance endogenous resorption by modulating macrophage polarization, stimulating physiological angiogenesis, regulating MMP activity, or targeting specific inflammatory signaling pathways. Such strategies could accelerate recovery while preserving disc structure and reducing the need for surgery.

Consequently, the decision to operate should primarily rely on neurological status and clinical evolution rather than imaging appearance alone.

Overall, the present case and the proposed biological model illustrate how an initially symptomatic lumbar disc herniation may evolve toward complete spontaneous resorption through coordinated inflammatory, angiogenic, and tissue-remodeling mechanisms (Figs. 2–4).

Strengths and Limitations of the Present Case

The principal strength of this report lies in the correlation between the clinical evolution and MRI-confirmed complete disappearance of the herniated fragment after conservative management. The observation also illustrates the importance of respecting patient preferences within a shared decision-making process.

Its limitations are those inherent to any single-case report. The biological mechanisms discussed are inferred from current experimental evidence rather than demonstrated directly in this patient, and histopathological confirmation is unavailable because surgery was not performed. Nevertheless, the radiological evolution closely matches the sequence of events described in experimental and translational studies, reinforcing the plausibility of the proposed mechanisms.

Future research should focus on identifying imaging and molecular biomarkers capable of predicting which patients are most likely to experience spontaneous regression. A better understanding of macrophage polarization, angiogenic signaling pathways, cytokine networks, and extracellular matrix remodeling may ultimately lead to targeted biological therapies that enhance endogenous resorption while reducing pain and avoiding unnecessary surgery (6,10,11,14,15).

Future Directions

Advances in molecular biology may soon enable clinicians to identify patients who are most likely to experience spontaneous regression through imaging biomarkers, circulating inflammatory mediators, or molecular profiling of the immune response. Future therapeutic strategies may combine biological modulation of macrophage polarization, targeted regulation of angiogenesis, extracellular matrix remodeling, and regenerative approaches using extracellular vesicles to accelerate endogenous disc resorption while avoiding unnecessary surgery.

Conclusion

This case demonstrates complete magnetic resonance imaging-confirmed spontaneous resorption of a symptomatic L5–S1 lumbar disc herniation following conservative treatment despite an initial recommendation for surgical intervention. The patient's favorable outcome highlights that, in the absence of progressive neurological deficit or cauda equina syndrome, continued non-operative management with close clinical follow-up may represent an appropriate therapeutic option, even in patients with severe radicular pain.

Current evidence indicates that spontaneous disc regression is not simply the consequence of passive dehydration but rather the result of a complex biological process involving loss of immune privilege,

inflammatory cell recruitment, angiogenesis, macrophage-mediated phagocytosis, matrix metalloproteinase activation, extracellular matrix remodeling, and apoptosis of disc cells. These coordinated mechanisms progressively eliminate the extruded nucleus pulposus and account for the radiological disappearance of the herniated fragment.

This case reinforces the importance of integrating clinical findings with imaging rather than basing treatment decisions solely on the size of the herniation. Advances in the understanding of the molecular pathways involved in spontaneous disc resorption may eventually facilitate the development of targeted biological therapies capable of accelerating endogenous regression and reducing the need for surgical intervention in selected patients.

Further prospective studies integrating advanced imaging and molecular biomarkers are warranted to identify patients most likely to benefit from prolonged conservative treatment.

Learning Points

- Complete spontaneous regression of lumbar disc herniation is an established component of the natural history of extruded and sequestrated discs.
- Large symptomatic lumbar disc herniations do not necessarily require immediate surgery when neurological examination remains stable.
- MRI follow-up may demonstrate complete disappearance of the herniated fragment after conservative treatment.
- Macrophage recruitment, angiogenesis, inflammatory cytokines, and extracellular matrix remodeling constitute the principal biological mechanisms responsible for spontaneous disc resorption.
- Careful patient selection and close follow-up remain essential when conservative management is pursued despite an initial surgical indication.

CARE Timeline

Time	Clinical Events
Month 0	Onset of mechanical low back pain
Month 3	Development of severe right L5–S1 radiculopathy with paresthesia and intermittent painful claudication
Initial consultation	VAS 9/10, positive straight-leg raise at 30°, diminished right Achilles reflex, no motor deficit, no sphincter dysfunction
Initial MRI	Right paramedian and foraminal L5–S1 disc herniation causing right foraminal narrowing
Initial treatment	Prednisolone 1 mg/kg/day tapered over 3 weeks (course every 3 months); paracetamol–codeine 500/30 mg four times daily; pregabalin 50 mg twice daily, repeated sick leave
Follow-up	Persistent symptoms leading to recommendation for lumbar discectomy
Shared decision	Patient declined surgery and continued conservative treatment
Rehabilitation	Progressive pain improvement followed by physiotherapy
Month 8	Follow-up MRI demonstrating complete spontaneous resorption of the L5–S1 disc herniation with marked clinical recovery

Declarations

Ethics and consent to participate

According to our institutional policy, ethical committee approval was not required for a single anonymized case report.

Consent for publication

Written informed consent was obtained from the patient for publication of this case report and the accompanying images. A copy of the written consent is available for review by the Editor-in-Chief upon request.

Availability of data and materials

All data generated or analyzed during this study are included in this published article. Additional anonymized information is available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

I.A wrote the main manuscript text

SC, GN, SH, DS, TR, MAS, NJ: supervise, review the manuscript and give method

RM and DL: validation and review

All authors contributed to drafting the manuscript, critically revised the article, and approved the final version.

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Figures

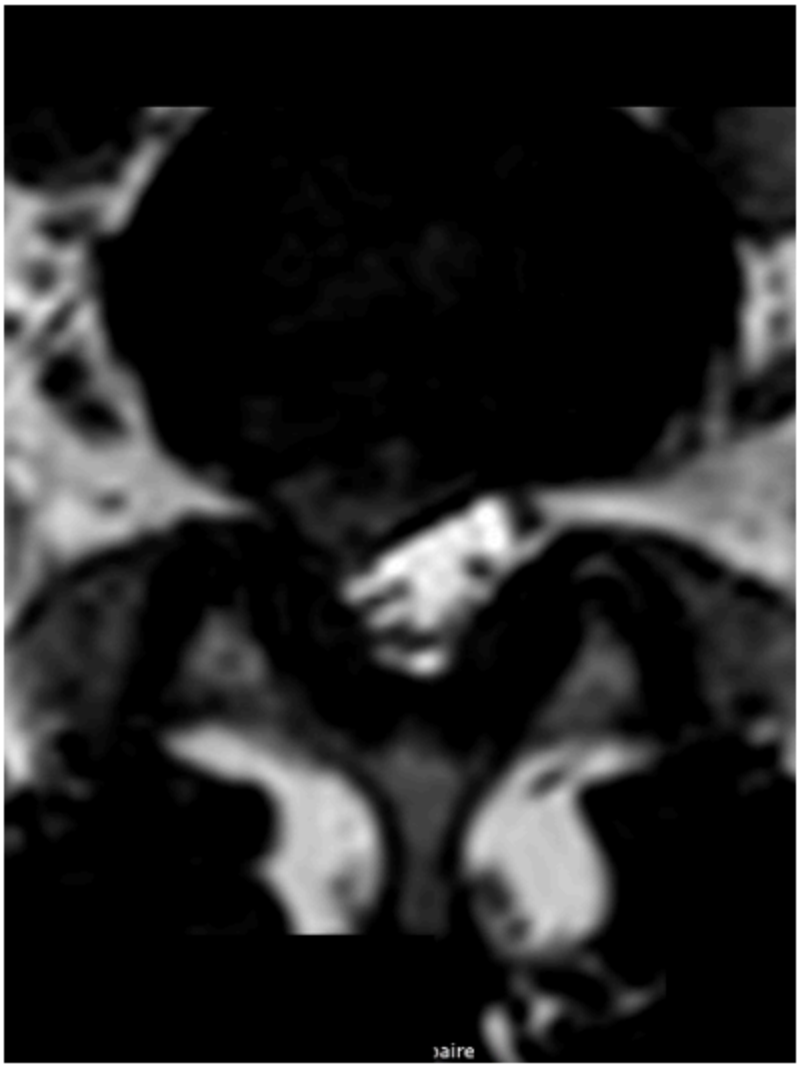


Figure 1

Initial lumbar magnetic resonance imaging. Axial T2-weighted image showing extension into the right neural foramen with compression of the corresponding nerve root.

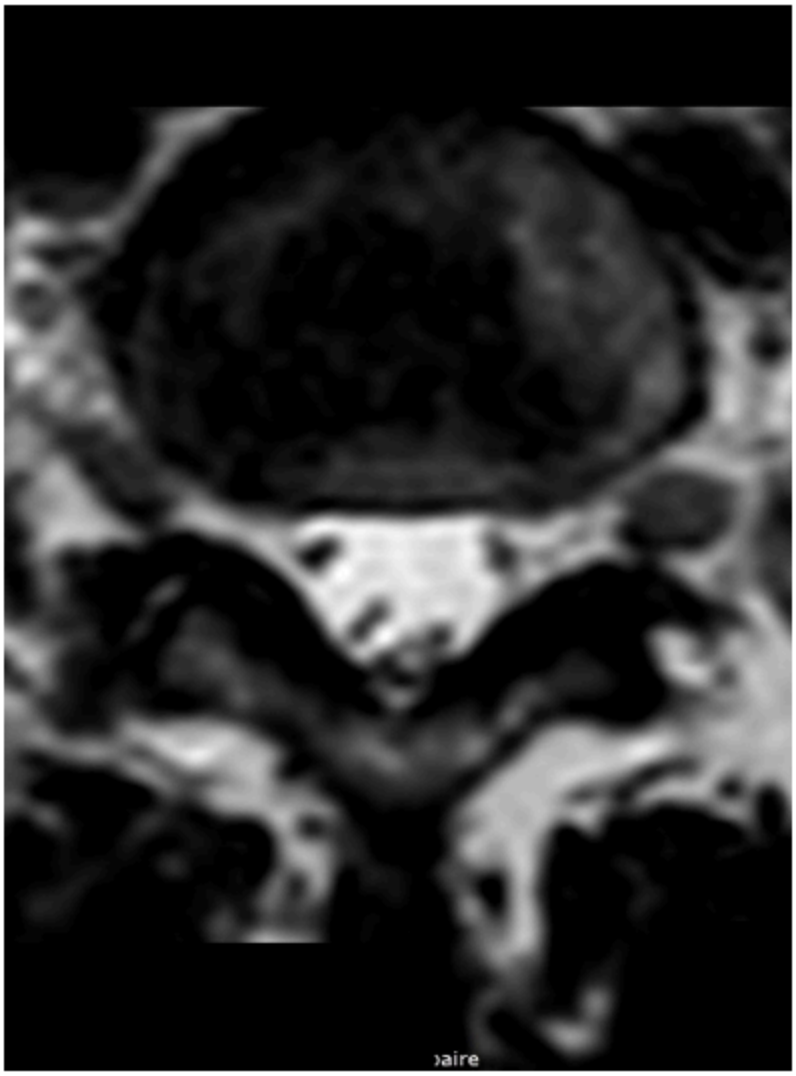


Figure 2

Follow-up lumbar magnetic resonance imaging obtained eight months after initiation of conservative treatment. Axial T2-weighted sequences demonstrate complete spontaneous disappearance of the L5–S1 disc herniation, restoration of the right neural foramen, and resolution of nerve root compression.

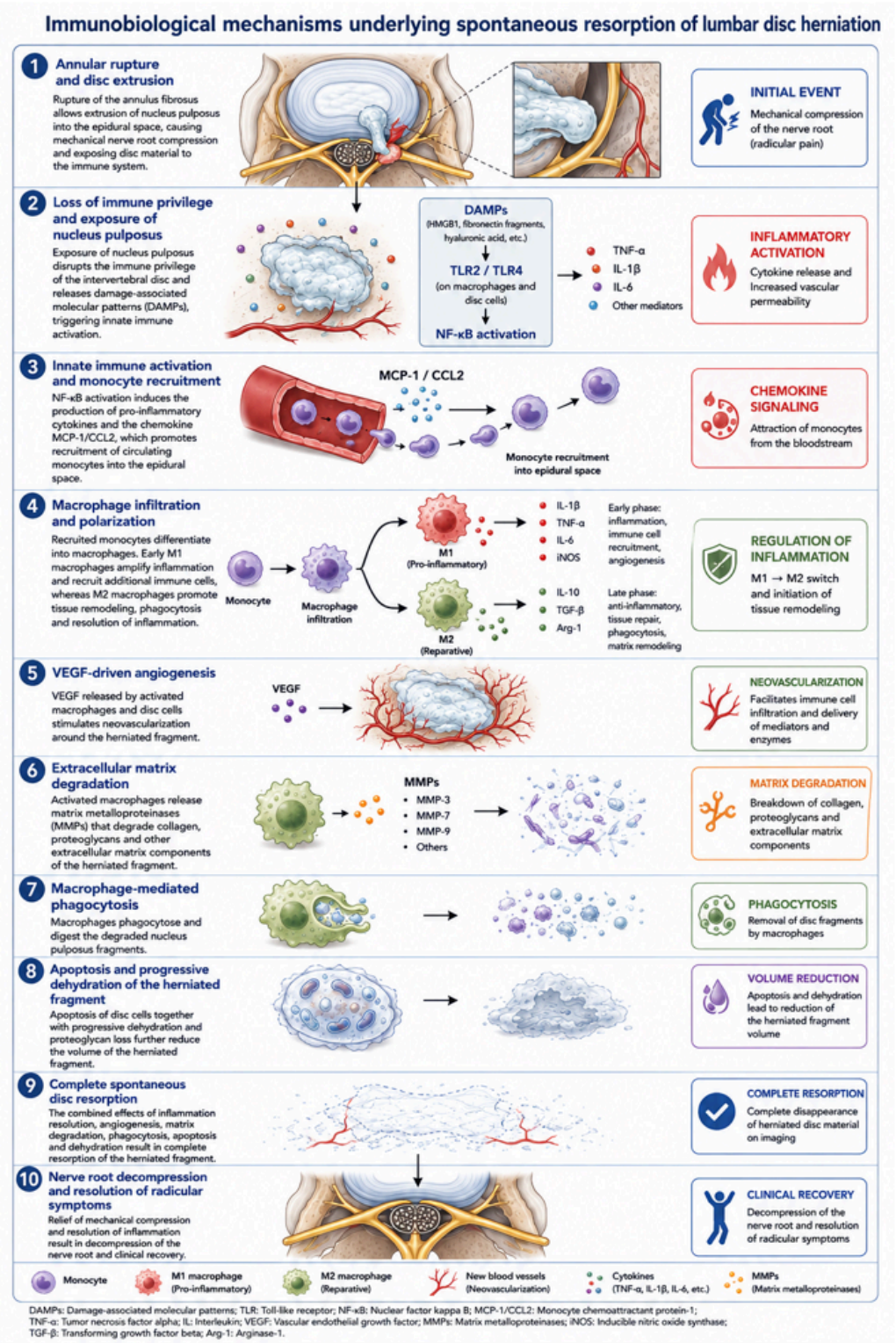


Figure 3

Proposed immunobiological mechanisms underlying spontaneous resorption of lumbar disc herniation

Spontaneous regression of lumbar disc herniation is an active biological process initiated by rupture of the annulus fibrosus, which allows extrusion of the nucleus pulposus into the epidural space. Exposure of the herniated disc material disrupts the immune privilege of the intervertebral disc and triggers

activation of the innate immune system. This process is characterized by the release of pro-inflammatory cytokines, including tumor necrosis factor-α (TNF-α), interleukin (IL)-1β, and IL-6, together with the chemokine monocyte chemoattractant protein-1 (MCP-1/CCL2), which promotes recruitment of circulating monocytes. Following infiltration into the epidural space, monocytes differentiate into macrophages that initially adopt a pro-inflammatory M1 phenotype before progressively switching toward a reparative M2 phenotype. Activated macrophages secrete vascular endothelial growth factor (VEGF), stimulating neovascularization, and matrix metalloproteinases (MMPs), particularly MMP-3, MMP-7, and MMP-9, which degrade collagen, proteoglycans, and other extracellular matrix components of the herniated fragment. In parallel, apoptosis of disc cells and progressive dehydration contribute to fragmentation and volume reduction of the extruded nucleus pulposus. The coordinated effects of inflammation, angiogenesis, extracellular matrix remodeling, macrophage-mediated phagocytosis, apoptosis, and dehydration ultimately result in complete resorption of the herniated disc, decompression of the affected nerve root, and clinical recovery. This figure represents an original synthesis created by the authors based on current evidence regarding the immunobiology of spontaneous lumbar disc herniation regression.

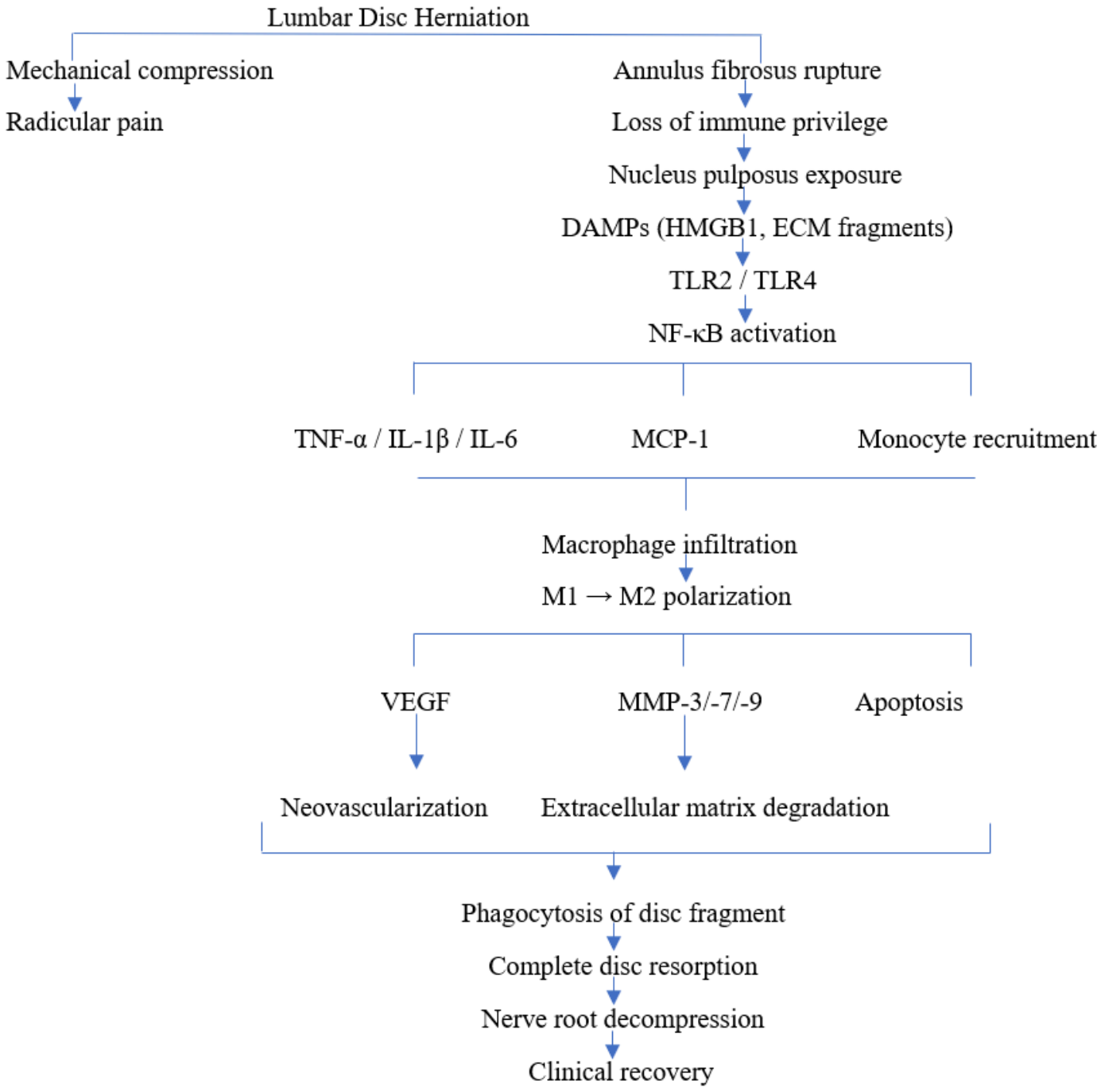


Figure 4

Proposed immunobiological mechanisms underlying spontaneous resorption of lumbar disc herniation.

Following rupture of the annulus fibrosus, extrusion of the nucleus pulposus into the epidural space disrupts the immune privilege of the intervertebral disc, exposing damage-associated molecular patterns (DAMPs) to the host immune system. Activation of Toll-like receptors (TLR2 and TLR4) induces the NF-κB signaling pathway, resulting in the production of pro-inflammatory cytokines, including tumor

necrosis factor-α(TNF-α), interleukin (IL)-1β, and IL-6, as well as the chemokine monocyte chemoattractant protein-1 (MCP-1/CCL2). MCP-1 promotes recruitment of circulating monocytes, which differentiate into macrophages within the epidural space. Macrophages initially exhibit a pro-inflammatory M1 phenotype before transitioning to an anti-inflammatory and reparative M2 phenotype. Activated macrophages release vascular endothelial growth factor (VEGF), promoting neovascularization, and matrix metalloproteinases (MMP-3, MMP-7, and MMP-9), which degrade the extracellular matrix of the herniated disc. In parallel, apoptosis of disc cells contributes to fragmentation of the nucleus pulposus. The combined effects of angiogenesis, extracellular matrix degradation, macrophage-mediated phagocytosis, and tissue remodeling ultimately result in complete resorption of the herniated fragment, decompression of the affected nerve root, and clinical recovery. This illustration is an original synthesis created by the authors based on current evidence regarding the immunobiology of spontaneous lumbar disc herniation regression.

Created by the authors based on the concepts described by Chiu et al., Macki et al., Risbud and Shapiro, Sun et al., Haro et al., and other key studies on spontaneous lumbar disc herniation regression.

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