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LOW BACK PAIN WITH RED FLAGS: MRI INDICATIONS AND DIAGNOSIS OF CAUDA EQUINA SYNDROME

DOR LOMBAR COM SINAIS DE ALERTA: INDICAÇÕES DE RESSONÂNCIA MAGNÉTICA E DIAGNÓSTICO DA SÍNDROME DA CAUDA EQUINA

LUMBALGIA CON SIGNOS DE ALARMA: INDICACIONES DE RESONANCIA MAGNÉTICA Y DIAGNÓSTICO DEL SÍNDROME DE LA COLA DE CABALLO

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Laysa Ohana Mada[1], Marília Canela dos Santos[2], Gabriel Ricardo Rodrigues Cavallaro[3], Joshua Gabriel Inácio[4], Enzo Irribarem Homsi[5], Cássio Antônio de Souza[6], Sophia Leite Arantes[7], Raissa Vieira da Silveira Vasconcellos Lisboa[8], Rodrigo Rodrigues de Brito[9], Erasmo Henrique Rezende Golinelli[10], Vinicius Gregório Plastina da Silva[11], Bianca Biranoski de Oliveira[12]

ABSTRACT

Low back pain rarely reflects a neurological emergency, but delayed recognition of cauda equina syndrome can cause permanent bladder, bowel, sexual, and lower-limb dysfunction. The central diagnostic problem is that commonly used red flags have limited sensitivity and cannot reliably exclude compression when absent. This focused narrative review examines PubMed-indexed guidelines, diagnostic studies, and evidence syntheses on magnetic resonance imaging indications and recognition of cauda equina syndrome. Uncomplicated acute low back pain generally does not require imaging, whereas new bladder dysfunction, saddle sensory disturbance, bowel dysfunction, or progressive neurological deficits warrant urgent assessment and, when cauda equina syndrome is suspected, emergency lumbar MRI. A prospective study of 260 suspected cases found that a post-void residual volume of at least 200 mL increased diagnostic accuracy, but subsequent evidence documented MRI-confirmed incomplete syndrome with residual volumes at or below this threshold. Bladder ultrasonography is therefore an adjunct rather than an exclusion test. Normal anal tone similarly provides insufficient reassurance. MRI establishes whether symptoms correspond to a compressive lesion and supports immediate specialist decisions, while negative imaging requires reassessment for alternative neurological, urological, or pain-related explanations. Decompression should proceed as soon as appropriate after confirmation, without treating a 24- or 48-hour interval as permission to delay. Safe practice depends on recognizing early

[1] Universidade de Marília (UNIMAR). E-mail: laysamada1@gmail.com
[2] Universidade de Araraquara (UNIARA). E-mail: mariliacanela@hotmail.com
[3] Universidade de Araraquara (UNIARA). E-mail: xuxacavallaro@gmail.com
[4] Faculdade de Medicina de Marilia (FAMEMA), E-mail: joshua.inacio@hotmail.com
[5] Universidade Federal de Santa Maria (UFSM). E-mail: enzohomsi@gmail.com
[6] Centro Universitário Faculdade de Medicina do ABC (FMABC). E-mail: cassio.antoniodesouza@gmail.com
[7] Faculdade São Leopoldo Mandic. E-mail: sophialeitearantes@gmail.com
[8] Pontifícia Universidade Católica de Minas Gerais (PUC). Poços de Caldas, Minas Gerais. E-mail: raissasilveiralisboa@gmail.com
[9] Centro Universitário de Maringá (UniCesumar). E-mail: roddrigobrito@hotmail.com
[10] Universidade de Marília (UNIMAR), E-mail: erasmogolinelli@hotmail.com
[11] Universidade Cesumar (UNICESUMAR). Maringá. E-mail: vinicius.gregorio2@hotmail.com
[12] Faculdades Pequeno Príncipe. E-mail: biancabiranoski@icloud.com

changes, documenting their onset, and maintaining a coordinated pathway from initial assessment to imaging and spinal surgical review.

Keywords: Low Back Pain. Cauda Equina Syndrome. Magnetic Resonance Imaging. Red Flags.

RESUMO

A dor lombar raramente reflete uma emergência neurológica, mas o reconhecimento tardio da síndrome da cauda equina pode causar disfunção permanente da bexiga, do intestino, da função sexual e dos membros inferiores. O principal problema diagnóstico é que os sinais de alerta comumente utilizados têm sensibilidade limitada e não podem excluir com segurança a compressão quando ausentes. Esta revisão narrativa focada examina diretrizes indexadas no PubMed, estudos diagnósticos e sínteses de evidências sobre as indicações de ressonância magnética e o reconhecimento da síndrome da cauda equina. A dor lombar aguda não complicada geralmente não requer exames de imagem, enquanto disfunção vesical recente, distúrbio sensorial na região perineal, disfunção intestinal ou déficits neurológicos progressivos justificam avaliação urgente e, quando há suspeita de síndrome da cauda equina, ressonância magnética lombar de emergência. Um estudo prospectivo com 260 casos suspeitos constatou que um volume residual pós-miccional de pelo menos 200 mL aumentava a precisão diagnóstica, mas evidências subsequentes documentaram síndrome incompleta confirmada por ressonância magnética com volumes residuais iguais ou inferiores a esse limiar. Portanto, a ultrassonografia da bexiga é um exame complementar, e não um teste de exclusão. Da mesma forma, o tônus anal normal não oferece segurança suficiente. A ressonância magnética estabelece se os sintomas correspondem a uma lesão compressiva e auxilia na tomada de decisões imediatas por especialistas, enquanto exames de imagem negativos exigem reavaliação para outras explicações neurológicas, urológicas ou relacionadas à dor. A descompressão deve ser realizada o mais breve possível após a confirmação, sem que um intervalo de 24 ou 48 horas seja interpretado como permissão para adiá-la. A prática segura depende do reconhecimento de alterações precoces, da documentação de seu início e da manutenção de um fluxo coordenado desde a avaliação inicial até os exames de imagem e a revisão cirúrgica da coluna vertebral.

Palavras-chave: Dor Lombar. Síndrome da Cauda Equina. Ressonância Magnética. Sinais de Alerta.

RESUMEN

El dolor lumbar rara vez constituye una urgencia neurológica; sin embargo, el retraso en el diagnóstico del síndrome de la cola de caballo puede provocar disfunciones permanentes en la vejiga, el intestino, la función sexual y las extremidades inferiores. El principal desafío diagnóstico radica en que los signos de alarma («banderas rojas») utilizados habitualmente poseen una sensibilidad limitada, de modo que su ausencia no permite descartar con fiabilidad la existencia de una compresión. Esta revisión narrativa analiza guías clínicas, estudios diagnósticos y síntesis de evidencia —indexados en PubMed— sobre las indicaciones para realizar una resonancia magnética (RM) y el reconocimiento del síndrome de la cola de caballo. Por lo general, el dolor lumbar agudo no complicado no requiere pruebas de imagen; no obstante, la aparición de disfunción vesical, alteraciones sensitivas en «silla de montar», disfunción intestinal o déficits neurológicos progresivos justifica una evaluación urgente. Ante la sospecha de un síndrome de la cola de caballo, está indicada una RM lumbar de urgencia. Un estudio prospectivo con 260 casos sospechosos reveló que

un volumen residual posmiccional de al menos 200 ml aumentaba la precisión diagnóstica; sin embargo, evidencia posterior ha documentado casos de síndrome incompleto —confirmados mediante RM— con volúmenes residuales iguales o inferiores a dicho umbral. Por tanto, la ecografía vesical debe considerarse una herramienta complementaria, no una prueba que permita descartar el diagnóstico. Del mismo modo, un tono anal normal no ofrece garantías suficientes. La RM permite determinar si los síntomas se deben a una lesión compresiva y facilita la toma de decisiones inmediatas por parte de los especialistas; si la prueba de imagen resulta negativa, es necesario reevaluar al paciente para buscar otras causas neurológicas, urológicas o relacionadas con el dolor. Una vez confirmado el diagnóstico, la descompresión debe realizarse a la mayor brevedad posible, sin interpretar los intervalos de 24 o 48 horas como un margen que justifique el retraso. Una práctica clínica segura depende de la detección precoz de los cambios, el registro de su momento de aparición y el mantenimiento de un circuito asistencial coordinado, desde la evaluación inicial hasta la realización de pruebas de imagen y la valoración por parte de un especialista en cirugía de columna.

Palabras clave: Dolor Lumbar. Síndrome de la Cola de Caballo. Resonancia Magnética. Signos de Alarma («banderas rojas»).

1 INTRODUCTION

Most episodes of acute low back pain can be managed without immediate imaging, including many presentations accompanied by radicular pain. The clinical task is to identify the smaller group with a credible risk of compression, infection, malignancy, or fracture without exposing all patients to unnecessary investigation. Imaging decisions should therefore reflect the suspected diagnosis and neurological findings rather than pain intensity alone.[1]

Cauda equina syndrome involves dysfunction of the lumbosacral nerve roots, particularly the sacral roots supporting bladder, bowel, sexual, and perineal function. A large lumbar disc herniation is an important cause, but tumors, infection, hematoma, and other compressive disorders can produce a similar emergency. Because irreversible deficits may develop before a complete classical syndrome appears, clinicians need to recognize evolving dysfunction rather than wait for established retention or dense saddle anesthesia.[2,3]

A systematic review of emergency-department low back pain found that serious pathology requiring urgent treatment occurred in 2.5%–5.1% of patients in prospective studies. That estimate includes several disorders and should not be interpreted as the prevalence of cauda equina syndrome itself. It nevertheless demonstrates why the setting, clinical context, and consequences of a missed diagnosis matter when evaluating red flags.[4]

2 OBJECTIVE

This review examines how red flags should guide MRI decisions in adults with low back pain and how cauda equina syndrome should be recognized and investigated. It evaluates the diagnostic contribution of symptoms, neurological examination, post-void residual measurement, and MRI. It also considers the limitations of timing evidence and the practical requirements for safe referral and follow-up.

3 METHODS

A focused narrative review was conducted using targeted PubMed searches through October 16, 2026. Search concepts included low back pain imaging guidelines, cauda equina syndrome, red flags, post-void residual volume, bladder scanning, and surgical timing. Additional records were retrieved by title or identifier to verify influential diagnostic studies and guideline recommendations.

The synthesis prioritized adult clinical evidence, society guidance, diagnostic accuracy studies, and systematic reviews relevant to initial assessment. PubMed metadata and available abstracts were checked for study design, population, numerical results, and limitations. This was not an exhaustive systematic review: no registered protocol, duplicate screening, formal risk-of-bias assessment, or new meta-analysis was undertaken.

4 RESULTS AND DISCUSSION

4.1 WHEN LOW BACK PAIN WARRANTS IMAGING

The American College of Radiology recommends against routine imaging for uncomplicated acute low back pain, with or without radiculopathy. Imaging may become appropriate after a period of unsuccessful conservative management when an intervention is being considered, but that elective pathway does not apply to suspected neurological emergencies. Red flags suggesting cauda equina compression, malignancy, infection, or fracture require a separate assessment and appropriately expedited investigation.[1]

Relevant contextual findings include a history of cancer, substantial trauma or fragility risk, immunosuppression, intravenous drug use, recent infection, and progressive neurological impairment. These findings are neither equally accurate nor interchangeable, and an isolated nonspecific feature should not automatically determine the imaging protocol. The suspected condition establishes both urgency and modality: suspected cauda equina compression requires urgent MRI, while a fracture assessment may begin with other imaging according to the circumstances.[1,4]

MRI is particularly useful when the diagnostic question concerns nerve-root compression and the soft tissues within the spinal canal. A noncontrast lumbar examination commonly identifies a disc-related compressive lesion, while contrast-enhanced imaging may be needed when infection, tumor, or postoperative complications are suspected. The examination should be tailored with radiology and the spinal service, and arranging additional sequences should not create avoidable delay in identifying a significant compressive lesion.[1,3]

4.2 RECOGNIZING EARLY SACRAL DYSFUNCTION

The distinction between incomplete syndrome and syndrome with retention is clinically useful because urinary dysfunction can precede a large retained volume. Patients may describe altered urinary sensation, reduced awareness of bladder filling, difficulty initiating urination, a weak stream, or the need to strain while retaining voluntary control. Painless

retention with overflow represents a more advanced presentation and should not be treated as a prerequisite for referral.[2]

Questions about bladder function should establish what has changed from baseline and when the change began. Asking only about incontinence can miss patients who have impaired sensation or voiding difficulty but have not yet developed leakage. Bowel sensation, continence, perineal sensation, and new sexual dysfunction provide complementary information, especially when symptoms accompany lumbar pain or radiculopathy.[2,5]

Bilateral sciatica and lower-limb weakness can support suspicion, but their absence does not exclude clinically important compression. Conversely, bilateral pain without sacral dysfunction is not itself diagnostic of cauda equina syndrome. Assessment should integrate the distribution, progression, and combination of symptoms while maintaining a low threshold for urgent investigation when new sacral neurological dysfunction is credible.[3,6]

4.3 THE LIMITATIONS OF RED FLAGS

A systematic review including seven studies and 569 participants found that the pooled sensitivities of individual red flags ranged from 0.19 to 0.43, while specificities ranged from 0.62 to 0.88. These ranges describe different symptoms and signs rather than the accuracy of one validated composite rule. Their practical implication is that the presence of a red flag can justify prompt investigation, whereas its absence often provides too little reassurance to exclude compression.[7]

A review of international pathways published in 2025 found broad agreement on urgent MRI when cauda equina syndrome is suspected. Perineal or saddle sensory disturbance and bladder or bowel dysfunction appeared across all included pathways, while other findings and adjunctive tests varied. Agreement on the need for urgent imaging is stronger than agreement on a single clinical checklist that can safely decide against it.[8]

Some traditional descriptions emphasize late findings, such as absent sensation or established incontinence. Using these descriptions rigidly can delay recognition until neurological dysfunction is already severe. Red flags are most useful when interpreted as changes requiring clarification and escalation, rather than as a demand that the patient satisfy every element of a complete syndrome.[2,5]

4.4 NEUROLOGICAL EXAMINATION AND ANAL TONE

The examination should document lower-limb strength, sensation, reflexes, and the relevant sacral sensory findings, with attention to asymmetry and progression. Findings should be described specifically rather than summarized as an unexplained normal neurological examination. A patient's symptoms may warrant MRI even when measurable motor loss is absent, because sacral dysfunction and limb motor deficits do not invariably evolve together.[3,8]

Digital rectal assessment of anal tone has traditionally been included in suspected cauda equina examinations, but its diagnostic value is limited. A systematic review of six studies involving 741 patients found anal-tone sensitivity ranging from 0.23 to 0.53 and warned about false reassurance. Normal tone should therefore not be used to cancel imaging or overrule a concerning history, and any examination performed should follow local guidance with consent and appropriate documentation.[9]

4.5 BLADDER SCANNING AS AN ADJUNCT

Katzouraki and colleagues prospectively assessed 260 patients with suspected syndrome using examination, bladder scanning, and MRI. A post-void residual threshold of at least 200 mL had 94.1% sensitivity and 66.8% specificity for MRI-demonstrated compression in that selected referral population. The high negative predictive value of 98.7% was population dependent and should not be interpreted as an intrinsic property guaranteeing exclusion in every patient.[6]

Subsequent evidence demonstrates why the threshold cannot function as an independent rule-out test. In a selected medicolegal series, 13 of 26 patients with recorded bladder measurements had a clear clinical and MRI diagnosis despite residual volumes at or below 200 mL, and all were classified as incomplete syndrome. The selection prevents estimating prevalence or sensitivity in routine care, but the cases establish that clinically important compression can occur before marked retention develops.[10]

A later systematic review found that a 200 mL threshold performed better than other tested residual cutoffs, with pooled sensitivity of approximately 82%. This estimate differs from the prospective cohort result and illustrates the effect of study selection and heterogeneity. Both bodies of evidence support using bladder ultrasonography to increase or refine suspicion while preserving urgent MRI when symptoms or examination remain concerning.[11]

A high residual volume can have explanations other than cauda equina compression, including medication effects and pre-existing urological dysfunction. A low residual can coexist with early or incomplete neurological impairment, especially if the patient can still void voluntarily. Recording the clinical context, timing of voiding, and baseline function is therefore more informative than documenting a number without interpretation.[10,11]

4.6 URGENT MRI AND REFERRAL

When the clinical picture suggests cauda equina syndrome, MRI and specialist referral should proceed through an emergency pathway. A routine outpatient request is inappropriate if it creates delay while neurological function is deteriorating. Where MRI is unavailable locally, clinicians should coordinate with the receiving spinal service and arrange access or transfer according to the patient's condition rather than substitute reassurance from a normal anal-tone examination or low residual volume.[3,12]

MRI interpretation must identify whether the anatomical lesion explains the clinical syndrome and whether urgent decompression is indicated. The referral should communicate symptom onset, progression, bladder and bowel changes, neurological findings, and any evidence of infection, malignancy, anticoagulant exposure, or trauma. Specific communication allows the specialist team to distinguish a time-critical compressive presentation from incidental degenerative abnormalities.[1,12]

A scan without cauda equina compression does not make the symptoms unimportant or prove a functional diagnosis. Persistent or unexplained deficits may require reassessment for another neurological level, noncompressive disease, urological pathology, or contributors related to pain and medication. The next investigation should follow the clinical findings, and a negative lumbar study should not prevent escalation when the patient continues to deteriorate.[3]

4.7 SURGICAL TIMING AND THE MEANING OF URGENCY

The World Federation of Neurosurgical Societies recommends decompression within 48 hours and preferably within 24 hours for confirmed cauda equina or conus medullaris compression. These recommendations support prompt treatment rather than a guaranteed safe interval before surgery. A patient with rapidly progressive deficits requires immediate specialist action, and a presentation beyond a proposed time threshold remains an emergency rather than becoming futile to treat.[3]

An updated systematic review of 110 studies involving 52,008 patients found substantial variation in definitions and the starting point used to measure time to surgery. Symptom onset, onset of urinary dysfunction, presentation, and diagnosis are different time points, making simple comparisons difficult. Observational timing evidence is also affected by baseline neurological severity and referral patterns, so it cannot define an exact biological deadline applicable to every patient.[13]

Documenting the sequence of symptoms and decisions remains essential despite uncertainty about the optimal numerical threshold. Delays in recognition, imaging access, interpretation, transfer, and surgical availability represent different opportunities for improvement. A coordinated pathway should reduce these avoidable delays while preserving individualized specialist judgment about the operation and perioperative risks.[8,12]

Table 1

Evidence informing diagnosis and urgent investigation

Reference	Population / Intervention / Comparison	Outcomes	Main conclusions
ACR Expert Panel (2021) [1]	ACR imaging guideline; adults with low back pain.	Routine imaging discouraged for uncomplicated acute symptoms.	Suspected CES, infection, malignancy, or fracture requires a separate imaging pathway.
Vaishya et al. (2024) [3]	WFNS recommendations on CES and related syndromes.	Urgent MRI for suspected CES; early decompression for confirmed compression.	Clinical suspicion should trigger an emergency investigation pathway.
Katzouraki et al. (2020) [6]	Prospective study; 260 suspected-CES referrals; bladder scanning before MRI.	PVR ≥200 mL: sensitivity 94.1%, specificity 66.8%, NPV 98.7%.	Useful adjunct; predictive values depend on the referred population.
Dionne et al. (2019) [7]	Systematic review; seven studies, 569 participants; red flags compared with MRI.	Sensitivity range 0.19–0.43; specificity range 0.62–0.88.	Individual red flags are insufficiently sensitive to exclude CES.
Tabrah et al. (2022) [9]	Systematic review; six studies, 741 patients; digital rectal examination.	Anal-tone sensitivity 0.23–0.53.	Normal tone risks false reassurance and should not cancel indicated MRI.
Todd et al. (2022) [10]	Selected medicolegal series; 26 of 50 cases had PVR measurements.	Thirteen clear MRI-confirmed incomplete-CES cases had PVR ≤200 mL.	Low residual does not exclude incomplete CES; selected series cannot estimate routine prevalence.

CES, cauda equina syndrome; MRI, magnetic resonance imaging; NPV, negative predictive value; PVR, post-void residual; WFNS, World Federation of Neurosurgical Societies. Values retain the original study definitions.

5 LIMITATIONS AND IMPLICATIONS FOR PRACTICE

Diagnostic studies often enroll referred patients rather than all adults presenting with back pain, which affects disease prevalence and predictive values. Symptom definitions, examination methods, and MRI criteria also differ between studies, and selected medicolegal cases cannot estimate routine diagnostic performance. These limitations favor an integrated assessment with urgent imaging when suspicion persists, rather than dependence on a single symptom or bedside measurement.[7,10,11]

This review used a focused, purposive selection of PubMed-indexed sources and relied substantially on abstracts and published guideline summaries. It did not perform a new quantitative synthesis or formal appraisal of each study. Its practical conclusions reflect convergence between diagnostic evidence and society recommendations, with uncertainty retained where the evidence does not support a precise threshold.

6 CONCLUSION

Suspected cauda equina syndrome requires urgent MRI because clinical red flags and examination findings lack sufficient sensitivity to exclude compression reliably. New bladder or bowel dysfunction, saddle sensory changes, and progressive neurological deficits should prompt immediate assessment, while a post-void residual at or below 200 mL and normal anal tone must not provide false reassurance. Prompt specialist coordination and decompression when indicated offer the best opportunity to prevent further neurological deterioration.[3,9,10]

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