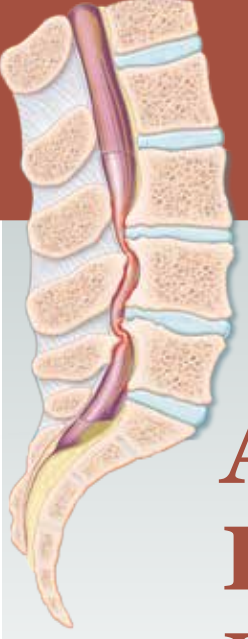

A Practical Guide to Managing Low Back Pain in the Primary Care Setting: Imaging, Diagnostic Interventions and Treatment—Part 2

ABSTRACT

Low back pain (LBP) is one of the most common presenting complaints in the primary care setting with significant economic implications and impairment of quality of life. Effective treatment of LBP can frequently be delivered in the primary care setting. Knowledge of common pain generators and recognition of pain patterns based on the history and physical exam helps guide the treatment of LBP without the need for excessive resource utilization. The majority of patients presenting with LBP can be confidently managed with targeted conservative management; when this fails further investigation may be warranted. Part 2 of this review focuses on imaging and diagnosis of LBP, as well as a detailed review of treatment modalities.

KEYWORDS: low back pain, imaging, diagnostic interventions, treatment

CME Pre-test Quiz

This paper represents the second part of a two-part series. See Part 1 for a detailed overview of the clinical evaluation and initial triage of LBP.

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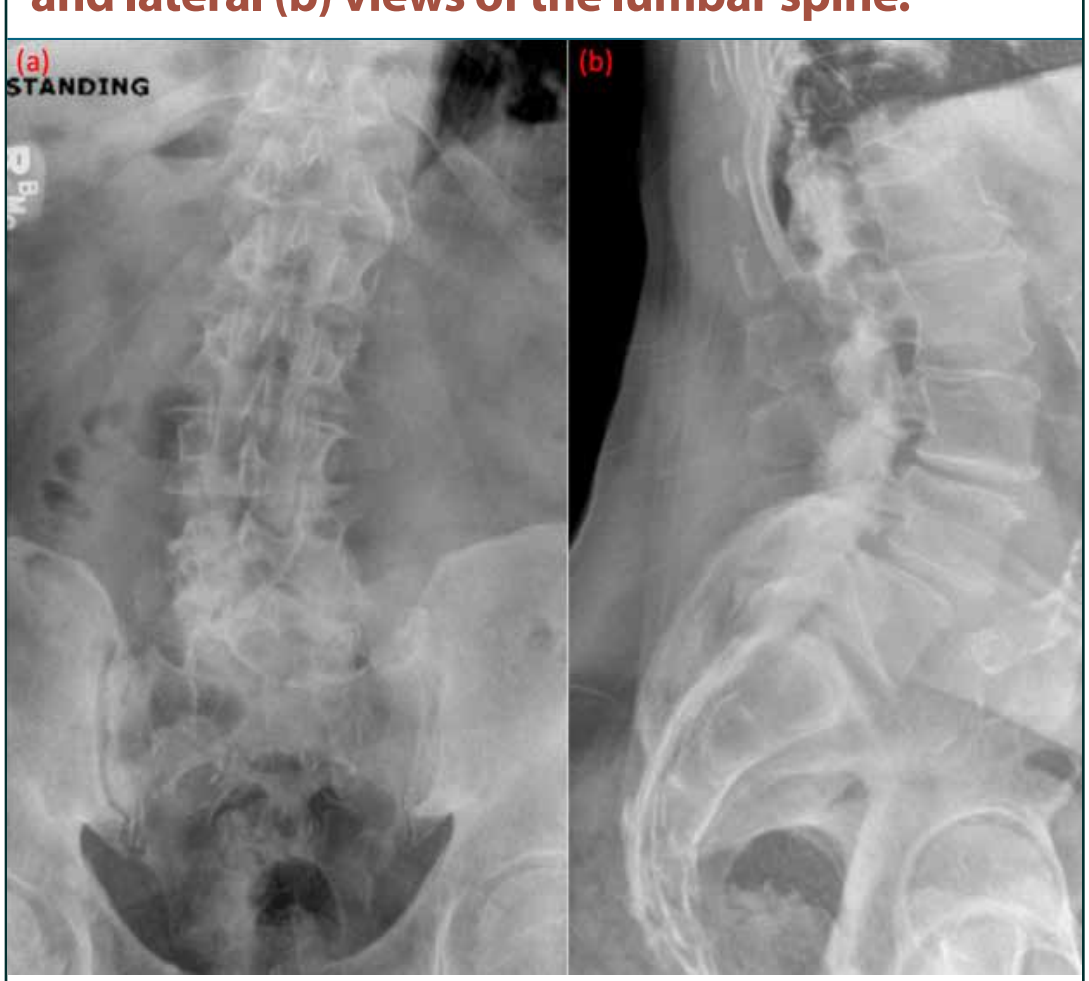
Imaging

Numerous studies have shown that imaging, before conservative treatments have been attempted, provides minimal clinical benefit in managing patients with mechanical low back pain (LBP).[1] Of course, if red flags are present, imaging may be urgently indicated as discussed in Part 1.[2] As a general guide, if 6-8 weeks of conservative management have not provided improvement, proceed with lumbar imaging.

Figure 1: Upright plain radiographs of the lumbar spine. Images represented are AP (a) and lateral (b) views of the lumbar spine.



There is a coronal plane deformity (scoliosis) on the AP view, and a grade 1 spondylolisthesis at the L4-5 level on the lateral view. On both images, radiographic degenerative changes can be seen including reduced disc height and non-bridging marginal syndesmophytes at multiple levels, and hypertrophic/sclerotic changes about the facet joints.

Plain Radiographs:

Upright plain AP and lateral radiographs (XRs) serve as the initial imaging study (Figure 1). XRs are economical, readily available and evaluate alignment and significant bony trauma. On dynamic flexion-extension views they can assess instability such as a mobile spondylolisthesis. They have limited effectiveness in identifying nondisplaced fractures, metastases, and soft-tissue abnormalities. It is prudent to avoid ordering oblique views as this results in substantially higher overall radiation exposure. The radiation dose limits use of XRs in pregnant patients.[1]

Computed Tomography (CT)

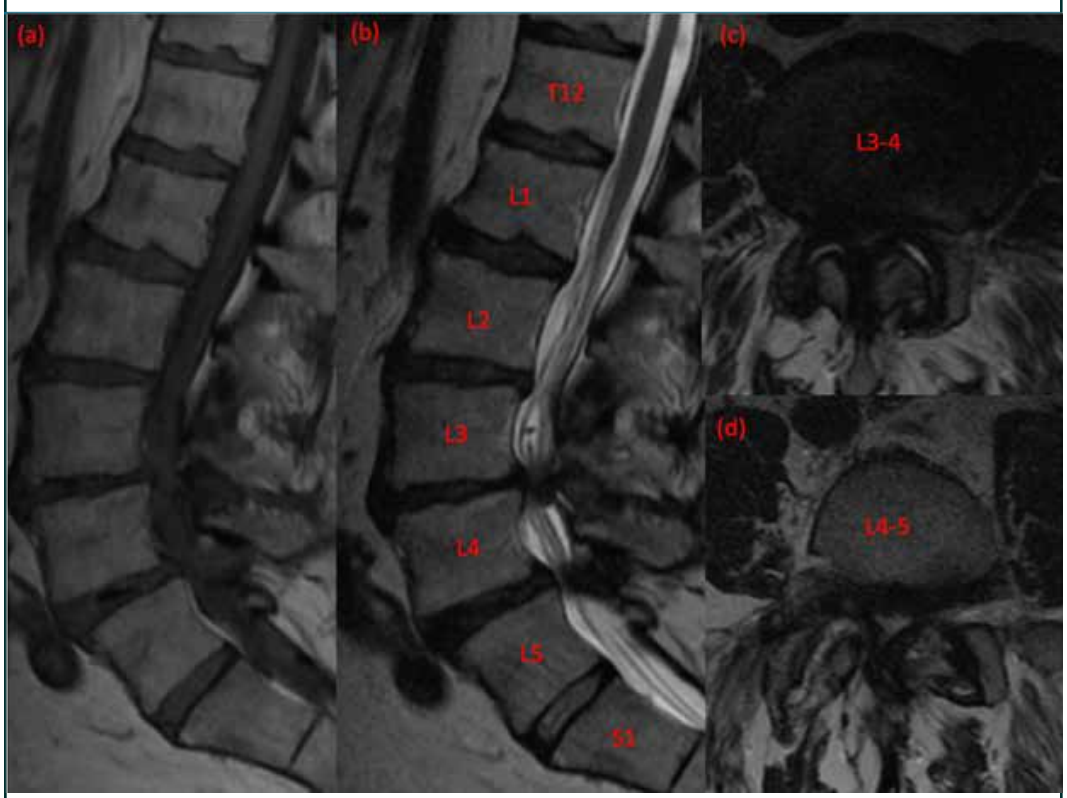
CT allows for high resolution imaging of the bony architecture and visualization of pathology such as fractures, facet arthropathy, osteophytes/syndesmophytes, or decreased bone density in a lytic lesion (Figure 3). Reduced disc height and the presence of a vacuum phenomenon may indicate disc degeneration. Using "soft-tissue windows" allows a crude assessment of lumbar spinal stenosis.[7] CT myelography is a reasonable alternative for patients in which MRI is contraindicated (Figure 4).[7]

Magnetic Resonance Imaging (MRI)

MRI is the gold standard to image spinal soft tissues and neural ele-

ments (Figure 2).[3] MRI allows visualization of degenerative changes in the disc and the facets, and shows neural compression in spinal canal and foramina. MRI with gadolinium contrast can be used to diagnose and characterize the extent of tumors and infection. Due to its sensitivity, there are frequently false positive findings and images often do not correlate with clinical complaints. The clinical relevance of MRI findings must be interpreted.[4-6]

Figure 2: MRI of the lumbar spine. Images represented are mid-sagittal T1-weighted sequence (a), mid-sagittal T2-weighted sequence (b), and axial cuts at the L3-4 (c) and L4-5 (d) levels.



On the mid-sagittal T2-weighted image, multi-level disc degeneration can be seen with low signal within the disc indicating desiccation of the nucleus pulposus. On this image, central canal stenosis can also be appreciated. However, the axial images are the most reliable for assessing the extent of stenosis in the central canal and lateral recesses. In the axial images above, high-grade central canal stenosis can be seen at both levels due to disc bulging and thickening of the ligamentum flavum, in the setting of pre-existing congenital canal stenosis. On the axial images, facet arthropathy can be appreciated as well, which is most pronounced on the right side at L4-5. In this instance, the conus medullaris ends roughly at the L1-2 level, as seen on the mid-sagittal images. The L5-S1 segment is a non-mobile transitional level in this patient, which is a normal variant.

Nuclear Medicine:

Nuclear medicine scans, including bone scintigraphy and gallium scans, can be helpful in select cases to identify malignancy, infection and certain osseous diseases such as Paget disease and fibrous dysplasia.[8] Bone scintigraphy with single photon emission computed tomography (SPECT/CT) is emerging as a novel modality for identifying axial pain generators in the spine. In the setting of diffuse spinal degeneration, uptake of radiotracer revealed on CT scan may aid in anatomical localization of pain; however, the specific indications and potential pitfalls of SPECT/CT are still being delineated.[9]

Diagnostic Interventions

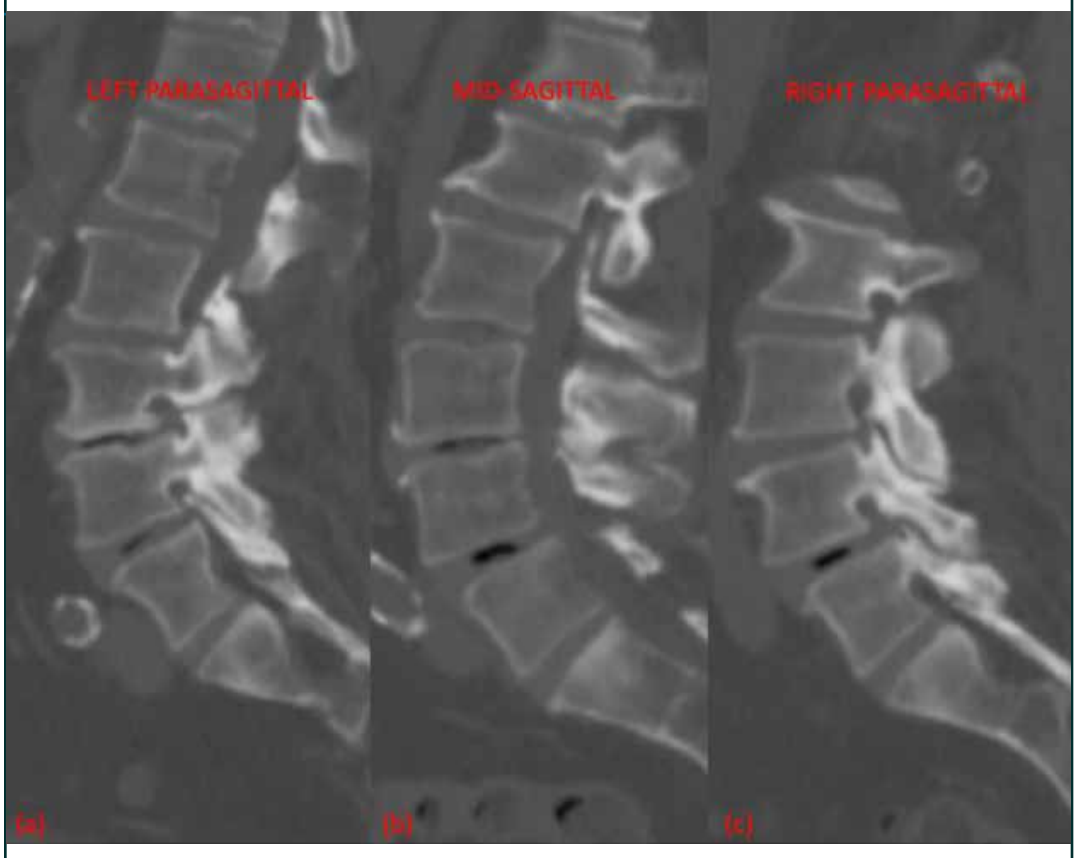
When a patient fails initial conservative treatment, it becomes more important to identify the pain generating structure(s). The differential diagnosis can be formed by combining the clinical evaluation with the findings on advanced imaging. Diagnostic injections may identify a relevant pain generator. It is important to distinguish between an injection that serves a purely diagnostic purpose versus a therapeutic intervention whose primary purpose

is symptom relief with diagnostic information as a secondary benefit. Table 1 lists some of the commonly utilized diagnostic interventions. The patient should keep a pain diary that can be reviewed by a provider to determine the patient's response (Figure 5).

Nonsurgical Treatment

Research has demonstrated that, compared to standard care, a risk-stratified approach with targeted treatments based on a patient's propensity for chronicity results in superior patient outcomes and is cost-effective.[10] The STarT Back assessment tool, which stratifies a patient's risk of chronicity as low, medium or high, is an efficient screening method that can be implemented in clinical practice.[10,11] It identifies patients likely to require more extensive treatment to successfully reduce their pain and disability. In this section we describe a variety of treatment options available to LBP patients; many are complementary and may be used in combination, especially if there is a high risk for chronicity (Table 2).

Figure 3: CT of the lumbar spine. Images represented are left parasagittal (a), mid-sagittal (b), and right parasagittal (c).



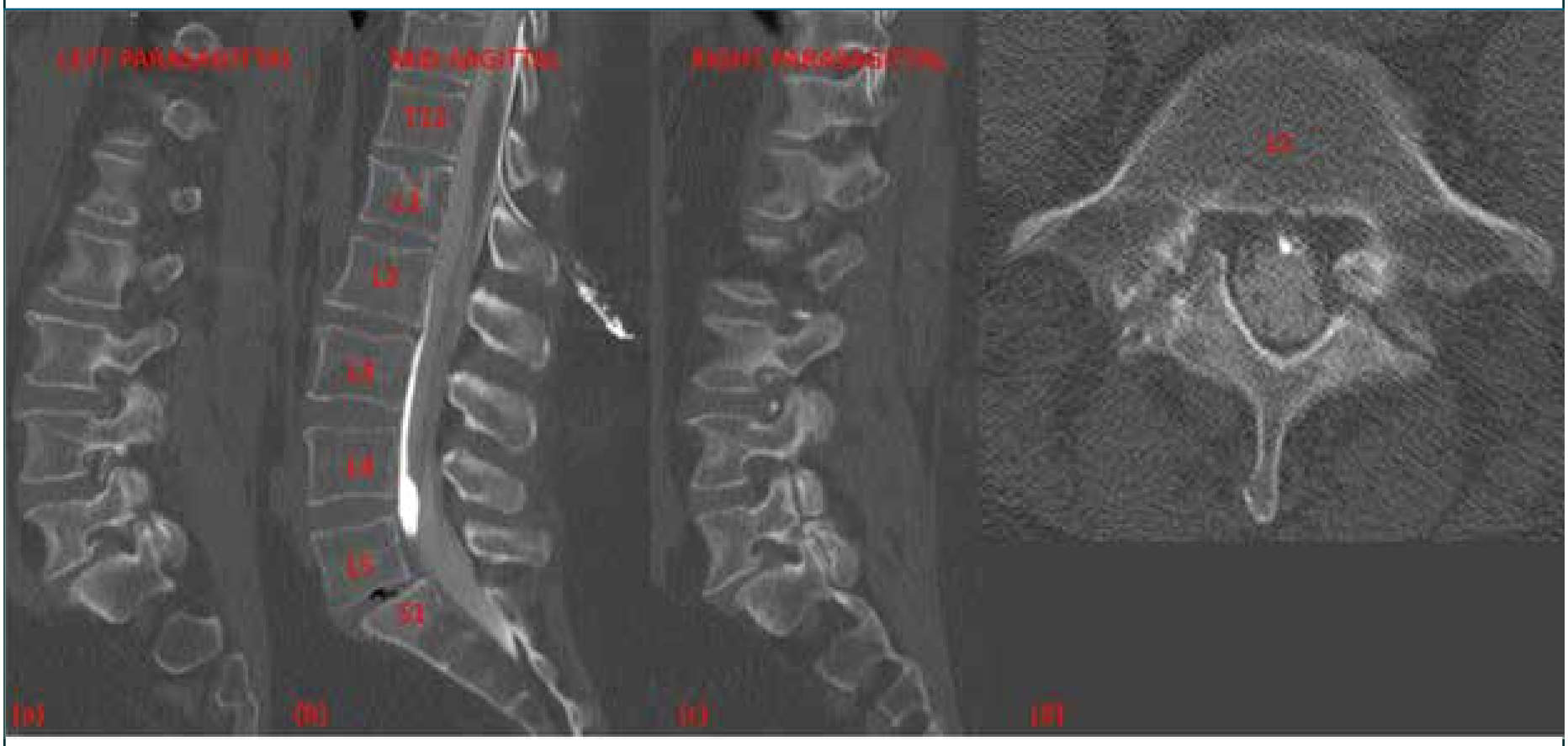
CT scan allows for high-resolution visualization of the bony structures. Note in these images the presence of diffuse degenerative changes in the form of multilevel facet arthropathy, as seen on the parasagittal images, and within the disc space in the form of reduced disc height and vacuum phenomenon (intradiscal gas) seen at the distal two mobile segments. The last disc space is at a non-mobile transitional level in this patient, which is a normal variant.

Oral Medications:

When considering pharmacological management, the potential risks should always be weighed against the benefits and medications should be used in the lowest effective doses for the shortest durations possible. Patient age, comorbidities and mobility status should be carefully considered.

Acetaminophen/Paracetamol: A systematic Cochrane review showed acetaminophen can reduce the intensity of LBP caused by osteoarthritic changes in the spine.[12] However, high quality evidence including three studies with 1,825 participants showed acetaminophen was no more effective than placebo. Treatment with acetaminophen may or may not reduce the pain severity, but given its generally

Figure 4: CT Myelogram of the lumbar spine. Images represented are left parasagittal (a), mid-sagittal (b), right sagittal (c), and axial at the L5 vertebral level (d).



In CT myelography, contrast dye is injected percutaneously into the intradural space, and the patient subsequently undergoes CT scan. This allows for assessment of the extent of stenosis, especially in the central canal. Neural tissue is represented by dark structures within the intradural space, while CSF appears bright. Note on the mid-sagittal image the conus medullaris and the cauda equina can be visualized. In this patient, there is an isthmic spondylolisthesis at L5-S1 with vacuum phenomenon within the disc at this level. Bilateral pars defects can be seen on both parasagittal images and the axial cut at the L5 level. Bilateral foraminal stenosis at L5-S1 can be seen on the parasagittal images. Incidentally, there are also leads from a spinal cord stimulator entering the canal at T12-L1.

favorable safety profile, a trial is reasonable in patients without hepatic disease.[12]

Non-Steroidal Anti-Inflammatory Drugs (NSAIDs): There is literature supporting the effectiveness of NSAIDs in reducing short-term pain scores for acute low back pain.[13,14] Particularly in chronic cases and in patients with diabetes, kidney disease, cardiac disease and hypertension, the risks of NSAIDs including gastrointestinal toxicity must be considered. Co-prescription of a PPI should be considered to minimize risk of gastrointestinal complications.[15]

Muscle Relaxants: The evidence for muscle relaxants is controversial.[16] In a systematic review of 30 trials (77% of which were high quality) benzodiazepines, non-benzodiazepines, and anti-spasticity muscle relaxants were effective in management of non-specific low back pain but due to side effects, caution was recommended.[16] Another systematic review of 49 trials involving 6,505 participants reported uncertain evidence about safety and clinical efficacy.[17]

Opioids: For patients with chronic LBP, the evidence sug-

Figure 5: Post-procedure pain diary

Post-Procedure Pain Diary

Patient Name: _____ ID #: _____

Provider: _____ Date: _____

Procedure: _____ Inject Date: _____

This is your pain diary. You underwent a diagnostic and/or therapeutic injection today. In order to obtain the most accurate information regarding the effectiveness of your procedure today, it is important that you complete this form to the best of your ability. Please bring it with you to your next appointment for review with your physician.

Instructions:
Please fill out the following diary of your pain (on a scale of 0 to 10, with 0 being no pain at all and 10 being the worst pain imaginable). Please complete this form in its entirety. Keep in mind, that if the injection you had today was only for diagnostic purposes, then you may only have temporary relief, after which time your pain symptoms may recur.

Time	Pain Level (0 to 10)	Comments
Immediately prior to procedure:		
Immediately after procedure:		
30 minutes after procedure:		
1 hour:		
2 hours:		
3 hours:		
4 hours:		
5 hours:		
6 hours:		
1 day:		
2 days:		
3 days:		
1 week:		
2 weeks:		

0-10 Numeric Pain Intensity Scale

0	1	2	3	4	5	6	7	8	9	10
None			Mild		Moderate		Severe		Worst	

Pain diaries are important tools for objectively determining a patient's response to an injection, with respect to both the extent of pain relief and the temporality, or durability of relief. They may be used for either diagnostic or therapeutic injections to evaluate the response to an intervention; however, it is the senior author's experience that quantifying the durability of an injection is more pertinent to therapeutic interventions, although this is not always the case. In general, a positive response is obtained when an injection elicits a >50% improvement in pain compared to baseline, with use of a targeted injection and a carefully measured volume of injectate.

gests opioids such as tramadol produce modest, short-term pain relief, but the effect may not be clinically important.[18-21] Considering the paucity of evidence demonstrating a beneficial effect of opioids on short- and long-term pain outcomes, and the potential for drug dependence and negative side-effects, their use is controversial.[21,22] We do not recommend opioid medication for back dominant

Table 1: Diagnostic Interventions

Diagnostic Intervention	Pain generator being interrogated	Technique	Diagnostic Utility	Considerations
Selective nerve root block (SNRB)[89]	Lumbar nerve root	Transforaminal injection of local anesthetic via long spinal needle in vicinity of exiting nerve root.	Confirm diagnosis of acute radiculopathy and confirms pain-generating nerve/level.	Allows identification of pain-generating nerve root to greater degree than intralaminar or caudal epidural steroid injection.[90] A negative SNRB is superior in predicting absence of an offending lesion when the MRI findings are equivocal.[91,92] Recommended injectate volume ranging between 2-4 ml to reduce spread to adjacent nerves/structures and obtain a more specific result.[72]
Diagnostic facet joint injection (dFJI)[77,79]	Facet joint	Intra-facet injection via long spinal needle of local anesthetic.	Confirm diagnosis of symptomatic facet arthropathy/facetogenic pain and confirms pain-generating facet joint. Can provide prognostic information when considering RFA.[72,93]	Recommended injectate volume of 0.5 cc to reduce spread to adjacent nerves/structures, and obtain a more specific result.[93]
Medial branch nerve (MbN) block[77–81]	Facet joint	Injection of local anesthetic via long spinal needle in immediate vicinity of MbN.	Confirm diagnosis of symptomatic facet arthropathy/facetogenic pain. Can provide prognostic information when considering RFA (More predictive than dFJI).[94,95]	Recommended injectate volume of 0.5 cc to reduce spread to adjacent nerves/structures, and obtain a more specific result.
Provocative discography/anesthetic discogram[96–98]	Intervertebral disc	Disc accessed with use of spinal needle via transforaminal approach, contrast medium is injected with increasing volumes to evaluate the response to pressurization in the disc.	Limited clinical utility with low positive predictive value of discography even using strict inclusion criteria such as low-pressure, single-level, and exact-pain reproduction. Controversial with respect to prognosticating response to surgery (interbody fusion). Simulates a mechanically loaded disc to demonstrate annular disruptions/fissures and may reproduce the patient's symptoms when discogenic pain is suspected. May provide some information regarding selection of levels when considering basivertebral nerve ablation.	To be used judiciously, and only in the context of overt degenerative changes within the IVD, as there is evidence that provocative discography accelerates disc degeneration.
Diagnostic Sacroiliac Joint Injection (dSIJI)	Sacroiliac joint	Joint accessed via percutaneous technique	Can confirm the sacroiliac joint (SIJ) as a clinically relevant pain-generator by application of local anesthetic to the SIJ.	Recommended injectate volume be limited to defined thresholds in the literature to reduce spread to adjacent nerves/structures, and obtain a more specific result.
Sacral (S1, S2, S3) Lateral Branch Blocks	Sacroiliac joint	Technique similar to MbN blocks	Can confirm the sacroiliac joint (SIJ) as a clinically relevant pain-generator by application of local anesthetic to sacral lateral branch nerves that provide pain innervation to the SIJ.	Recommended injectate volume be limited to defined thresholds in the literature to reduce spread to adjacent nerves/structures, and obtain a more specific result.
Electromyography/Nerve conduction studies (EMG/NCS)[99,100]	Lumbar nerve roots vs peripheral nerves	Needle electrodes are used to directly stimulate nerves, and evaluate conduction velocity and muscle responses.	Rule out pathologies of the peripheral nervous system. Can provide an objective baseline before surgery. Can aid when there is a discrepancy between clinical presentation and imaging findings with respect to radicular level. Can distinguish between acute and chronic radiculopathy.	Evaluate the integrity of the nerve axons and their myelination, as well as the functional integrity of the muscle and the neuromuscular junction. Root compression usually leads to a decrease in proximal amplitudes of the nerve conduction, with normal distal sensory responses.

mechanical low back pain.

Oral Steroids: Oral steroids in the treatment of low back pain have not shown benefit over placebo and given their significant side-effect profile, these medications are not recommended.[21,23] Although widely used, we recommend considering the use of other medications and against use of oral steroids for axial LBP not related to inflammatory arthropathies.

Atypical Anticonvulsants: Overall, there is evidence both for and against the use of atypical anticonvulsants (topiramate, gabapentin, pregabalin) in managing low back pain. One systematic review and metanalysis concluded that anticonvulsants were ineffective in reducing axial symptoms while another 10-week randomized, double-blind placebo-controlled study with 96 participants found topiramate was relatively safe and effective in treating chronic LBP.[24] We do not recommend anticonvulsant medications for axial mechanical pain. They may have therapeutic utility for radiculopathy and neuropathic pain.[25,26]

Antidepressants: A meta-analysis including five clinical trials for chronic LBP showed no difference in pain reduction between using selective serotonin reuptake inhibitors (SSRIs) or tricyclic antidepressants (TCAs) versus placebo.[24,27] There is no evidence for patients with chronic back pain taking these types of antidepressants to reduce pain or disability.[24,27] There is recent support for using SNRI class antidepressants (Duloxetine) in cases of back pain with depression/anxiety[110]. Patients with clinically significant comorbid depression should receive treatment.

Glucosamine: A systematic review of 148 randomized controlled trials showed no convincing evidence that glucosamine provided benefit over placebo.[28] We do not recommend glucosamine for patients with LBP.

Topicals:

Topical Lidocaine: Mixed evidence exists for the effectiveness of topical lidocaine. A meta-analysis of 13 Cochrane reviews assessed efficacy of topical analgesics for acute and chronic pain in adults, including low back pain, and concluded that topical lidocaine does not significantly reduce pain compared to placebo.[29] However, a systematic review including 43 articles and another trial reported topical lidocaine can reduce pain when combined with systemic analgesics.[30,31] Though there is controversial evidence, the low-risk of side effects make it reasonable to consider use of topical lidocaine for short-term pain relief.

Topical Diclofenac: Evidence supports the use of topical diclofenac for pain relief in patients with chronic musculoskeletal pain.[32,33] In the absence of significant adverse effects with topical

NSAIDS, a trial of topical NSAIDS for chronic low back pain is reasonable. If effective, topical application could reduce the need for oral NSAIDS and their associated risks.[32]

Topical Capsaicin: There is evidence supporting the effectiveness of topical capsaicin compared to placebo in the short-term reduction of low back pain.[34,35] The most common unwanted side effect is skin irritation; systemic or significant adverse events are rare.[34,35] It may be reasonable to use topical capsaicin as an adjunct therapy.

Therapies:

Physical Therapy (PT): Evidence supports the use of PT for patients with subacute and chronic LBP.[36] PT in this context should focus on patient education, positive activity modification and core strengthening tailored to the pain pattern (i.e. extension exercises for Pattern 1 pain and flexion exercises for Pattern 2 pain).[2] The purpose of therapy is to reassure patients about the benign nature of their back pain, to offer instruction in self-management and to strengthen the muscles supporting anatomic lumbar lordosis thereby unloading presumptive pain generators. The McKenzie method is a popular approach among physical therapists and focuses on appropriate posture and positioning to control mechanical back pain. This method has demonstrated short term success in pain control but the long-term results are about the same as for other rehabilitation interventions. One benefit of the McKenzie method is to allow physicians to provide specific direction when ordering PT.[36-40]

Acupuncture & Dry Needling: In a recent meta-analysis, compared to placebo, acupuncture resulted in a moderate improvement in back pain intensity both in the short term and at 12 month follow-up in patients with subacute and chronic LBP.[41,42] The addition of acupuncture to other treatments may improve pain levels immediately after a session as well as several months later.[42] There is insufficient evidence to compare different acupuncture techniques.[38,43]

Massage: Massage therapy has been shown to decrease pain intensity and disability in the short term.[40] In patients for whom massage therapy does not impose significant financial hardship, it may provide temporary symptomatic relief.

Spinal manipulation: Various manipulative techniques have demonstrated mixed benefits in both the acute and chronic setting.[36] Typical chiropractic spinal manipulation involves high velocity manipulations administered to synovial joints, forcing them beyond their normal ranges of motion.[44] Cavitation of joints has been shown to contribute to localized muscle

relaxation, which has been theorized to contribute to short term pain relief. No long-term benefit has been demonstrated.[45,46] Other studies have shown that high-velocity low-amplitude (HVLA) manipulation did not reduce pain.[40]

Traction: There is conflicting evidence regarding efficacy of traction. The procedure attempts to reduce compressive forces on the discs, stretch spinal ligaments, reduce muscular spasm, enlarge neural foramina and consequently decrease nerve root compression.[47] Traction may be applied in various forms including motorized, gravitational, and manual traction. Karimi et al. reported significant pain reduction in 15 patients after a traction treatment protocol. Other studies showed that when compared to no traction, lumbar traction resulted in pain reduction and functional improvements only in the short term.[47-49] There is no evidence to support the effect of lumbar traction on reducing the size of a disk herniation.[48] Due to its questionable efficacy and the potential for adverse effects, we recommend caution when considering traction.

Other Passive Modalities:

Heat: Heat can provide short-term pain relief in both acute and subacute situations and offers the most significant improvement in combination with exercise therapy.[50-52] Heat should be used with caution in patients with diminished skin sensation to avoid the risk of irritation or burns.

Ice: A systematic review showed inconclusive evidence for the effect of ice; however, cold therapy in addition to NSAIDs can improve acute or subacute back pain.[50,53] For these reasons, with a favorable side effect profile, we can recommend a trial of ice or cold therapy with NSAIDS.

Transcutaneous Electrical Nerve Stimulation (TENS): There is controversial evidence regarding TENS. Multiple sources, including a review of four high-quality RCTs involving 585 patients, reported TENS was not effective in reducing lower back pain intensity.[54] Other Level II evidence shows that there was significant improvement in the short term.[55,56] Given its minimal risk of side effects, it is reasonable to attempt TENS. However, this treatment is contraindicated in patients with a pacemaker.[57,58]

Therapeutic Ultrasound (TUS): A meta-analysis of 10 RCTs involving 1,025 participants with chronic LBP showed uncertain evidence that TUS has a positive influence on low back pain compared to placebo.[59,60] Since the associated risks are negligible, a trial of TUS for LBP may be reasonable.

Bracing: Although short-term bracing may decrease low back pain, long term use has the potential to create dependency and

Table 2: Nonsurgical treatment modalities for LBP

Oral medications	Evidence	Considerations & Cautions
Acetaminophen/ Paracetamol	- Level 1 evidence that tramadol/paracetamol (extended release) can reduce LBP better than placebo for short term pain relief.[101] - Systematic review from Cochrane showed LBP secondary to hip and knee osteoarthritis is effectively reduced short term.[12] - High quality evidence showed acetaminophen was no more effective than placebo to reduce acute LBP.[102]	- Use with caution in patients with liver impairment.
NSAIDs	- Low to Moderate certainty evidence for chronic LBP.[13] - Moderate-quality evidence that NSAIDs are slightly more effective than placebo for short term pain relief of acute LBP.[13,103] - High-quality evidence that NSAIDS are more effective than placebo for reducing disability in acute LBP in small magnitude.[13,14]	- Caution in those with renal impairment, history of GI bleed, cardiac disease, age >65, DM, patients with hypertension.
Muscles relaxants	- Low quality evidence that non-benzodiazepine antispasmodics (i.e. cyclobenzaprine, carisoprodol, and metaxalone) can provide a small, but clinically insignificant reduction in pain intensity.[17] - Strong evidence that benzodiazepines, non-benzodiazepines, and anti-spasticity muscle relaxants are more effective than placebo for short term pain relief of acute LBP.[16]	- Do not use in patients with known congenital deficiency of plasma cholinesterase, cardiac arrythmia's, history of malignant hyperthermia, hyperkalemia, or risk for hyperkalemia.[17] - Caution in age >65.[17] - Known adverse effects include respiratory depression and/or apnea, emesis, increased fall risk.[17] - Adverse effects of nonbenzodiazepine anti-spasmodics are elevated compared to placebo and should therefore be used with caution.[17]
Tramadol	- Provides significant relief compared to placebo when used independently.[104] - Best pain reduction when used in combination with NSAIDs.[18]	- Use caution in all patients and prescribe one month at a time.[19,20] Check urine drug screens and prescription drug monitoring data regularly.[18] Coordination with pain management colleague may be helpful. - Caution in patients with history of substance abuse or mood disorder.[20] - Risk of addiction, overdose related mortality, decreased seizure threshold, sedation, falls, respiratory depression, bradycardia, depression, sexual dysfunction, constipation, nausea,

Oral medications	Evidence	Considerations & Cautions
		urinary retention, Sphincter of Oddi dysfunction, and pruritis.[20]
Oral steroids	- Not superior to placebo for LBP.[21,23]	- Use caution in patients with active infection, Cushing syndrome, immunosuppression, diabetes mellitus, amenorrhea, osteoporosis, cataracts, psychosis.[23] - Adverse effects include poor wound healing, stretch marks, hypertension, weight gain, hyperglycemia, and peptic ulcers.[23] - Associated with more adverse effects than placebo.[21,23]
Atypical anticonvulsants	- Insufficient evidence to support recommendation for or against use of anticonvulsants (i.e. topiramate, gabapentin, pregabalin) for LBP. - Moderate-quality evidence that anticonvulsants are more effective at treating back pain when used with analgesics and nonpharmacological strategies.[15] - Level I evidence that topiramate is more effect than placebo for treatment of LBP over 10 weeks.[24] - Moderate to high-quality evidence that anticonvulsants compared to placebo were ineffective to reduce axial LBP.[27]	- Therapy with anticonvulsants should start with lowest possible dose and gradually increase based on response and adverse effects.[15] - Monitor carbamazepine use with hepatic transaminases, complete blood count, creatinine, blood urea nitrogen, electrolytes, and serum carbamazepine level.[15] - Monitor for sedation, ataxia and edema if using gabapentin or pregabalin.[15] - Monitor for Stevens-Jonson syndrome when using lamotrigine.[15] - Reported side effects of topiramate include somnolence, vision problems, psychomotor slowing, memory issues, dizziness, headache, and paresthesia.[24] - Higher risk for adverse events compared to placebo such as drowsiness, somnolence, dizziness, and nausea.[27]
Antidepressants	- No evidence that antidepressants provide more pain relief than placebo for chronic musculoskeletal pain.[105–108] - Level I evidence that paroxetine offered no benefit over placebo for LBP.[106] - Level II evidence that trazadone HCL offered no effect on chronic LBP compared to placebo in short term study.[107] - Level II evidence that duloxetine provided no statistical improvement in pain or function of chronic LBP in 12-week time frame.[108] - No evidence that serotonergic antidepressants provide more pain relief than placebo for	- Common side effects among various classes: decreased appetite, fatigue, nausea, hyperhidrosis, constipation, and dry mouth[105] - Sexual dysfunction is associated with SSRI and SNRI.[111] - Increase risk of suicide in adolescents and children with SSRIs.[110] - Paroxetine: constipation and dry mouth are relatively more common side effects due to anticholinergic activity.[112] - Duloxetine: increase risk for irritability, anxiety, nervousness, mydriasis, and increased blood pressures.[111]

Oral medications	Evidence	Considerations & Cautions
	antidepressants provide more pain relief than placebo for chronic musculoskeletal pain.[109] - Level II evidence that noradrenergic agents (i.e. maprotiline) more effectively reduce LBP compared with SSRIs in non-depressed patients, but not greater than placebo.[109] - Duloxetine offers modest to moderate effects on pain relief, functional improvement, and mood regulation for patients with chronic low back pain.[110]	
Glucosamine/ chondroitin	- No strong evidence for benefit over placebo for chronic LBP or spinal changes secondary to osteoarthritis.[28]	- Most common adverse effects: oral glucosamine included epigastric pain, heart burn, diarrhea, and nausea.[113] - May reduce the efficacy of diabetes medications, though this is not well supported with data.[114] - Patients with diabetes should monitor blood glucose levels more carefully when using glucosamine.[114]
Topicals	**Evidence**	**Considerations & Cautions**
Topical lidocaine	- Cannot recommend for or against as evidence is mixed but may be considered when used carefully. - No significant reduction of pain with topical lidocaine.[29] - Limited evidence that lidocaine can reduce pain in patients with chronic LBP when combined with systemic analgesics such as gabapentin.[30,31] - Level III evidence that lidocaine patch 5% provides a significant reduction in pain intensity and improvement in quality of life.[115]	- Most common adverse effect is contact dermatitis.[116] - Rare complication of methemoglobinemia.[116]
Topical NSAIDs	- Moderate-quality evidence that topical diclofenac and ketoprofen can provide pain relief in patients with chronic musculoskeletal pain.[32] - Topical diclofenac shows a small reduction in pain short term compared to celecoxib or meloxicam.[33]	- Adverse effects are minimal as there is no significant systemic effect with use of topical NSAIDs.[32]

Topical capsaicin/menthol	- Moderate quality evidence that topical Capsaicin reduced LBP more than placebo.[34] - Level I evidence that topical capsicum provides short term pain relief in nonspecific LBP.[117]	- Adverse effects are mainly at the application site (burning, stinging, erythema) with rare systemic events.[35]
Therapies	**Evidence**	**Considerations & Cautions**
Physical therapy	- Pain intensity and disability are significantly reduced at short term follow up compared to usual care.[118–120]	- Adverse effects not reported.[118,120]
Acupuncture/dry needling	- Low-certainty evidence that acupuncture is more effective than no treatment for immediate improvement in pain and function.[43,121–125]	- Most common adverse event was insertion site pain, bruising, hematoma, bleeding, worsening LBP, and pain other than LBP (i.e., leg or shoulder pain).[43]
Massage	- Low certainty evidence that massage is effective for acute, sub-acute, or chronic LBP pain relief in the short term.[126] - No significant reduction in pain long term.[126,127] - Level II evidence that exercise is more effective for treatment of LBP than massage.[128]	- No serious adverse effects reported.[126] - Most common adverse effect reported was increased intensity of pain.[126]
Chiropractic	- Conflicting evidence regarding efficacy of spinal manipulation therapy. - Spinal manipulation therapy alone and combined with other interventions does not significantly relieve acute low back pain compared to standard treatments.[40,45,129–132] - Cavitation of joints can provide short term pain relief.[46]	- Adverse events include cerebrovascular accidents, permanent neurologic sequalae, dislocation, vertebral fracture, disk herniation, and death.[133] - It is our opinion that patients should not undergo cervical spinal manipulation under any circumstances due to these serious adverse events.
TENS	- Conflicting evidence regarding efficacy of TENS for LBP. - No significant difference in pain intensity with use of TENS.[54,118,134,135] - Level II evidence that TENS provided significant improvement in pain and function in short term.[55,56]	- Adverse effects include skin irritation at electrode placement site and rare but possible severe rash after four continuous days of treatment.[54] - Contraindicated in patients with cardiac pacemakers due to potential for pacemaker interference.[57,58]
Traction	- Controversial evidence for and against traction for LBP treatment. - Very low-quality evidence reports little to no impact on pain intensity or functionality	- Adverse effects include increased pain, aggravation of neurological signs, and subsequent surgery.[139] - Most serious adverse effects included atonic seizures, syncope, and TIA.[140]

	alone or in combination with other therapy.[136–138] - Traction provided significant pain reduction compared to placebo for improvement of function and pain in short term.[48,49]	
Therapeutic ultrasound	- Level I evidence for no significant improvement in pain and function with therapeutic ultrasound compared to placebo.[59,60]	- No significant adverse effects associated with therapeutic ultrasound.[59]
Passive modalities	**Evidence**	**Considerations & Cautions**
Heat	- Heat provided short term pain relief of acute and subacute LBP compared to no heat. - Best results when heat and exercise therapy are used in combination.[50,51,141]	- Use with caution, especially in patients with diminished sensation due to the risk of skin irritation/burns.[50]
Ice	- No definitive conclusions can be drawn; however, Level II evidence that addition of cold therapy to an NSAID improved pain outcomes for LBP at 3 weeks.[50,53]	- Use with caution, especially in patients with diminished sensation due to the risk of skin irritation/burns.[50]
Bracing	- Conflicting evidence on efficacy of bracing to reduce LBP. - Conflicting evidence on efficacy as a supplemental treatment.[142]	- Long-term use of lumbosacral orthoses has no significant adverse effect.[142]
Ergonomic interventions	- Uncertain effect of ergonomic interventions on low back pain.[143] - Moderate-quality evidence that physical and organizational ergonomic interventions did not provide significant benefit over no ergonomic intervention in short- and long-term LBP incidence, prevalence, or intensity.[144] - Objectively measured prolonged standing for desk work did not reduce perceived LBP compared to seated positions.[145]	
Rest	- Little or no difference between physiotherapy, rest, or active advice for patients with sciatica.[146,147] - Functional outcomes improve with active recovery and limited bed rest for short and	- Rest in elderly patients may lead to deconditioning. We recommend activity over rest.

	intermediate term follow up.[148,149]	
Weight loss	- Small to moderate reduction in pain and disability for spinal pain with weight-loss interventions.[64]	
Injections/minor procedures	**Evidence**	**Considerations & Cautions**
Facet Injections	- Although there is controversial evidence for and against facet joint injections, overall, this would be a recommended intervention when facet arthropathy is suspected source of LBP.[74,150] - Facet joint injections can provide long term pain relief for patients with lower back pain.[74,150] - Moderate-quality evidence for short term lumbar pain relief.[151] - No difference in pain relief with steroid injections compared to saline injections.[151] - Might provide prognostic value before radiofrequency ablation.[68]	- The most common complications are self-limited pain at the site of needle insertion, local swelling, and LBP.[68]
Botox Injections	- Insufficient evidence to recommend for or against. - Low-quality evidence for reduced pain and improved function at 3 and 8 weeks.[152,153] - Level II evidence trigger point injections with botulinum toxin A did not improve pain or function compared to placebo.[152]	
Prolotherapy	- High-quality evidence that prolotherapy is not an effective independent therapy for chronic back pain.[154] - May improve back pain and disability when combined with spinal manipulation, exercise, etc.[154]	
Epidural Steroid Injections (ESIs)	- Though there is controversial evidence, this intervention is recommended when stenosis is suspected source of symptoms. - Very low- to moderate-quality evidence that epidural	- Significant adverse effects include spinal epidural abscess and epidural hematoma.[158] - Other possible adverse effects include transient increase in radicular leg symptoms which is typically self-limiting.

	corticosteroid injections were slightly more effective compared to placebo in reducing leg pain and disability at short term follow up.[155–157] - No significant difference between saline injection vs. bupivacaine or steroids.[73,74]	
Radiofrequency ablation (RFA)	- Very low- to moderate-quality evidence that RF denervation provides pain relief for patient with chronic LBP.[76,159–161]	- Potential complication of ventral branch injury during the procedure.[6,77–80] - Complications are rare.[6,77–80] - Risk of self-limited localized neuritis.[6,77–80]
Basivertebral nerve ablation (BNA)	- Moderate-quality evidence that BNA has a small significant reduction in pain and disability in appropriately selected patients.[81,162]	- The procedure is considered safe.[81] - Low risk of injuring dorsal root ganglion with percutaneous transpedicular approach.[81] - Appropriate patients have evidence of discogenic/vertebrogenic pain, with Modic changes on the MRI, and are unresponsive to least 6 months of conservative treatment.[81]
Therapeutic Sacroiliac Joint Injection (SIJI)	- Therapeutic SIJI with corticosteroid and local anesthetic can commonly afford durable relief of pain when the SIJ has been established as the dominant pain-generator.	- The SIJ may become a clinically significant pain-generator in a variety of circumstances, notably in the setting of previous lumbar fusion. - Patients who have achieved only transient relief after two or more therapeutic SIJI, after other sources of pain have been addressed/ruled out, can be considered for sacroiliac fusion procedures,
Cognitive interventions	**Evidence**	**Considerations & Cautions**
Back school/educational program	- Very low- to low-quality evidence showed uncertain effect of back schools on decreasing pain.[163–165] - Addition of back school to exercise and physical treatment in patients with chronic LBP showed more effect on pain reduction.[166]	
Cognitive Functional Therapy (CFT)	- Level I evidence that CFT combined with physical therapy improves pain levels, functional outcomes, and return to work.[167,168] - Long-term effects of CFT were seen in patients with subacute and acute back pain.[168]	- Successful results in patients with chronic back pain that were treated in orthopedic inpatient rehabilitation for 3 weeks.[168] - Best results in combination with active physical therapy, patient education, and motivation to exercise.[168]

deconditioning. A short course of bracing for acute pain may help mobilize a bed-bound patient but bracing must be employed judiciously to prevent an over-reliance on passive modalities to the exclusion of more active, evidence-based treatments.[61]

Patient education has been shown to improve the rate of return to work and the patient's global impression of recovery while reducing the frequency of subsequent primary care visits.

Cognitive interventions:

Patient education: Patient education must include a valid perspective on the source of back pain: over 90% is benign mechanical dysfunction and less than 3% is more sinister pathology. The possibility of malignancy is under 1% and can be ruled out with a proper review of the patient's history and a proficient physical examination. Many patients have an expectation they will undergoing imaging and require an explanation why that may not be necessary and could even be counterproductive.[62,63] They need to be reassured with a discussion of the natural history and self-limiting nature of acute episodes of mechanical LBP. Patient education has been shown to improve the rate of return to work and the patient's global impression of recovery while reducing the frequency of subsequent primary care visits.[37,44] Counselling may include conversations about healthy weight reduction and smoking cessation.[64]

Cognitive Behavioral Therapy (CBT)/Cognitive Functional Therapy (CFT): A range of factors, including psychological factors, contribute to back pain.[65] CBT/CFT are strategies addressing physical, lifestyle and psychological issues that may play a role. Pain-related behaviors are usually protective and include adaptive responses characterized by stiffer musculature, less muscle relaxation and slower, less variable spinal movements. These behaviors can be sufficiently disproportionate to become pathological and associated with enhanced sympathetic nervous system responses.[62] CBT/CFT combined with PT and patient education can improve coping techniques, produce a greater reduction in disability and demonstrate long-term superior efficacy compared to education and exercise alone.[37,44,63] Some case series also show significant pain reduction.[62] CBT/CFT may result in significant postoperative improvement after spine surgery.[62,66]

Injections/Minor Procedures:

Facet Joint Injections (FJIs): This is a technique to both identify and treat axial pain secondary to facet joint degeneration. The most common complications are self-limited pain at the site of needle inser-

tion, local swelling and increased back pain.[67] The evidence for short-term pain relief is moderate.[67] A recent clinical trial suggests that facet blocks can provide prognostic information when considering radiofrequency ablation of the medial branch nerve but it has also been postulated that pain relief after FJIs may be due to the relief of radicular symptoms from an adjacent inflamed nerve root and not from any effect on the facet joint.[68,69-72]

Epidural Steroid Injections (ESIs): In one meta-analysis, ESIs for low back pain showed no benefit compared to placebo.[73] Another meta-analysis compared ESIs to epidural lidocaine injections and showed significant reduction of pain and better functional outcomes at three months with ESIs.[73,74] Zhai et al. in their meta-analysis demonstrated that injections of local anesthetic with or without steroids showed a small benefit in patients with lower back and radicular pain.[75,76] Although there is mixed evidence in favor of ESIs for LBP, this intervention is widely recommended for symptomatic spinal stenosis or radicular pain.

Radiofrequency Ablation (RFA) of the Medial Branch Nerve (MbN): This procedure involves placement of a percutaneous electrode in proximity to the MbN, creating a thermal neurotomy. Multiple sources, including a Cochrane review of 23 studies, report low- to moderate-quality evidence that RFA provides pain relief for chronic back pain. RFA would be appropriate if non-facetogenic pain sources are ruled out and a facet joint injection produces an appreciable reduction in pain. It would be reasonable to consider RFA as a treatment for facet joint pain in the absence of radicular symptoms.[6,77-80]

Basivertebral Nerve Ablation (BNA): It is postulated that the basivertebral nerve can conduct a nociceptive signal from a damaged vertebral endplate under certain circumstances. Patients presenting with debilitating pain and Modic Changes on the MRI who are unresponsive at least 6 months of conservative treatment may be candidates for BNA. This is a new technique with great promise in appropriately selected patients.[81]

Surgical Treatment

Surgery is a localized, mechanical treatment. It is therefore reasonable to expect that it will be the appropriate management for limited, structural spinal pathologies unresponsive to non-operative measures. Surgery is not always the treatment of last resort, nor is it the ultimate cure for back pain. Some conditions, such as acute cauda equina syndrome require immediate operative intervention. Conversely, many patients with severe axial pain and diffuse degenerative abnormalities are unlikely to improve with surgery but may

benefit from alternative treatment strategies.

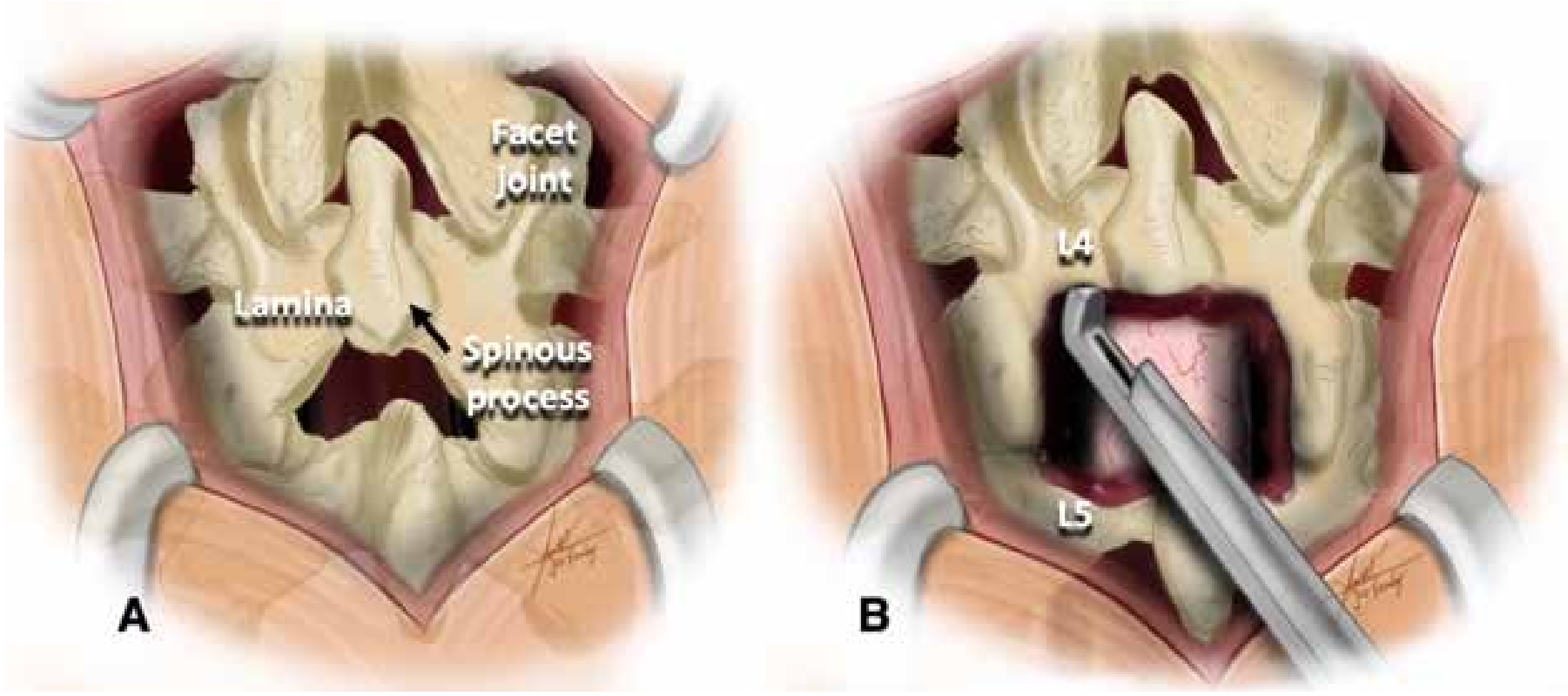
In addition to cases of serious trauma, sudden neurological deterioration, malignancy, infection, or severe or progressive spinal deformity, primary care providers can reasonably refer patients with low back pain to a spine surgeon or an interventional spine specialist following an extended course of unsuccessful conservative care during which the patient has failed to achieve durable pain relief, or acceptable function. The referral is most appropriate when there is a working diagnosis. Specialist referral should advance the diagnostic investigations or move beyond non-invasive therapy.

Surgical options in the management of lumbar pathology fall into two large categories:

- Decompression—removing material that is excessively intruding upon or compressing neural structures.
- Fusion (Arthrodesis) or Replacement—joining or stabilizing areas that are unstable or painful with motion.

Within those broad groupings, there are many specific options available. These include laminectomy, hemilaminectomy, laminotomy, hemilaminotomy, discectomy, discotomy, partial discectomy, posterolateral fusion, interbody fusion, as well as combinations of decompression and arthrodesis. Motion

Figure 6: Illustration of the L4-5 level, as seen by the surgical team, during a posterior midline approach to the lumbar spine, before (A) and after (B) direct lumbar decompression.



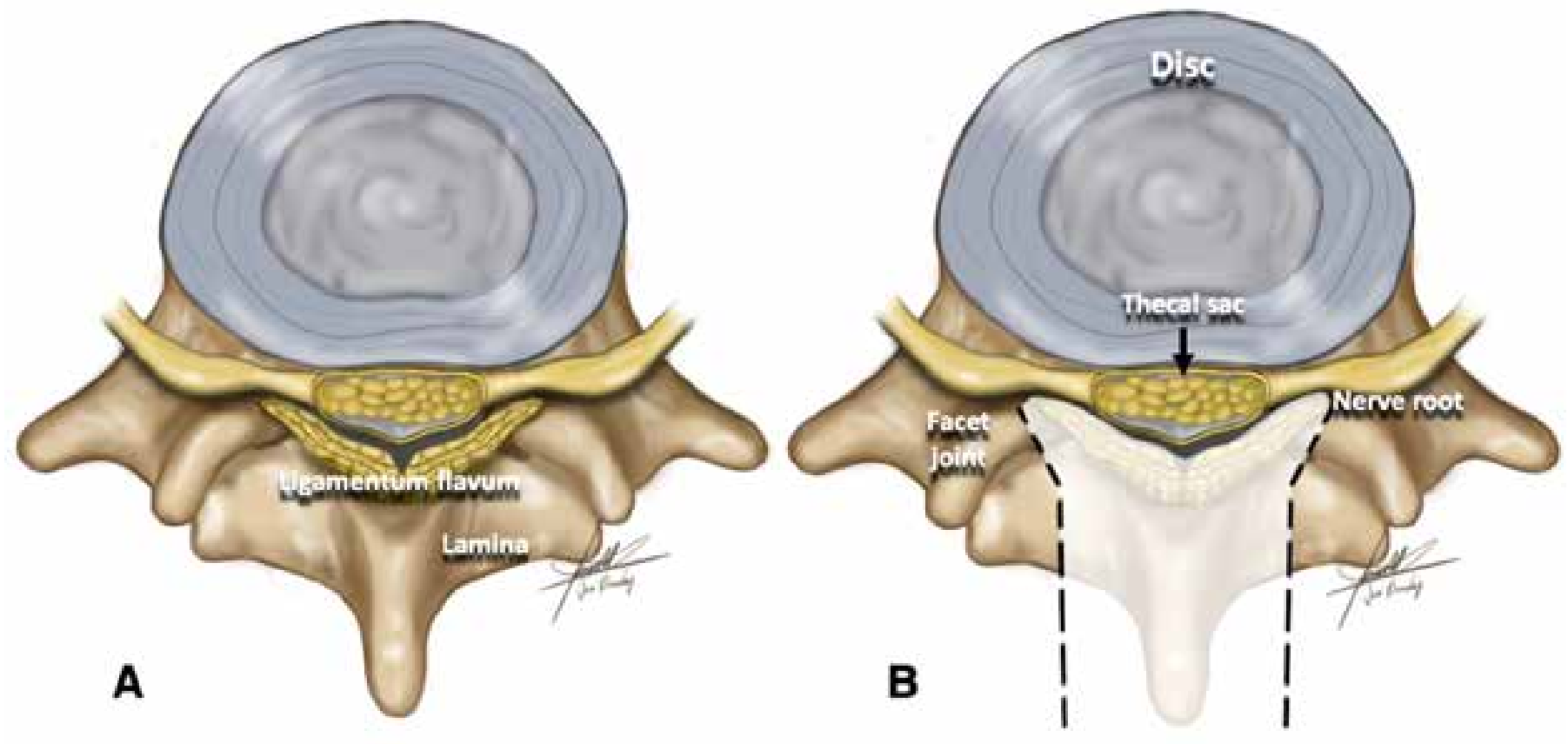
Direct decompression of a stenotic lumbar motion segment includes central decompressive laminectomy, medial facetectomies to free the traversing nerve roots in the lateral recesses, and direct foraminotomies via resection of the tip of the superior articular processes.

sparing procedures, such as an artificial disc may also be considered.[82]

Patients with leg-dominant pain (Patterns 3 and 4) are likely to benefit from procedures that involve the decompression of neural structures, as leg-dominant pain patterns are typically radiculopathies resulting from compression or inflammation of the lumbar nerve roots (Figure 6-7). In some circumstances patients with back-dominant pain (Patterns 1 and 2) may benefit from surgery, especially if the source of the axial pain is localized and can be identified via diagnostic tests. Surgery in these instances may involve a fusion to prevent painful or pathological movement (Figure 8). Surgical intervention for end-stage degenerative disc disease or facet arthropathy is controversial and should only be considered in extremely refractory cases.[83-85] Patients with significant sagittal or coronal plane deformities may benefit from deformity correction and instrumented fusion.[86]

While surgery may afford patients significant improvement, it is important to recognize the

Figure 7: Schematic illustration of an axial view of the anatomical structures and their relationships at the L4-5 level, both before (A) and after (B) direct lumbar decompression.



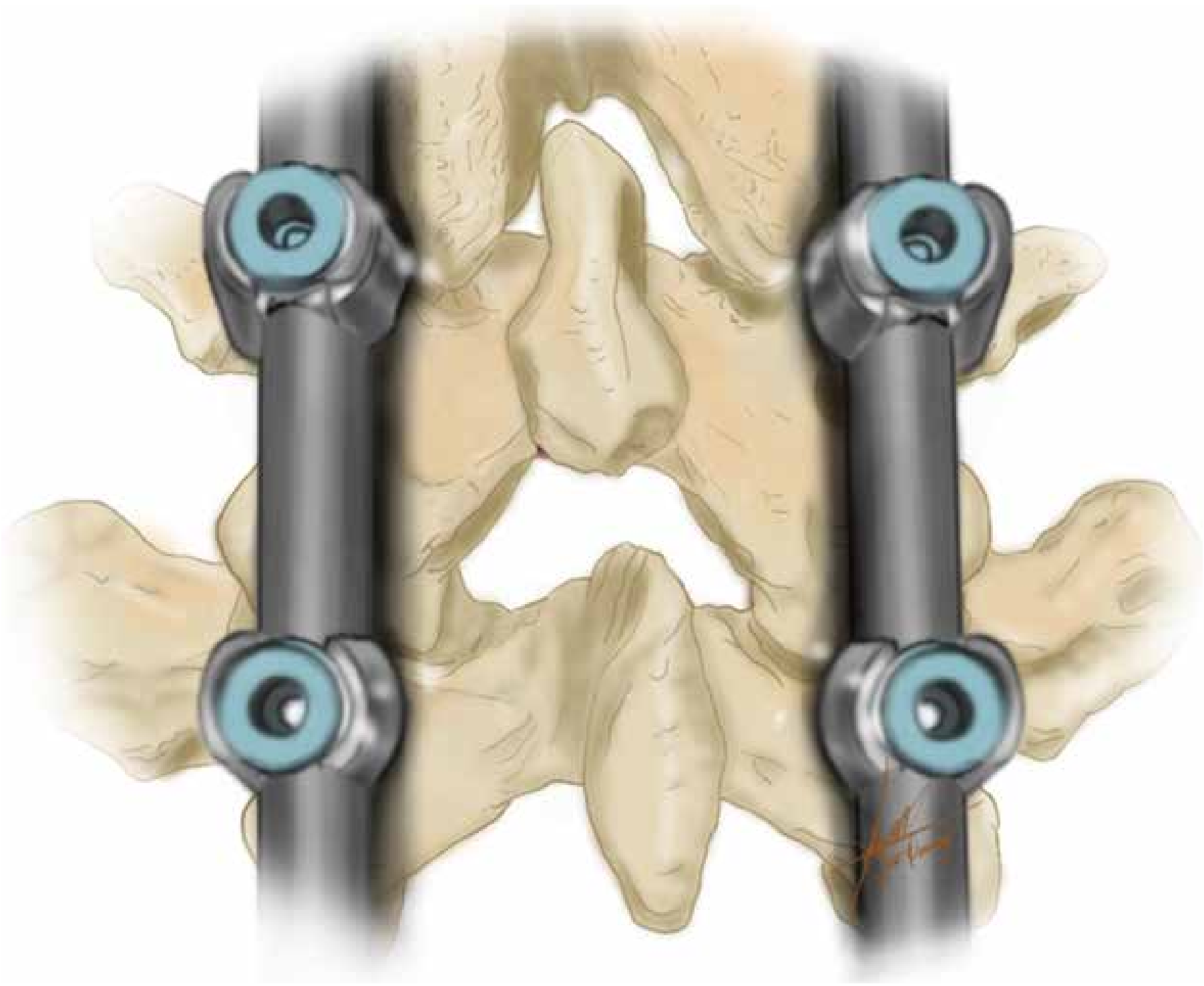
LSS results from narrowing of the caliber of the spinal canal and neural foramina. In the degenerative setting, this results from hypertrophy of the ligamentum flavum, facet arthropathy, and disc bulging. When executing a lumbar decompression, one performs a central decompressive laminectomy and resection of the ligamentum flavum, medial facetectomies, and direct foraminotomies, in order to increase the space available to house the neural elements.

potential pitfalls. There is always a risk of surgical complications, perioperative medical adverse events and a poor outcome.[87,88]

Conclusions

Low back pain is common in primary care and requires a structured, practical approach. Understanding the natural history and confidently delineating the mechanical pain patterns allows providers to offer a comprehensive and holistic approach to management with a high degree of patient satisfaction. Appropriate

Figure 8: Illustration of a lumbar instrumented fusion with posterior instrumentation.



Fusion procedures can be considered in cases of instability or deformity, which are refractory to nonsurgical care. Most commonly, fusions are performed via inserting pedicle screws and rods, with or without the use of interbody devices, and application of bone graft or graft substitute.

SUMMARY OF KEY POINTS

Patients presenting with lumbar-related complaints, in the absence of red flags or neurological deficits, can safely undergo a course of conservative treatment prior to ordering imaging studies.

Nonsurgical treatment modalities that can be attempted in patients with LBP include oral medications, topical medications, passive modalities, active physical therapy and cognitive interventions.

Diagnostic interventions such as selective nerve root blocks, diagnostic facet joint injections, medial branch blocks and provocative discography can be useful in confirming that a particular anatomical structure is a clinically relevant pain generator.

Surgery, in the absence of red flags or neurological deficits, should only be considered after the patient fails a thorough course of conservative treatment.

recognition of the signs and symptoms of sinister pathology identifies patients requiring urgent/emergent referral. When conservative management fails to relieve pain and improve function, understanding the role of spinal imaging and diagnostic interventions to identify the pain generator(s) can guide further treatment (Figure 9).

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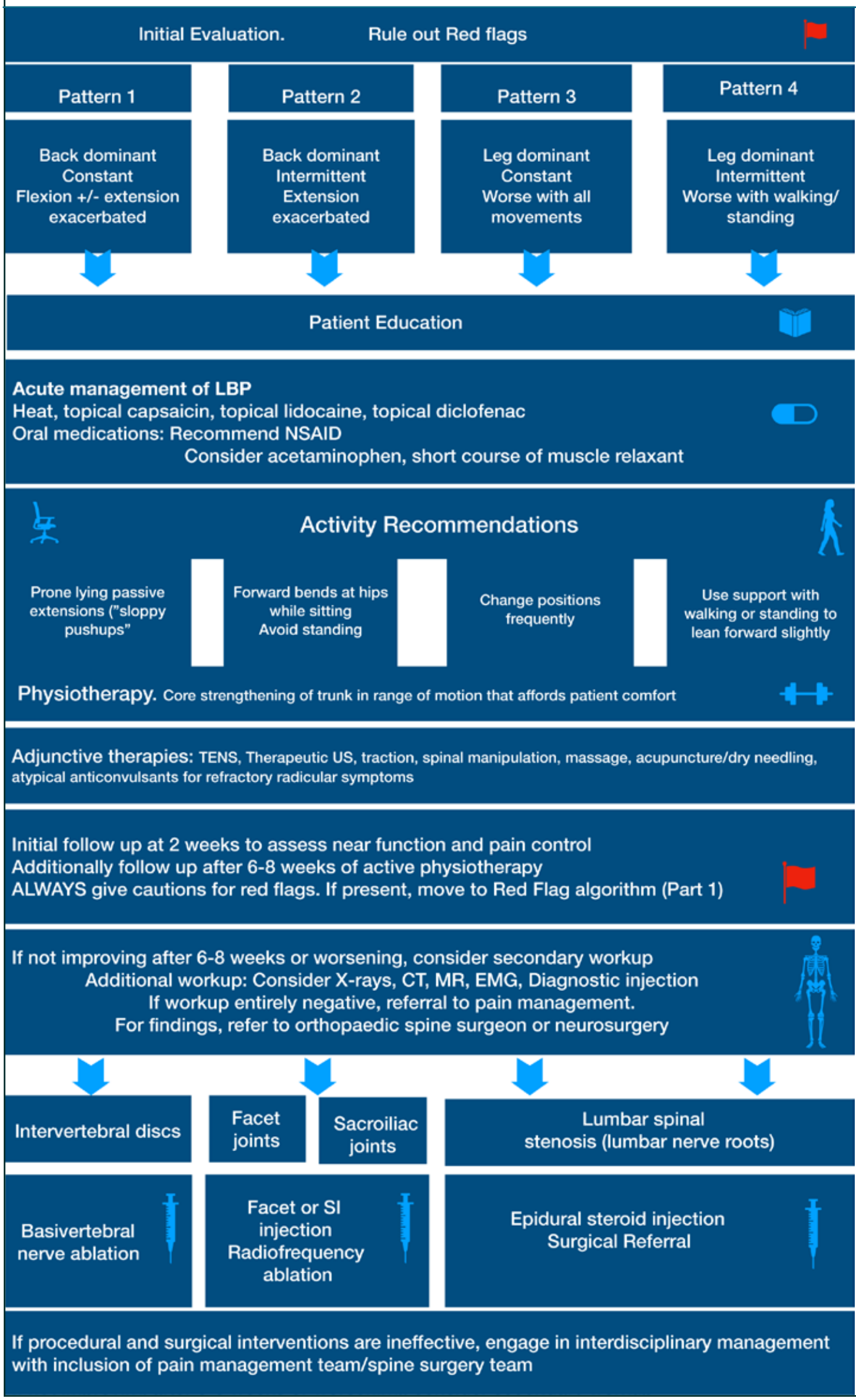
CLINICAL PEARLS

Images of the spine are not necessary to initiate management of mechanical low back pain; they may even be counterproductive.

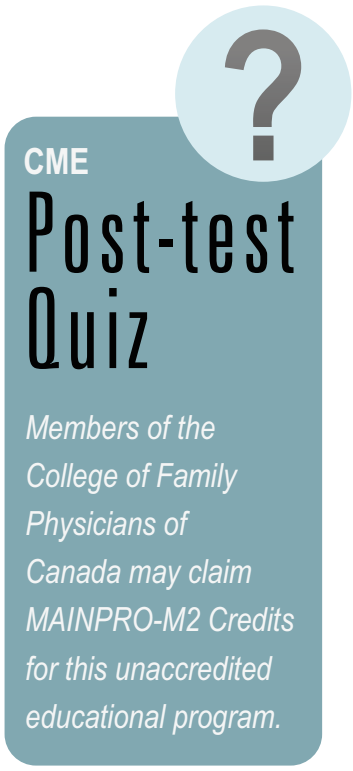
When required, initial radiological evaluation of the lumbar spine involves upright plain radiographs. Further investigation may include use of MRI or CT myelography.

Diagnostic interventions can aid in establishing the dominant pain-generating anatomical structure but are not required if the patient is improving as anticipated.

Figure 9: Authors' Proposed LBP Treatment Algorithm.



Proposed treatment algorithm for a patient presenting with LBP or a lumbar-related complaint, in the absence of neurological deficits or red flags. In these patients, it is important to characterize their pattern, then initiate conservative treatment. Topical medications, heat, and oral over-the-counter analgesics offered alongside a course of physical therapy and activity modifications tailored to the patient's pain pattern is the authors' preferred approach at this juncture. One may consider other adjunctive therapies as well, taking into consideration their potential risks and benefits. A minimum of 6-8 weeks is suggested for the initial course of conservative treatment. At the discretion of the primary care physician, a more exhaustive and thorough course of conservative care may be trialed as well, so long as the suspicion for urgent/emergent pathology is low. Subsequently, should the patient continue to experience significant pain and disability, it is reasonable to proceed with further investigations, in the form of imaging studies and diagnostic interventions. These investigations are selected in order to rule in or rule out potential anatomical pain-generating structures. Degeneration/dysfunction in these anatomical structures form the basis for the 4 clinical pain patterns. Once the differential diagnosis has been narrowed down, it is reasonable to proceed with further management. This may include further non-surgical treatment, requisitioning of therapeutic injections, or specialist referral. At any point in time, if the patient displays red flag signs/symptoms, proceed with the red flag treatment algorithm in part 1.[2]



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