

LOW BACK PAIN AS PERCEIVED BY THE PAIN SPECIALIST

MARWAN RIZK^{*}, ELIE ABI NADER^{**}, CYNTHIA KARAM^{***}
AND CHAKIB AYOUB^{****}

Low back pain is considered to be chronic if it has been present for longer than three months. Chronic low back pain may originate from an injury, disease or stresses on different structures of the body. The type of pain may vary greatly and may be felt as bone pain, nerve pain or muscle pain. The sensation of pain may also vary. For instance, pain may be aching, burning, stabbing or tingling, sharp or dull, and well-defined or vague. The intensity may range from mild to severe. Many different theories try to explain chronic pain. The exact mechanism is not completely understood. The specialty of interventional pain management continues to emerge. There is a wide degree of variance in the definition and practice of interventional pain management and interventional techniques. Application of interventional techniques by multiple specialties is highly variable for even the most commonly performed procedures and treated conditions¹⁻¹².

Diagnostic Approach to Low Back Pain

Appropriate history, physical examination, and medical decision-making are essential to provide appropriate documentation and patient care. The socioeconomic issues and psychosocial factors are important in the clinical decision-making process.

Kuslich et al identified intervertebral discs, facet joints, ligaments, fascia, muscles, and nerve root dura as tissues capable of transmitting pain in the low back¹³. Facet joint pain, discogenic pain, nerve root pain, and sacroiliac joint pain have been proven to be common causes of pain with proven diagnostic techniques¹⁴⁻²³. In a prospective evaluation²⁴, the relative contributions of various structures in patients with chronic low back pain who failed to respond to conservative modalities of treatments, with lack of radiological evidence to indicate disc protrusion or radiculopathy, were evaluated utilizing controlled, comparative, diagnostic blocks. In this study, 40% of the patients were shown to have facet joint pain, 26% discogenic pain, 2% sacroiliac joint pain, and possibly, 13% segmental dural nerve root irritation. No cause was identified in 19% of the patients. If there is evidence of radiculitis, spinal stenosis, or other demonstrable causes resulting in radiculitis, one may proceed with diagnostic transforaminal or therapeutic epidural injections²³. Otherwise, the approach should include the diagnostic interventions with facet joint blocks, sacroiliac joint injections, followed by discography.

Lumbar discography at the present time suffers from significant controversy with Level II-2 evidence¹⁴. In contrast, facet joint nerve blocks in the diagnosis of lumbar facet joint pain

* Instructor, Department of Anesthesiology, American University of Beirut Medical Center, Beirut 1107-2020 Lebanon.
** Assistant Professor, Chairman of the Department of Anesthesiology, University Medical Center Rizk Hospital, Beirut, Lebanon.
*** Resident, Department of Anesthesiology, American University of Beirut Medical Center, Beirut 1107-2020 Lebanon.
**** Professor, Department of Anesthesiology, American University of Beirut Medical Center, Beirut 1107-2020 Lebanon.
Corresponding author: Dr. Marwan Rizk, Department of Anesthesiology, American University of Beirut Medical Center, Beirut 1107-2020 Lebanon. E-mail: mr04@aub.edu.lb.

provide higher evidence with Level I or Level II-1¹⁵. However, sacroiliac joint injections provide Level II-2 evidence¹⁶.

The investigation of chronic low back pain without disc herniation commences with clinical questions, physical findings, and findings of radiological investigations. Radiological investigations should be obtained if the history and physical exam findings indicate their need. Controlled studies have illustrated a prevalence of lumbar facet joint pain in 21% to 41% of patients with chronic low back pain^{15,17-20,24-29} and 16% in post laminectomy syndrome³⁰. Thus, facet joints are entertained first because of their commonality as a source of chronic low back pain, available treatment, and ease of performance of the blocks. Further, among all the diagnostic approaches in the lumbosacral spine, medial branch blocks have the best evidence (Level I) with the ability to rule out false-positives (27% to 47%) and demonstrated validity with multiple confounding factors, including psychological factors^{31,32}, exposure to opioids³³, and sedation³⁴⁻³⁶. In this approach, investigation of facet joint pain is considered as a prime investigation, ahead of disc provocation and sacroiliac joint blocks. Multiple studies have indicated that facet joint pain may be bilateral in 60% to 79% of cases, involving at least 2 joints and involving 3 joints in 21% to 37% of patients²⁶⁻²⁸. Due to the innocuous nature of lumbar facet joint nerve blocks, it is recommended that all blocks be performed in one setting. However, based on the clinical examination, only 2 blocks are performed provided the first block was positive, thus avoiding a screening block and repeat blocks for separate joints³⁷. If a patient experiences at least 80% relief with the ability to perform previously painful movements within a time frame that is appropriate for the duration of the local anesthetic used and the duration of relief with the second block relative to the first block is commensurate with the respective local anesthetic employed in each block, then a positive diagnosis is made.

The sacroiliac joint as the pain generator, pain must be caudal to L5 and must be positive with flexion and abduction of the hip, along with tenderness over the sacroiliac joint on palpation^{16,38,39}. Sacroiliac joint blocks have a Level II-2 evidence in the diagnosis of sacroiliac joint pain utilizing comparative controlled

local anesthetic blocks. The prevalence of sacroiliac joint pain is estimated to range between 2% and 38% using a double block paradigm in specific study populations^{16,21,22,24,39-44}. The false-positive rates of single, uncontrolled, sacroiliac joint injections have been shown to be 20% to 54%¹⁶. However, there has been a paucity of the evidence in the evaluation of the effectiveness of sacroiliac joint blocks in the diagnosis of sacroiliac joint pain^{16,21,22}. The relief obtained should be 80% with the ability to perform previously painful movements and also should be concordant based on the local anesthetic injection^{16,38}.

If pain is not suggestive of facet joint or sacroiliac joint origin, then an epidural is to be considered. Caudal and lumbar interlaminar epidurals are non-specific as far as identifying the source of pain. If a patient fails to respond to epidural injections, the discogenic approach may be undertaken.

Provocation lumbar discography is performed as the first test in only specific settings of suspected discogenic pain and availability of a definitive treatment is offered solely for diagnostic purposes prior to fusion. Otherwise, once facet joint pain, and if applicable sacroiliac joint pain, is ruled out and the patient fails to respond to at least 2 fluoroscopically directed epidural injections, discography may be pursued if determination of the disc as the source of pain is crucial. Moreover, lumbar provocation discography is the last step in the diagnostic algorithm and is utilized only when appropriate treatment can be performed if disc abnormality is noted. Magnetic resonance imaging (MRI) will assist in ruling out any red flags and disc herniation, but will not determine if the disc is the cause of the pain. Lumbar provocation discography has been shown to reveal abnormalities in asymptomatic patients with normal MRI scans^{45,46}. Thus, when performed appropriately, discography can enhance sensitivity and specificity compared to non-provocational imaging. Discography continues to be the only diagnostic tool capable of establishing whether or not a particular disc is painful, irrespective of the presence or absence of degenerative pathology observed on other imaging modalities. Provocation discography continues to be controversial with respect to diagnostic accuracy^{14, 47-49}, utilization^{4-11,50}, and its impact on surgical volume^{51,52}. However,

lumbar discography has been refined substantially since its inception and its diagnostic accuracy has been established as Level II-2^{14,53,38,49}. In order to be valid, the provocation discography must be performed utilizing strict criteria of having concordant pain in one disc with at least 2 negative discs, one above and one below except when the L5/S1 is involved. Studies have shown the effectiveness of epidural injections in discogenic pain, with or without the use of steroids, after facet joint pain and other sources of low back pain have been eliminated⁵⁴⁻⁵⁶. In addition, the relief derived from discogenic pain with caudal epidural injections, with or without steroids, was equivalent to relief in managing disc herniation and superior to the relief obtained by patients with either spinal stenosis or post lumbar laminectomy syndrome⁵⁴⁻⁵⁹.

Given the realities of health care in the United States and the available evidence from the literature, it appears that lumbar facet joints account for 30% of cases of chronic low back pain, sacroiliac joint pain accounts for less than 10% of cases, and discogenic pain accounts for 25% of cases.

Approximately 70% of low back pain patients would undergo investigations of their facet joints, with approximately 30% proving positive and requiring no other investigations. Of the 70% remaining, approximately 10% will require sacroiliac joint blocks and perhaps 30% will prove to be positive. The remaining 60% of 70% and original 30% not undergoing facet injections - overall 60% to 70% - will probably undergo epidural injections and approximately 65% will respond to epidural injections and the remaining 20% of 35% will be candidates for provocation discography if a treatment can be provided^{1,60-63,54-59}.

Treatment of Somatic Pain

The patients testing positive for facet joint pain may undergo either therapeutic facet joint nerve blocks or radiofrequency neurotomy based on the patients' preferences, values, and physician expertise. However, there is no evidence for lumbar intraarticular facet joint injections¹⁵. In contrast, based on the review of included therapeutic studies⁶⁴⁻⁶⁶, Level II-1 to II-2 evidence is presented for lumbar facet joint nerve blocks with an indicated level of evidence of II-2 to

II-3 for lumbar radiofrequency neurotomy^{15, 64-68}.

The next modality of treatment is epidural injections. Epidural injections have been shown to present with variable evidence. A recent systematic review of caudal epidural injections in the management of chronic low back pain⁵⁴ showed Level I evidence for relief of chronic pain secondary to disc herniation or radiculitis and discogenic pain without disc herniation or radiculitis⁵⁵⁻⁵⁷. Further, the indicated evidence was Level II-1 or II-2 for caudal epidural injections in managing chronic pain of post lumbar surgery syndrome and spinal stenosis^{54,58,59}.

The indicated evidence for therapeutic sacroiliac joint interventions^{16,21,22} is Level II-2 with no evidence for sacroiliac joint neurotomy.

Treatment of Radicular Pain

While disc protrusion, herniation, or prolapsed resulting in sciatica are seen in less than 5% of the patients with low back pain^{69,70}, approximately 30% of the patients presenting to interventional pain management clinics will require either caudal, interlaminar, or transforaminal epidural injections as an initial treatment. Many patients with post-surgery syndrome, spinal stenosis, and radiculitis without disc protrusion may respond to epidural injections^{54,60,61,63,71-74}. Patients non-responsive to epidural injections will require either mechanical disc decompression⁷⁵⁻⁷⁸, percutaneous adhesiolysis^{79,71,73}, spinal endoscopic adhesiolysis^{71,73,80}, implantation of spinal cord stimulation⁸¹, or intrathecal infusion systems⁸² depending on the clinical presentation, pathology, and other biopsychosocial factors. Transforaminal epidural injections may be performed for diagnostic purposes; however, these also lead to therapeutic improvement. Buenaventura et al⁶³ in a systematic review of therapeutic lumbar transforaminal epidural steroid injections showed the indicated level of evidence as II-1 for short-term relief of 6 months or less and Level II-2 for long-term relief of longer than 6 months in managing chronic low back and lower extremity pain. Conn et al⁵⁴ in a systematic review of caudal epidural injections in the management of chronic low back pain showed variable evidence for various conditions causing low back and lower extremity pain. The evidence level shown is Level I for short- and long-

term relief in managing chronic low back and lower extremity pain secondary to lumbar disc herniation and radiculitis and discogenic pain without disc herniation or radiculitis. The indicated level of evidence is Level II-1 or II-2 for caudal epidural injections in managing low back pain of post-lumbar laminectomy syndrome and spinal stenosis.

In contrast to lumbar transforaminal epidural and caudal epidural injections, the evidence for lumbar interlaminar epidural injections in managing chronic low back and lower extremity pain is limited due to the lack of availability of studies utilizing fluoroscopy. The evidence is delivered from blind interlaminar epidural injections. Based on Parr et al's⁶⁰ systematic review, the indicated evidence is Level II-2 for short-term relief of pain of disc herniation or radiculitis utilizing blind interlaminar epidural steroid injections with a lack of evidence with Level III for long-term relief of disc herniation and radiculitis. Furthermore, the evidence at present is lacking for short- and long-term relief of spinal stenosis and discogenic pain without radiculitis or disc herniation utilizing blind epidural injections.

If a patient presents with unilateral, single, or 2 level involvement, one may proceed with transforaminal epidural injections (diagnostic and therapeutic). Bilateral or extensive involvement of multiple segments will lead to either interlaminar or caudal based on the upper or lower levels being involved, extensive stenosis (central or foraminal) and lack of response to caudal or interlaminar approaches. Except in specific documented circumstances with spinal stenosis, the approach also is based on the same philosophy as described above for transforaminal epidurals. For postsurgery syndrome, a caudal epidural is preferred and one may consider a transforaminal epidural if essential in patients without obstructing hardware.

The evidence for intradiscal procedures with thermal annular technology is also limited. The systematic review of the effectiveness of thermal annular procedures in treating discogenic low back pain⁶² showed an indicated level of evidence of II-2 for IDET, Level II-3 for radiofrequency annuloplasty, and limited or lack of evidence for intradiscal biacuplasty.

Treatment of Chronic Pain non responsive to conventional management

Patients non-responsive to epidural injections may be considered for mechanical disc decompression, percutaneous adhesiolysis, spinal endoscopic adhesiolysis, spinal cord stimulation, or implantation of intrathecal infusion systems.

Percutaneous mechanical disc decompression lacks evidence. There are 4 modalities, namely automated percutaneous lumbar discectomy, percutaneous laser discectomy, a high RPM device utilizing Dekompressor, and coblation nucleoplasty or plasma decompression. Recent systematic reviews⁷⁵⁻⁷⁸ showed the evidence to be Level II-2 for short- and long-term (> 1 year) improvement for percutaneous automated lumbar discectomy and laser discectomy. The evidence for coblation nucleoplasty (Level II-3) and Dekompressor (Level III) is only emerging.

In patients with post-lumbar surgery syndrome after failure to respond to fluoroscopically directed epidural injections, percutaneous adhesiolysis is considered⁷⁹. Despite a paucity of efficacy and pragmatic trials, the systematic review by Epter et al⁷⁹ indicated the evidence as Level I or II-1 with short term relief being considered as 6 months or less and long-term longer than 6 months⁸³⁻⁸⁹, in managing post-lumbar laminectomy syndrome. Another type of adhesiolysis is spinal endoscopic adhesiolysis, which is considered to be an experimental procedure. It also showed the indicated level of evidence of II-1 for short-term and Level III for long-term relief (≤ 6 months or > 6 months)⁸⁰.

The next step in the radicular pain is implantable therapy. Frey et al⁸¹ in a systematic review of spinal cord stimulation for patients with failed back surgery syndrome (FBSS) indicated the level of evidence as II-1 or II-2 for long-term relief (> 1 year) in managing patients with FBSS. In this systematic review⁸¹, 2 randomized trials^{90,91} and 8 observational studies were included⁹²⁻⁹⁹. Despite early increased expense, cost-effectiveness has been demonstrated for spinal cord stimulation¹⁰⁰⁻¹⁰⁴.

Finally, long-term management of chronic noncancer pain may be achieved with intrathecal infusion systems⁸². Intrathecal infusion systems are also

utilized for non-cancer pain in FBSS as an advanced stage intervention. While there is a lack of conclusive evidence due to the paucity of quality literature, Patel et al concluded that the level of evidence for intrathecal infusion systems was indicated as Level II-3 or Level III with longer than one-year improvement considered as long-term response⁸².

Interventional Pain Management

There is no consensus among interventional pain management specialists with regards to type, dosage, frequency, total number of injections, or other interventions. The literature provides some guidance even though not conclusive. The recent literature shows no significant difference in the outcomes with or without steroids with medial branch blocks^{15,64,105,106} and epidural injections^{60,61,63,54,55,57-59}. Many of the techniques including radiofrequency neurolysis and disc decompressions do not require any steroids.

The most commonly used formulations of long acting steroids include methylprednisolone (Depo-Medrol), triamcinolone acetonide (Aristocort or Kenalog), and betamethasone acetate¹⁰⁷⁻¹³².

Soon after the historic introduction of cortisone in 1949, steroids were used for various other purposes including placement in the epidural space, facet joints, sacro-iliac joints, and for infiltration of other nerves^{127,133-135}. The first published report of the injection of steroids into an arthritic joint was in 1951¹³³, followed by the application of transforaminal epidural steroid injections in 1952 and 1953. Since then, the use of spinal steroids has been reported with various approaches^{127,136-140}. Simultaneous with the introduction of neuraxial steroids in interventional pain management, various complications related to steroid therapy, including systematic effects of particulate steroids, have been described with increasing frequency, cautioning against use of spinal steroids in interventional pain management^{1,72,74,127-138}. The rationale for the use of epidural steroids into various joints and epidural space has been based on the strong anti-inflammatory effects of corticosteroids¹³⁸. However, while inflammation is an issue with discogenic pain and radiculitis, no inflammation has been proven to be present in other cases. It is postulated that corticosteroids reduce inflammation either by

inhibiting the synthesis of or release of a number of pro-inflammatory substances or by causing irreversible local anesthetic effect on C-fibers¹⁴¹⁻¹⁵⁶. The role of epidural steroids has been evaluated in experimental models with betamethasone reducing the nerve root injury produced by epidural application^{146,149}, with suppression of disc resorption by high dose steroids¹⁵³, the depression of heat hyperalgesia and mechano-allodynia¹⁵⁵, prevention of neuropathic edema and blockade of neurogenic extravasation¹⁵⁴, inhibition of phospholipase A2 activity¹⁵⁰, protection of C-fibers from damage¹⁵¹, prevention of endoneural vascular permeability induced by nucleus pulposus¹⁵², and decrease of the extent of intramedullary spinal cord injury secondary to spinal cord hemorrhage¹⁵⁶. The chemistry of neuraxial steroids has taken center stage in recent years due to devastating complications following epidural injections, specifically transforaminals^{128-131,157-168,169}. Steroid particle embolization into small radicular arteries is believed to be an important causative factor^{131,163}. Tiso et al¹²⁸ and Benzon et al¹²⁹ extensively evaluated chemical properties and their relationship to interventional pain management. Data from Tiso et al and Benzon et al regarding particle sizes were in general agreement with regards to methylprednisolone, triamcinolone, and commercial betamethasone. However, there were some differences pertaining to dexamethasone and betamethasone sodium phosphate. Nonetheless, based on the available literature and scientific applications, all the formulations of steroids may be considered clinically safe; however important physiochemical characteristics distinguish one compound from the others (Table 1). Though all formulations of steroids may be considered safe, formulations of betamethasone appear to be safer with no significant difference in the effectiveness¹²⁷. Formulations of commonly used epidural steroids are shown in Table 1 and the pharmacologic profile of commonly used epidural steroids is shown in Table 1.

Steroids lead to suppression of the hypothalamic pituitary axis with decreased plasma cortisol, decreased plasma adrenocorticotrophic hormone (ACTH), and adrenal atrophy^{127,170,171}. Other side effects may be specific to the site of injection which includes arachnoiditis, intrathecal injection, and particulate embolism. Numerous arguments of steroid toxicity to

the nervous system stem from the potential toxicity of multiple chemical entities used mostly as preservatives in the formulations of epidural steroids. Nelson¹³² spearheaded the crusade against intraspinal therapy using steroids and argued that methylprednisolone acetate was neurotoxic. Betamethasone does not contain either polyethylene glycol or benzyl alcohol.

Similarly, single dose vials of methylprednisolone (DepoMedrol) are available without alcohol. Latham et al¹¹⁹ reported that when injected deliberately into the subarachnoid space in sheep, betamethasone caused no reaction in the meninges or neural structures when small doses of 1 mL were used, even on repeated occasions. Other central nervous system (CNS) events described are worrisome. These are based on the particle size of epidural steroids and the risk of vascular obstruction and ischemic CNS injury as a result of embolization. There have been several reported cases of CNS injuries after transforaminal epidural injections^{172,173,128,129,160-167}. One of the postulated mechanisms of these events is occlusion of the segmental artery accompanying the nerve root by the particulate steroid or embolization of the particulate steroid through the vertebral artery^{128,129,165,168,171}. Consistent with the present literature of the pharmacology of steroids, it appears that non-particulate steroids may be the agents of choice for transforaminal epidural injections, though no trials have compared particulate to non-particulate steroids. However, particulate steroids may be safely utilized for interlaminar or caudal epidural injections. Caution must be exercised in the use of particulate steroids in transforaminal epidural injections and

specifically for cervical transforaminal epidural injections, particularly if sharp needles are used.

The frequency and total number of injections have been considered important issues, even though controversial and poorly addressed. These are based on flawed assumptions from non-existing evidence. Over the years, some authors have recommended one injection for diagnostic as well as therapeutic purposes. Some have preached 3 injections in a series, irrespective of a patient's progress or lack thereof, whereas others suggest 3 injections followed by a repeat course of 3 injections after 3-, 6-, or 12-month intervals. There are also proponents of an unlimited number of injections with no established goals or parameters. A limitation of 3 mg per kilogram of body weight of steroid or 210 mg per year in an average person and a lifetime dose of 420 mg of steroid also have been advocated, however, with no scientific basis. The review of the literature and of all the systematic reviews has not shown any basis for the above reported assumptions and limitations. The administration must be based solely on the patients' responses, safety profile of the drug, experience of the physician, and pharmacological and chemical properties such as duration of action and suppression of adrenals.

Indication and frequency of interventional pain management techniques

Some criteria should be considered carefully before performing any interventional technique. The physician has to complete an initial evaluation,

Table 1
Epidural Steroids

Drug	Equivalent Dose	Epidural Dose	Anti-Inflammatory Potency	Sodium Retention Capacity	Duration of adrenal Suppression		
					IM	Single Epidural	Three Epidurals
Hydrocortisone	20 mg	N/A	1	1	N/A	N/A	N/A
Depo-Methylprednisolone (Depo-Medrol)	4 mg	40–80 mg	5	0.5	1–6 weeks	1–3 weeks	N/A
Triamcinolone acetonide (Kenalog)	4 mg	40–80 mg	5	0	2–6 weeks	N/A	2–3 months
Dexamethasone (Decadron)	0.75 mg	8–16 mg	27	1	N/A	N/A	N/A

N/A = Not available

Data adapted and modified from McEvoy et al (109), Jacobs et al (161) Kay et al (158), Hsu et al (159), Manchikanti et al (105,106), Schimmer and Parker (108), and Benzon et al (129).

including history and physical examination, with a psychosocial and functional assessment. The indications are a suspected organic problem, nonresponsiveness to less invasive modalities of treatments except in acute situations such as acute disc herniation, herpes zoster, complex regional pain syndrome (CRPS), and intractable cancer-related pain. These techniques are applied when the pain and disability are of moderate-to-severe degree and when there is no contraindication such as severe spinal stenosis resulting in intraspinal obstruction, infection, impaired coagulation, or predominantly psychogenic pain. The responsiveness to prior interventions with improvement in physical and functional status is a must to justify repeat blocks or other interventions. The interventions are repeated only upon return of pain and deterioration in functional status with a documented decreased pain and increased function after the initial intervention. The indications are variable for various types of interventional techniques.

Facet Joint interventional procedures

Lumbar facet joints are a well-recognized source of low back and referred pain in the lower extremity in patients with chronic low back pain. Facet joints are well innervated by the medial branches of the dorsal rami^{174,175}. Kalichman et al¹⁷⁶ evaluated facet joint osteoarthritis and low back pain in the community-based Framingham Heart Study. They concluded that there is a high prevalence of facet joint osteoarthritis in the community-based population with a prevalence of 59.6% in males and 66.7% in females. The prevalence of facet joint osteoarthritis increased with age and reached 89.2% in individuals 60 to 69 years old with highest prevalence of facet joint osteoarthritis found at the L4/5 spinal level. Facet joint pain may be managed by intraarticular injections, facet joint nerve blocks, and neurolysis of facet joint nerves. Facet arthrosis has been suggested as a cause of low back pain for decades. However, the exact source of pain in the facet joints is ambiguous. Theories on the generation of pain range from mechanical alterations to vascular changes and molecular signaling. While disc degeneration can clearly cause low back pain, some patients may not experience pain until degenerative changes in the facet joints alter mechanical alignment

sufficiently to produce “articular” low back pain¹⁷⁷. Most publications agree that 2 diagnostic blocks must be performed before radiofrequency denervation and many payors are requiring 80% or more pain relief. Consequently, a single block will definitely increase costs of care as the single diagnostic block will lead to an increase in number of radiofrequency denervations, which are more expensive and time consuming. The most common and worrisome complications of facet joint interventions are related to needle placement and drug administration. Potential complications include dural puncture, spinal cord trauma, infection, intraarterial or intravenous injection, spinal anesthesia, chemical meningitis, neural trauma, pneumothorax, radiation exposure, facet capsule rupture, hematoma formation, and steroid side effects¹⁷⁸⁻¹⁷⁹. Potential side effects with radiofrequency denervation include painful cutaneous dysesthesias, increased pain due to neuritis or neurogenic inflammation, anesthesia dolorosa, cutaneous hyperesthesia, pneumothorax, and deafferentation pain. Unintentional damage to a spinal nerve during medial branch radiofrequency, causing a motor deficit, is also a complication of a neurolytic procedure¹⁸⁰.

Common indications for diagnostic facet joint interventions are somatic or nonradicular low back, midback, or upper back and/or lower extremity pain. This pain should be intermittent or continuous in nature, causing functional disability and is present at least for the past 3 months. Those blocks are performed after eliminating a disc herniation or evidence of radiculitis and when more conservative management, including physical therapy modalities with exercises, chiropractic management, and nonsteroidal anti-inflammatory agents fails.

In the diagnostic phase, a patient may receive two procedures at intervals of no sooner than one week or preferably two weeks, with careful judgment of response. A positive response to controlled local anesthetic blocks (<1 mL) is associated with 80% pain relief and the ability to perform prior painful movements without any significant pain. In the therapeutic phase (after the diagnostic phase is completed), the suggested frequency would be two to three months or longer between injections, provided that $\geq 50\%$ relief is obtained for 6–8 weeks. If the

interventional procedures are applied for different regions, they may be performed at intervals of no sooner than one week or preferably two weeks for most types of procedures. It is suggested that therapeutic frequency remain at least a minimum of 2 months for each region; it is further suggested that all the regions be treated at the same time provided that all procedures can be performed safely. In the treatment or therapeutic phase, facet joint interventions should be repeated only as necessary according to the medical necessity criteria, and it is suggested that these be limited to a maximum of 4 to 6 times for local anesthetic and steroid blocks over a period of one year, per region. Under unusual circumstances with a recurrent injury, procedures may be repeated at intervals of 6 weeks after stabilization in the treatment phase. For medial branch neurotomy, the suggested frequency would be 3 months or longer (maximum of 3 times per year) between each procedure, provided that 50% or greater relief is obtained for 10 to 12 weeks. The therapeutic frequency for medial branch neurotomy should remain at intervals of at least 3 months per each region with multiple regions involved. It is further suggested that all regions be treated at the same time, provided all procedures are performed safely.

Epidural Infiltrations

Epidural injections in the lumbar spine are provided by caudal, lumbar interlaminar, or transforaminal routes. While interlaminar entry is considered to deliver the medication closely to the assumed site of pathology, the transforaminal approach is considered as target-specific requiring the smallest volume to reach the primary site of pathology. Caudal epidurals are considered as the safest and easiest, with minimal risk of inadvertent dural puncture, even though requiring relatively high volumes. They have also been shown to be significantly effective compared to interlaminar epidural injections^{181,182}. Even then, controversy continues with regards to the medical necessity and indications of lumbar epidural injections. These guidelines apply to all epidural injections including caudal, interlaminar, and transforaminal.

Complications and side effects include infection, intravascular injection, extra epidural placement, hematoma formation, abscess formation,

subdural injection, intracranial air injection, epidural lipomatosis, dural puncture, nerve damage, headache, increased intracranial pressure, vascular injury, cerebral vascular or pulmonary embolus and effects of steroids.

Caudal

The caudal approach to the epidural space via the sacral hiatus is often the preferred injection method in the treatment of low back pain caused by lumbosacral root compression. Many nonanesthetists prefer this injection method because it carries a lower risk of inadvertent thecal sac puncture and intrathecal injection. Successful caudal epidural injection relies on the proper placement of the needle in the epidural space. The most common method used to identify the caudal epidural space is by detecting the characteristic “give” or “pop” when the sacrococcygeal ligament is penetrated. In the event of unaided or blind needle insertion, incorrect needle placement has been reported to occur in 25% to 38% of cases, even in the hands of experienced physicians. Furthermore, even when physicians are confident with their injection technique, incorrect needle placement has been observed in about 1 of 7 caudal injection procedures. An incorrect needle position would most likely result in deep subcutaneous injections. In clinical practice, the “whoosh” test, nerve stimulation, and fluoroscopy are the 3 methods that can be used to identify the caudal space before the injection of medications. Approximately 3% of the studied population has closed sacral canals, thus making caudal epidural injections impossible for these subjects.

The common indications are chronic low back and/or lower extremity pain which has failed to respond or poorly responded to noninterventional and nonsurgical conservative management resulting from disc herniation, lumbar radiculitis, lumbar spinal stenosis, post lumbar surgery syndrome, epidural fibrosis, degenerative disc disease and discogenic low back pain. The facet joint pain should be eliminated by controlled local anesthetic blocks.

Lumbar Interlaminar

In a randomized, double-blind, controlled trial of lumbar interlaminar epidural injections in chronic

function-limiting low back pain without facet joint pain, disc herniation, and/or radiculitis, Manchikanti et al demonstrated an effectiveness in 74% of the patients receiving local anesthetic only and 63% of patients receiving local anesthetic and steroids with an average of 4 procedures per year.

The indications are the same as for caudal epidural injections, except for post-surgery syndrome where caudal epidural is the modality of choice¹⁸³.

Lumbar Transforaminal

Lumbar transforaminal epidurals are provided for diagnostic and therapeutic purposes. The aim of the diagnostic procedure is to identify an inflamed nerve root in a patient with a history of radicular pain when results of visual anatomic studies and neurophysiologic studies are not collaborative. It also helps to identify the pain generator when patients have multiple abnormalities on visual anatomic studies and to determine a primary pain generator in the spine-hip syndrome, the symptomatic level in multilevel disc herniation or stenosis and the irritated root in patients with documented postoperative fibrosis or spondylolisthesis.

The therapeutic indications are an intermittent or continuous pain causing functional disability. A chronic low back and/or lower extremity pain which has failed to respond or poorly responded to non-interventional and non-surgical conservative management, resulting from disc herniation, failed back syndrome without extensive scar tissue and hardware, spinal stenosis with radiculitis and discogenic pain with radiculitis.

The guidelines of frequency of interventions apply to epidural injections caudal, interlaminar, and transforaminal. In the diagnostic phase, a patient may receive two procedures at intervals of no sooner than one week or preferably two weeks except in cancer-related pain or when a continuous administration of local anesthetic is employed for CRPS.

In the therapeutic phase (after the diagnostic phase is completed), the suggested frequency of interventional techniques should be two months or longer between each injection, provided that > 50% relief is obtained for six to eight weeks. If the neural blockade is applied for different regions, they may be

performed at intervals of no sooner than one week and preferably two weeks for most types of procedures. The therapeutic frequency may remain at intervals of at least two months for each region. It is further suggested that all regions be treated at the same time, provided all procedures can be performed safely. In the treatment or therapeutic phase, the epidural injections should be repeated only as necessary according to medical necessity criteria, and it is suggested that these be limited to a maximum of 4–6 times per year. Under unusual circumstances with a recurrent injury, cancer-related pain, or CRPS, blocks may be repeated at intervals of 6 weeks or less after diagnosis/stabilization in the treatment phase.

Percutaneous Adhesiolysis

Adhesiolysis of epidural scar tissue, followed by the injection of hypertonic saline, has been described by Racz and coworkers in multiple publications. The technique described by Racz and colleagues involved epidurography, adhesiolysis, and injection of hyaluronidase, bupivacaine, triamcinolone diacetate, and 10% sodium chloride solution on day one, followed by injections of bupivacaine and hypertonic sodium chloride solution on days 2 and 3. Manchikanti and colleagues modified the Racz protocol from a 3-day procedure to a one-day procedure. The goal of percutaneous lysis of epidural adhesions is to assure delivery of high concentrations of injected drugs to the target areas. Thus, percutaneous epidural lysis of adhesions is the first and most commonly used treatment to incorporate multiple therapeutic goals^{184,185}. Inflammation, edema, fibrosis, and venous congestion; mechanical pressure on posterior longitudinal ligaments, annulus fibrosus, and spinal nerve; reduced or absent nutrient delivery to the spinal nerve or nerve root; and central sensitization may be present in patients with radiculitis with disc herniation, stenosis, and epidural fibrosis. Hence, it has been postulated as reasonable to treat back pain with or without radiculopathy with the local application of anti-inflammatory medication agents (e.g., corticosteroids) aimed at reducing edema (e.g., hypertonic sodium chloride solution, corticosteroids), local anesthetics, and hyaluronidase to promote lysis^{185,186}. Thus, percutaneous lysis of adhesions is indicated in patients with appropriate diagnostic evaluation and after the

failure or ineffectiveness of conservative modalities of treatment have been proven.

The most common and worrisome complications of adhesiolysis in the lumbar spine are related to dural puncture, spinal cord compression, catheter shearing, infection, steroids, hypertonic saline, and hyaluronidase^{187, 188-191}. Spinal cord compression following rapid injections into the epidural space, which may cause large increases in intraspinal pressure with a risk of cerebral hemorrhage, visual disturbance, headache, and compromise of spinal cord blood flow, has been mentioned.

The indications for an epidural adhesiolysis are chronic low back and/or lower extremity pain resulting from a failed back surgery syndrome or epidural fibrosis, spinal stenosis, disc herniation with radiculitis and failure to respond or poor response to noninterventional and non-surgical conservative management and fluoroscopically-directed epidural injections. Adhesiolysis can be performed after eliminating a facet joint pain by controlled local anesthetic blocks. The number of procedures is preferably limited to two interventions per year.

Spinal Endoscopic Adhesiolysis

There is insufficient evidence to conclude that epiduroscopy can improve patient management or disease outcomes. The available studies primarily evaluated the feasibility of the procedure and the ability to visualize normal and pathological structures with an epiduroscope. Some studies concluded that epiduroscopy could identify the cause of pain and other neurological signs in some patients who had been either undiagnosed or incorrectly diagnosed by radiography or magnetic resonance imaging (MRI). Geurts et al. reported that epiduroscopy outperformed MRI in 8 out of 20 patients with chronic sciatica with or without failed back syndrome (Geurts, 2002). In this study, MRI findings agreed with epiduroscopy observations in 11 patients, while epiduroscopy identified an adhesion on the nerve root in 8 patients in whom MRI detected no abnormalities of the spinal structures. There is insufficient evidence to conclude that epidural lysis of adhesions can provide sustained reduction in chronic back pain in patients with a presumptive diagnosis of epidural adhesions. The

common indications of this procedure are chronic low back and lower extremity pain nonresponsive or poorly responsive to conservative treatment, including fluoroscopically directed epidural injections and percutaneous adhesiolysis with hypertonic saline neurolysis. The procedures are preferably limited to a maximum of two per year provided the relief was > 50% for > 4 months.

Intradiscal Procedures

The lumbar intervertebral discs have been shown to be sources of chronic back pain without disc herniation in 26% to 39%. Lumbar provocation discography, which includes disc stimulation and morphological evaluation, is often used to distinguish a painful disc from other potential sources of pain. Conversely, there is evidence that subtle but painful lesions may be present in discs that appear morphologically normal on MRI. Discography has been shown to reveal abnormalities in symptomatic patients with normal MRI scans^{192,193}. Lei et al¹⁹⁴ concluded that MRI should continue to supplement discography rather than replace it. In a meta-analysis by Wolfer et al¹⁹⁵, the authors concluded that the false-positive rate was acceptably low and indicated the level of evidence for discography was Level II-2. In a therapeutic attempt, a steroid might be injected to decrease inflammation and swelling that may be present within a disc. The steroid usually starts to work in 2-3 days, but the optimal effects are not known until 1-2 weeks after the injection. The duration and extent of pain relief from therapeutic intradiscal injection is associated with variable results. The indications are axial low back pain of at least 6 months duration with failure to respond to conservative treatment, abnormal nucleus signal on T2-weighted MRI images with > 60% residual disc height and no evidence of root compression, tumor, or infection. Finally, even though lumbar provocation discography with a double needle technique is considered safe¹⁹⁶, discitis is a serious problem. Further, needle puncture injury was shown to affect intervertebral disc mechanics and biology in an organ culture model¹⁹⁷. In addition, incidence of intravascular uptake during fluoroscopically guided lumbar disc injections also has been demonstrated¹⁹⁸.

Mechanical Disc Decompression

Lumbar disc prolapse, protrusion, or extrusion account for less than 5% of all low back problems, but are the most common causes of nerve root pain and surgical interventions. The primary rationale for any form of surgery for disc prolapse is to relieve nerve root irritation or compression due to herniated disc material. The primary modality of treatment continues to be either open or microdiscectomy, but several alternative techniques including nucleoplasty, automated percutaneous discectomy, and laser discectomy have been described¹⁹⁹. Disc herniations consist of both contained and non-contained types. While for non-contained disc herniations, open discectomy is the approach of choice²⁰⁰, partial removal of the nucleus pulposus in contained discs has been shown to decompress herniated discs and relieve pressure on nerve roots in a much less invasive manner^{201,202}.

Nucleoplasty, a minimally invasive procedure, uses radiofrequency energy to remove nuclear material and create small channels within the disc. Nucleoplasty utilizing Coblation technology dissolves the nuclear material through molecular dissociation, and is thought to lower nuclear pressure, thereby reducing the nerve root tension and allowing a protrusion to implode inward. However, epidural fibrosis may develop with nucleoplasty²⁰³. At present, the common indication is unilateral leg pain with radicular symptoms in a specific dermatomal distribution that correlates with MRI findings. Imaging studies (CT, MRI, discography) should indicate a subligamentous contained disc herniation with a well maintained disc height of 60%. Nucleoplasty may be considered prior to open discectomy, however, automated percutaneous lumbar discectomy and laser discectomy have been shown to have better evidence with extensive experience²⁰¹.

Sacroiliac Joint Injections

The sacroiliac joint is a diarthrodial joint, receiving innervation from the lumbosacral nerve roots²⁰⁴. Controlled local anesthetic blocks continue to be the best available tool to identify either the intervertebral discs, facet, or sacroiliac joints as the source of low back pain^{205,206}. Sacroiliac joint pain may be managed by intraarticular injections or

neurolysis of the nerve supply. A retrospective review by Borowsky and Fagen²⁰⁷ conducted in 120 patients found the combination of intra- and peri-articular injectate deposition provided superior analgesia than intraarticular injection alone.

The common indications are somatic or nonradicular low back and lower extremity pain below the level of L5 vertebra which failed to respond to more conservative management, including physical therapy modalities with exercises, chiropractic management, and non-steroidal anti-inflammatory agents. For therapeutic sacroiliac joint interventions with intraarticular injections or radiofrequency neurotomy, the joint should have been positive utilizing controlled diagnostic blocks.

In the diagnostic phase, a patient may receive two SI joint injections at intervals of no sooner than one week or preferably two weeks. In the therapeutic phase (after the diagnostic phase is completed), the suggested frequency would be two months or longer between injections, provided that >50% relief is obtained for six weeks. If the procedures are done for different joints, they should be performed at intervals of no sooner than one week or preferably two weeks. It is suggested that therapeutic frequency remain at two months for each joint. It is further suggested that both joints be treated at the same time, provided the injections can be performed safely. In the therapeutic phase, the interventional procedures should be repeated only as necessary according to the medical necessity criteria, and it is suggested that they be limited to a maximum of 4 – 6 times for local anesthetic and steroid blocks over a period of one year, per region. Under unusual circumstances with a recurrent injury, procedures may be repeated at intervals of six weeks after stabilization in the treatment phase. For sacroiliac joint radiofrequency neurotomy the suggested frequency is three months or longer between each procedure (maximum of 3 times per year), provided that >50% relief is obtained for 10 to 12 weeks.

Trigger-Point and Ligamental Injections

Limited evidence was found suggesting that a combination of corticosteroid injections and local anaesthetic injections in trigger points and phenol-injections in lumbar ligaments were effective in

chronic low back pain. 15 One RCT (n=57) compared 'trigger-point' injections with methyl-prednisolone plus lidocaine versus triamcinolone plus lidocaine versus lidocaine alone. 60-80% of patients with a combination of lidocaine and corticosteroid had complete relief of pain after three months compared to 20% in the lidocaine group. The other RCT (n=81) compared ligamental dextrose-glycerine-phenol injections with saline. The decrease in pain and improvement in functional status was larger with phenol than with saline at one, three and six months.

Spinal Cord Stimulator

Patients may have persistent disabling low back pain despite use of several standard therapies or following back surgery (i.e, failed back surgery syndrome). Chronic opioids may be used in such patients to manage pain, but responses are incomplete, long-term outcome unknown, and side effects can be serious. Opioids should only be used after adequate risk assessment and with appropriate monitoring and supervision. Spinal cord stimulation involves the placement of electrodes in the epidural space adjacent to the spinal area presumed to be the source of pain. An electric current is then applied to achieve sympatholytic and other neuromodulatory effects. The resulting impulses in the fibers may inhibit the conduction of pain signals to the brain according to the pain gate theory. Moreover, the number and type of leads (unipolar, bipolar, or multipolar) and the parameters of stimulation (amplitude pulse wide electrode sensation) may vary depending on the nerve roots involved and the intensity of the pain being experienced by the patient. Further, the electrodes may be implanted percutaneously or by laminectomy, and power for the spinal cord stimulator is supplied by an implanted battery or transcutaneously through an external radiofrequency transmitter. The implanted source of power is equipped with a computerized telemetry system that allows transcutaneous programming of the specific pattern of stimulation²⁰⁸. In the randomized trials, 26 to 32 percent of patients experienced a complication following spinal cord stimulator implantation, including electrode migration, infection or wound breakdown, generator pocket-related complications, and lead problem.

Currently, the common indications for a spinal cord stimulator implantation are a documented lumbosacral arachnoiditis that has not responded to medical management. The best candidates are those with intractable pain caused by nerve root injuries, including the postlaminectomy syndrome, this umbrella term overlies a constellation of different symptoms and etiologies, predominantly neuropathic extremity pain²⁰⁹. Demonstration of pain relief stipulates a screening period using temporary percutaneous placement of leads and an external generator²¹⁰.

Intrathecal Pump Insertion

Intrathecal drug delivery systems are implanted for chronic pain when conservative therapies have failed, surgery is ruled out, no active or untreated addiction exists, psychological testing indicates appropriateness for implantable therapy, medical contraindications have been eliminated (coagulopathies, infections), and a successful intrathecal drug trial has been completed²¹¹. Intrathecal pumps deliver small doses of medication directly to the spinal fluid. It consists of a small battery-powered, programmable pump that is implanted under the subcutaneous tissue of the abdomen and connected to a small catheter tunneled to the site of spinal entry. Sophisticated drug dose regimens can be instituted. Implanted pumps need to be refilled every 1 to 3 months. There is no evidence showing whether it is more clinically effective to use bolus or continuous dosing. No intrathecal device should be implanted for pain management of chronic low back pain without first performing a trial. This phase determines whether a patient will benefit from an implant²¹². The first line of treatment includes morphine and hydromorphone. The second protocol may actually be chosen as first line in cases where an individual has prominently neuropathic symptoms. This consists of either hydromorphone or morphine with the addition of bupivacaine or clonidine. After failure of first and second line drug combination treatments, either due to intolerable side effects or inadequate analgesia, the physician might consider using lipophilic opioid agents such as fentanyl and gamma-aminobutyric acid (GABA) agonists such as baclofen and midolazam. Bleeding, neurological injury, infection, cerebral spinal leaks, shredded catheters, and malpositioned subcutaneous pockets

are the surgical complications during the insertion of an intrathecal pump. Drug refills must be done by trained individuals who are able to accurately assess pain and subtle changes in the patient condition. Drug tolerance is caused by psychological, pharmacological or physiological aspects and can best be described as the need for dose escalation for equivalent effect. A Canadian study in 2002 showed that patients who responded to intrathecal drug treatment for failed low back syndrome is cost-effective in the long term, despite high initial costs of the implantable devices²¹³.

Biography

Dr. Marwan Rizk is an instructor of clinical anesthesiology at the Department of Anesthesiology at AUB-MC.

Dr. Rizk received his MD from St. Joseph University of Beirut in 1997. Following graduation, he completed four years of residency training in anesthesiology at the FM/AUBMC from 1998-2002. He subsequently completed a year of advanced training in pain management and regional anesthesia at Wayne State University School of Medicine. He also attained a DISS and Masters degree in Hospital Management from Denis Diderot University, Paris in 2007.

Conclusion

In this chapter, we described the most common modalities of management. However, there is no single approach that covers every patient. Further, typical patients present with multiple problems. Thus, this should not be construed as the entire evaluation. Only relevant descriptions are provided. Abuse and overuse of multiple procedures is a major concern. These guidelines must not be used to justify multiple procedures, without documentation of medical necessity.

Dr. Rizk is Arab board certified in anesthesiology and critical care medicine. He has more than 15 publications in international journals.

Dr. Rizk added clinical expertise is mostly in the area of pain and regional anesthesia. He was employed as an attending physician in anesthesiology and director of Pain Clinic at St. Joseph Hospital, Beirut, where he also served as vice Medical Director and director of the Quality Management Program and Patient Safety Committee and a member in the Governing and Strategic Committee, 2003-10.

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