DEGENERATIVE LUMBAR STENOSIS

Update

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Abstract – We present a literature review of the diagnosis and treatment of acquired lumbar spinal stenosis (LS), with a brief description of new surgical techniques. LS is the most common cause of spinal surgery in individuals older than 65 years of age. Neurogenic claudication and radiculopathy result from compression of the cauda equina and lumbosacral nerve roots by degenerated spinal elements. Surgical decompression is a well established treatment for patients with refractory, or moderate to severe clinical symptoms. However, the variety of surgical options is vast. New techniques have been developed with the goal of increasing long term functional outcomes. In this article we review lumbar decompression and fusion as treatment options for LS but also present other recent developments. Prospective long term studies are necessary to know which procedures would result in optimal patient outcome.

KEY WORDS: acquired lumbar stenosis, surgical treatment, new techniques, fusion.

Estenose lombar degenerativa: atualização

Resumo – Apresentamos uma revisão de literatura do diagnóstico e tratamento da estenose lombar (EL) adquirida, enfatizando as novas técnicas de manejo cirúrgico. A EL é a causa mais comum de cirurgia na coluna de pacientes com mais de 65 anos de idade. Claudicação neurogênica e radiculopatias são sintomas resultantes da compressão das raízes lombossacrais pelos elementos degenerados. A descompressão cirúrgica é um procedimento bem estabelecido para pacientes com sintomas severos ou refratários ao tratamento clínico. Contudo, as opções cirúrgicas são amplas. Novas técnicas de fusão e artrodese são úteis para melhorar os resultados funcionais. Neste artigo, varias alternativas cirúrgicas são apresentadas, incluindo as novas tecnologias na área. Evidências científicas mais contundentes com seguimento longo são necessárias para a incorporação destas práticas na atividade médica de rotina.

PALAVRAS-CHAVE: estenose lombar adquirida, tratamento cirúrgico, novas técnicas, fusão.

Lumbar stenosis (LS) is narrowing of any part of the lumbar spinal canal. Absolute stenosis has been defined as an antero-posterior lumbar spine diameter of less than 10 mm[1]. Although numerical criteria for the diagnosis of LS have been established, the diagnosis can be made without measurements when the narrowing results in clinical symptoms. It is important to note that it is not unusual to encounter patients with radiographic abnormalities who do not have symptoms[2].

LS can be congenital or acquired. Degenerative disease is the most common cause of acquired stenosis, mainly affecting adults and the elderly. With an increase in life expectancy, there is a concomitant increase in age-related disease. Although the exact incidence is unknown, it is estimated that LS affects 1 in 1000 patients older than 65 years, being the most common cause of spinal surgery in this group of patients[3].

Spinal stenosis is secondary to hypertrophy of one or more of the following elements: facet joint, ligamenta flava, posterior longitudinal ligament, intervertebral disc, epidural fat, and osteophytic disease of the vertebral body[4,5]. The degenerative process begins with disc height loss and dehydration, with substitution of collagen type II fibers and proteoglycans for fibrous tissue, with segmental mobility[6]. This results in disc bulging, facet degeneration and hypertrophy, and osteophyte formation that en-

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Received 10 September 2008, received in final form 26 February 2009. Accepted 30 April 2009.

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croach the spinal canal and/or the lateral recess[4,5]. Facet degeneration may result in degenerative spondylolisthesis with more severe segmental instability[7]. The narrowing can be predominantly central, subarticular (under the facet articulation), or lateral (at the neural foramen). When severe, there can be associated sagittal or coronal deformity.

HISTORY

LS can cause pain or discomfort in the lower back, buttocks, or legs. These symptoms are predominantly due to lateral recess stenosis. Less commonly, neurogenic claudication (NC) secondary to central canal stenosis can also result in these findings[8]. NC is characterized by leg or thigh pain that is exacerbated with prolonged walking and lumbar extension, which improves with lumbar flexion. In the setting of central canal stenosis, ischemia of the nerve roots may develop from further compression by an engorged venous plexus[9]. Although typical, NC is not pathognomonic of LS. In one report of 62 patients, 92% presented with lower limb complaints, whereas claudication was detected in 75%[10]. Rarely one can find sphincter dysfunction due to cauda equina compression, necessitating urgent surgery[6]. The severity of symptoms should be measured using scales, such as the visual analog scale for pain, or the Oswestry low back pain scale[11].

PHYSICAL EXAM

Objective neurological findings are not commonly detected on physical examination. The Lasègue test is generally negative, differing LS from acute disc herniation[10]. Lumbar extension can cause discomfort that is relieved with spinal flexion. Muscular weakness is not common, and if present may be due to pain. There may be associated sensory loss in a dermatomal distribution[6].

DIFFERENTIAL DIAGNOSIS

A good history and physical examination can help narrow down the differential diagnosis. Hip osteoarthritis may be present when pain is exacerbated by external hip rotation (Patrick's sign or Fabere test – *flexion, abduction, external rotation*)[12]. Trochanteric bursitis is associated with tenderness over the greater trochanter. Peripheral neuropathy can be associated with sensory deficits in the stocking and glove distribution. Vascular claudication is associated with a decrease in amplitude of the peripheral pulse with trophic changes in the skin. The pain is not altered with spinal flexion or extension, and decreases with rest. Impotence is also associated with vascular claudication. Conus medullaris and/or cauda equina compression by disc herniation, neoplasms, fractures, facet joint syndromes, infectious diseases, and demyelinating diseases are included in the differential diagnosis. Imaging is required to help make the correct diagnosis[13,14].

RADIOLOGICAL FINDINGS

The diagnosis of LS is essentially clinical, confirmed by computer tomography (CT) or magnetic resonance (MRI), showing narrowing of the canal and foramina and excluding other elements of the differential diagnosis. While MRI is particularly useful for visualization of the soft tissues resulting in stenosis, CT allows for clear definition of bone anatomy. In our daily practice, we obtain both imaging studies since they are useful for surgical planning. CT myelography may be useful in patients with previous lumbar surgery or in patients in whom MRI is contraindicated. Radiological findings consistent with LS are found in 20% of asymptomatic patients older than 60 years[7]. The extent of pathology seen on imaging does not necessarily correlate with clinical symptoms[2].

Standing plain film radiographs (antero-posterior and lateral neutral, flexion, and extension) are essential for surgical planning. These films are required to demonstrate instability. Long cassette standing plain films are also important when one suspects that patients may have associated sagittal or coronal imbalance[15].

NEUROPHYSIOLOGICAL TESTING

Electromyography and nerve conduction studies, although not essential, can assist with ruling out lumbosacral plexopathies and peripheral neuropathies from the differential diagnosis. There is a broad spectrum of possible electrophysiological findings in patients with LS. In early stages of the disease normal results may be possible. More advanced disease may demonstrate significantly decreased nerve conduction, with axonal loss and evidence of demyelination in a multi-radicular pattern[16-19].

TREATMENT

Before any treatment proposal, it is important to know the natural history of the disease. Most patients have a slowly progressive clinical course, without acute deterioration[20,21]. Johnsson et al. followed 32 patients with moderate LS for 4 years without surgical intervention[22]. They observed that only 16% had worsening pain; however 30% had decreased ability to walk.

Non-surgical management

Spine rehabilitation in the form of physical therapy has been demonstrated to decrease patient symptoms[23]. Exercises that improve abdominal strength may be useful to avoid excessive loading of the lumbar spine, and reduce extension.

There are a variety of ways to obtain non-surgical symptomatic relief. Passive modalities such as heating or cooling pads, lumbar corsets, transcutaneous electrical stimulation (TENS), and ultrasound may provide transient pain relief[7]. Non-steroidal anti-inflammatory med-

ications or acetaminophen may be used as initial therapy, but when not effective, muscle relaxants and opioids can be used. Anticonvulsants and tricyclic antidepressants are often prescribed as well, but may have adverse effects limiting their use in elderly people. There is no class I evidence to prove the effectiveness of these medications in the treatment of LS[7].

Patients not deemed suitable for surgical treatment with persistent radicular pain can benefit from epidural corticosteroid injections (either interlaminar or trans-foraminal). Their effect is attributed to decreasing the inflammation between the nerve root and the elements compressing it. Some patients have a temporary control (weeks to months) of symptoms after having these injections[24]. Despite some controversy associated with the real efficacy of these injections, they are being used at increased frequency around the world and being promoted as a form of safe and minimally invasive treatment[25].

Surgical treatment

Patients with persistent symptoms despite non-surgical treatment should be referred to spine surgeons. The goal of surgery is to decompress the spinal canal and neural foramina through laminectomies and partial facetectomies. Many surgical techniques are described in the literature, without a global consensus. There is class I evidence that in patients with persistent symptoms for more than 12 weeks, decompressive surgery (without fusion) improves function and pain control when compared to patients in the non-surgical treatment group. The effects of the surgical procedure were followed for at least 2 years[26,27].

Since many surgical options to treat LS can be found at the literature, one may find it difficult to choose the optimal procedure. The traditional procedure is a decompressive laminectomy, consisting of removal of the spinous processes, lamina, ligamenta flava, and medial portions of the facet joints[26,27]. Fenestration is a modified partial laminectomy and facetectomy with preservation of the midline structures and the dorsal tension band. Some surgeons advocate its use in patients to prevent iatrogenic instability[28]. It can also be done with minimally invasive techniques.

Regarding fusion and instrumentation procedures, there are no class I studies to prove that fusion and instrumentation improve functional outcomes in patients without criteria of instability. However, there are many papers with class II and III evidence levels advocating concomitant spinal fusion and arthrodesis to improve outcomes and avoid late instabilities, even in patients without spondylolisthesis or spinal deformities[29-34]. It is known that when more than 30% of the articular facets are removed bilaterally, we have a greater probability of developing late instability, justifying fusion in patients subjected to large decompressive surgeries[35].

Many instrumentation techniques to achieve fusion can be found in the literature. Pedicle screws with rods and postero-lateral autologous bone fusion have become the standard way to instrument and fuse the lumbar spine. Often, this technique can be supplemented with anterior column support to distract the disc space, and help improve fusion rates. These supplemental techniques are briefly mentioned below and are often utilized in cases with associated segmental instability, revision procedures, sagittal/coronal plane deformities, or severe degenerative disease[36,37].

1) Posterior lumbar interbody fusion (PLIF): Performed through a posterior approach after pedicle screw insertion. This technique is the earliest form of interbody fusions. When compared to other techniques, it requires greater manipulation of the thecal sac during the placement of the interbody spacer, and may be at higher risk of causing nerve root injury[38].

2) Transforaminal lumbar interbody fusion (TLIF): Generally performed on the more symptomatic side after pedicle screw insertion. This procedure requires a complete facetectomy and causes less medial displacement of the nerve root during its insertion into the disc space. It has comparable results to other interbody fusions but less morbidity than PLIF. When bilateral facetectomies are performed, the TLIF procedure can improve lumbar lordosis, foraminal height, and sagittal balance[36,39].

3) Anterior lumbar interbody fusion (ALIF): A complete anterior discectomy is performed using a retroperitoneal or transperitoneal approach. The bone graft or interbody spacer with graft is implanted into the empty disc space. A greater area of arthrodesis is achieved with the ALIF procedure. An additional advantage is its ability to restore lumbar lordosis and foraminal height and improve sagittal balance. The ALIF procedure may or may not require additional posterior instrumentation depending on the individual circumstances of the patient[36,40].

4) Extreme lateral lumbar interbody fusion (XLIF): A lateral retroperitoneal trans-psoas approach allows discectomy, distraction and interbody fusion in a minimally invasive approach[41]. This technique is usually supplemented by pedicle screws. Advantages of the XLIF are the lack of need for an approach surgeon and the ability to treat multiple levels from a small incision. However, it is not capable of reaching the L5 S1 disc space. Long term follow-up is needed to assess its ultimate outcome.

Bone grafts and adjuncts to fusions

The ultimate goal of instrumentation is to correct deformity and achieve fusion. Cancelous autologous bone is the most effective graft, since it contains osteogenic cells, and is both osteoinductive and osteoconductive. However, harvesting autograft bone is also associated with sur-

gical morbidity, especially when obtained from the iliac crest[42]. Because of morbidity associated with bone graft harvesting, many substitutes are being studied. One of their disadvantages is the high cost and limited long term follow-up. Cadaveric allograft bone has osteoconductive and osteoinductive properties, but very limited osteogenic cells. It has an extremely low risk of disease transmission such as hepatitis C and aids[43]. New generations of allograft bone, such as a demineralized bone matrix, have been shown to have osteoinductive properties in animal studies. Although the efficacy in patients to achieve fusion has been established, long term results have not been performed to determine it ultimate utility[44].

The use of growth factors such as members of the bone morphogenetic protein (BMP) family to enhance spinal arthrodesis has gradually increased in the last several years. These growth factors are proteins that induce the differentiation of undifferentiated stem cells to osteoblasts. They have a very short half-life, and must be administered in high doses with a carrier (collagen sponge). Recombinant human BMP-2 (rhBMP-2) has been primarily investigated in lumbar spine fusions, where it has significantly enhanced the fusion rate and decreased the length of surgery, blood loss, and hospital stay. Its practical application is limited by the significant cost of application, which can be up to U$7000 per fusion level[45,46]. Despite the early enthusiasm researchers expressed for using rhBMP-2 to enhance spinal fusion, there are significant risks associated with using BMP's supraphysiological doses including inflammatory reaction, effusion, seroma, ectopic bone formation and other untoward side effects not appreciated earlier in their use[47]. BMP-2 has been approved by the FDA for its use in conjunction with threaded cages and bone dowels for single-level ALIFs, and has been successfully used in postero-lateral fusion associated with local bone or bone expander[48].

New surgical alternatives to fusion

1) Lumbar disk replacement: The rationale for its use is to decrease adjacent level degeneration after fusion procedures. There are two systems approved in the US for clinical use[49]. For stable single level symptomatic disc degeneration unresponsive to conservative treatment (with good bone quality), total disk replacement may be an alternative to fusion[50]. There is controversy regarding its routine use in the US.

2) Interspinous spacer: The objective of this device is to provide a flexion-distractive force in the posterior elements of the spine, relieving symptoms secondary to narrowing of the spinal canal and neural foramina in patients without spondylolisthesis or grade I spondylolisthesis[51]. There are data suggesting that surgical results are similar to lumbar decompression surgery at 4 year follow-up with less hospital costs[52]. In carefully selected patients this may be an alternative to non-instrumented lumbar decompression.

3) Dynamic stabilization: This system consists of a pedicle screw construct with a polyethylene cord and polyurethane spacer connecting the screws instead of metal rods, hence permitting some motion. No bone grafting is necessary in light of the concept of motion preservation to theoretically avoid adjacent level degenerative disease. Welch et al. in 2007 demonstrate good results as an alternative to fusion[53].

4) Nucleus pulposis replacement: This is biomechanically similar to a native nucleus pulposis. The replacement nucleus pulposis is a hydrogel pellet encased in a polyethylene jacket that is capable of absorbing impact and maintaining disc height. It is under preliminary analysis. General indications have not been clearly defined[54].

In conclusion, LS has a broad spectrum of potential treatment options since there is a broad spectrum of disease severity. Accurate diagnosis is extremely important for good clinical results. The appropriate treatment strategy is determined by carefully evaluating the specific circumstances of each patient. Steroids injections and rehabilitation programs are established non-surgical modalities to help improve the symptoms of patients with LS. After attempts of conservative management, surgery is the best option in selected patients with positive radiographic findings and appropriate clinical correlation. Depending upon various factors, fusion may be necessary. New techniques and technologies in spinal surgery are constantly being developed to potentially improve surgical results. More long term studies of new technologies will be needed to determine the optimal treatment.

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