Journal Scan

Spine

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Treatment of Lumbar Spinal Stenosis

Surgical or nonoperative treatment for lumbar spinal stenosis? A randomized controlled trial. Malmivaara A, Slätis P, Heliövaara M, Sainio P, Kinnunen H, Kankare J, Dalin-Hirvonen N, Seitsalo S, Hernö A, Kortekangas P, Niinimäki T, Rönty H, Tallroth K, Turunen V, Knekt P, Härkänen T, Hurri H; Finnish Lumbar Spinal Research Group. *Spine*. 2007;32:1–8.

Context: The effect of surgery on the natural course of back pain, leg pain, and disability caused by spinal stenosis has not been established.

Study Design and Results: This is a prospective, randomized trial comparing the outcome in 94 patients with sustained but nonprogressive symptoms of spinal stenosis; 44 patients were treated nonoperatively and 50 patients were treated with surgical decompression. Patients were excluded if their symptoms were either mild or severe, or if they had progressive symptoms. Patients also were excluded if they had another spinal disorder including spondylolysis, or any painful affliction of the extremities. The authors found a significant reduction in back and leg pain and disability in both groups, with the operative group having greater improvements that were sustained until the final evaluation at 2 years. There was no difference in walking ability between patients who had nonoperative or operative treatment. Ten patients underwent instrumented fusion for degenerative spondylolisthesis but a statistically

significant difference in this subgroup could not be assessed owing to the small numbers.

Conclusions: Although nonoperative treatment and surgical decompression can improve pain and disability in patients with nonprogressive but sustained clinical symptoms from lumbar spinal stenosis, those undergoing decompression reported greater improvement. The improvement in walking ability was equivalent between patients who had surgical and nonsurgical treatment.

Comments: The goal of treatment of degenerative lumbar spinal stenosis is to decrease back and leg pain and improve disability. This is the first prospective, randomized study evaluating surgical and nonsurgical treatment in patients with relatively static but sustained symptoms. Longer followup is needed to evaluate whether the difference between groups would remain. Patients were not blinded to the treatment received, possibly influencing the perception of the results.

Pearls: The goal of surgical decompression in lumbar stenosis is significant relief of leg pain and improved function—primarily walking tolerance. As shown in this study, this goal often can be achieved, at least in part, by conservative means. For this reason, conservative measures should be attempted before surgical intervention is contemplated in most cases.

Cervical Orthoses

Reduction in head and intervertebral motion provided by 7 contemporary cervical orthoses in 45 individuals. Schneider AM, Hipp JA, Nguyen L, Reitman CA. *Spine*. 2007;32:E1–6.

Context: Cervical orthoses often are used as definitive treatment of fractures of the cervical spine or as additional support after cervical spine surgery. Although many braces

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have been evaluated to determine the ability to restrict cervical motion, the evaluation tools and comparisons between orthoses have not been consistent.

Study Design and Results: The range of cervical motion of 45 asymptomatic volunteers was evaluated with three-dimensional digital tracking and quantitative lateral fluoroscopy in the supine and standing positions. The patients' baseline range of motion was compared with range of motion while wearing one of seven cervical orthoses (Miami J, Aspen, PMT, Philadelphia, SOMI, pinless halo, and Minerva). All braces significantly reduced cervical motion, with cervicothoracic orthoses more effective than cervical orthoses. The Miami J and Aspen orthoses were the most comfortable but were not as effective at limiting cervical motion. The Philadelphia collar was the most effective overall at limiting sagittal motion. None of the orthoses became less effective at restricting motion in the supine position compared with standing. Gender and BMI did not affect cervical motion in any brace, although the SOMI brace was less able to be adequately fitted as BMI increased.

Conclusions: Cervicothoracic orthoses restrict motion more than cervical orthoses. Comfort plays an important part in selection of a cervical orthosis. Cervical orthoses do not appear to be less effective in the supine position.

Pearls: The surgeon using an orthosis should consider which plane of motion has greatest need for restriction as different orthoses are relatively better in one plane or another: the Philadelphia collar was the most effective cervical orthosis at restricting sagittal motion, whereas cervicothoracic orthoses were better at controlling lateral bending and axial rotation.

Lumbar Decompression and Fusion in the Elderly

Risk factors for the development of perioperative complications in elderly patients undergoing lumbar decompression and arthrodesis for spinal stenosis: an analysis of 166 patients. Cassinelli EH, Eubanks J, Vogt M, Furey C, Yoo J, Bohlman HH. *Spine*. 2007;32:230–235.

Context: Advanced age once was considered to be a contraindication for lumbar spinal surgery owing to high rates of perioperative complications. However, as the population ages and wishes to remain active, lumbar decompression and fusion are being performed more frequently. The particular risk factors for complications have not been fully elucidated.

Study Design and Results: This is a retrospective review of 166 patients 65 years or older who underwent decompression and posterolateral fusion for lumbar spinal stenosis with instability. In ninety-one cases, fusion was augmented with instrumentation. Minor complications

(defined as ones that did not cause a negative effect on the patient's recovery) occurred in 30.7% of patients who did not have instrumentation and 31.9% of patients who did have instrumentation. There were five major complications (3% of all patients) which included pulmonary embolism, myocardial infarction, retroperitoneal hematoma, urosepsis, and epidural hematoma, that were distributed equally among patients with instrumentation and without instrumentation. Patients 80 years and older were significantly more likely to have procedures of three or more levels. Estimated blood loss and operative times were increased in the patients who underwent decompression and fusion for three or more levels. Decompression and fusion over four or more levels correlated with the occurrence of a major complication. The presence of medical comorbidities, advanced age, or instrumentation did not correlate with perioperative complications.

Conclusions: This study shows that lumbar decompression and fusion, with or without instrumentation, can be performed safely in elderly patients. The reported complication rate is approximately comparable to that seen after elective joint replacement.

Comments: These results are from previous reports of lumbar decompression and fusion in elderly patients. Carreon et al. (*J Bone Joint Surg Am*. 2003;85:2089–2092) reported 21% incidences of major and 70% incidences of minor complications after lumbar decompression and instrumented fusion with advanced age increasing the risk of major complications. They did agree however, that complications increased with an increasing number of fusion levels.

Pearls: The elderly also are at increased risk for complications from medical management of spinal stenosis (such as NSAIDs) and may be less tolerant of the inactivity imposed by symptoms. Therefore, the complication rate has to be evaluated in the context of the risks and benefits of the alternatives.

Neurologic Complications of Anterior Thoracolumbar Surgery

Avoiding neurologic complications following ligation of the segmental vessels during anterior instrumentation of the thoracolumbar spine. Mirovsky Y, Hod-Feins R, Agar G, Anekstein Y. *Spine*. 2007;32:275–280.

Context: Anterior exposure of the thoracolumbar spine typically requires ligation of one or more segmental vessels. Considerable variability may exist concerning the anatomy of the anterior spinal artery and its segmental contributions. Ligation of segmental vessels may place the spinal cord at risk for ischemic injury.

Study Design and Results: This is a retrospective review of 29 patients who underwent anterior thoracolumbar

discectomy or corpectomy and instrumented fusion. In only seven of these patients were the segmental vessels preserved; in the remaining 22 patients the authors were unable to preserve these vessels because of the need to insert two screws or wide cage. In four patients, segmental vessels were temporarily clamped while spinal cord monitoring was performed with somatosensory evoked potentials (SSEPs) and motor-evoked potentials (MEPs) to assess whether vascular compromise would occur. These vessels were ligated and divided when the cord was found to function despite temporary occlusion of the particular vessel.

Conclusions: It is feasible to preserve the segmental vessels during anterior instrumentation of the lumbar spine in approximately 25% of cases, thereby potentially limiting the risk of ischemic insult to the spinal cord.

Pearls: Thoracolumbar segmental vessels usually are located at the middle third of the vertebral body and curve superiorly toward the intervertebral foramen. Adequate space exists above or below the segmental vessels for safe placement of one screw. The surgeon must assess the benefit of a second screw in comparison to the risks associated with the sacrifice of the vessel caused by adding this screw.

Outcome of Cauda Equina Syndrome

Cauda equina syndrome: factors affecting long-term functional and sphincteric outcome. McCarthy MJ, Aylott CE, Grevitt MP, Hegarty J. *Spine*. 2007;32:207–216.

Context: Cauda equina syndrome represents a rare surgical emergency, with lower extremity neurologic deficit and bowel or bladder dysfunction. Considerable controversy exists regarding the perioperative factors affecting neurologic outcome.

Study Design and Results: This is a retrospective evaluation of 42 patients who were followed for a mean of 60 months after spinal decompression for cauda equina syndrome secondary to an acute herniated nucleus pulposus. Twelve percent underwent surgery within 24 hours of the onset of symptoms, 50% within 48 hours, and 38% after 48 hours. The following variables that initially were present did not influence long-term outcome: age, gender, speed of onset, time to surgery, presence of chronic or acute low back pain, radiculopathy, or sensory deficit. Females were more likely to present with urinary incontinence than were males. Ten of 23 patients (43%) presenting with urinary incontinence still had this finding at long-term followup. Three of 25 patients (12%) presenting with urinary retention did not improve at followup. Reduced perianal sensation persisted in 21 of 32 patients (66%) at followup. Reduced rectal tone persisted in five of

21 patients (24%) at followup. Bowel dysfunction at presentation correlated significantly with sexual dysfunction at long-term followup. Thirty percent of men reported complete inability to attain an erection and 17% had partial impairment at the final followup. Presentation with muscle strength graded as 4 or less was strongly associated with persistent weakness. No patients had validated outcome measures consistent with normal, age-matched controls; scores remained between those of patients with acute and chronic low back pain.

Conclusions: Complete resolution of cauda equina syndrome despite treatment is unlikely. Significant numbers of patients will continue to have symptoms long after treatment. In this study, speed of onset of symptoms and duration of time before decompression do not affect outcome.

Comments: The currently accepted treatment of cauda equina syndrome involves expeditious diagnosis and surgical decompression of the spine. Outcome studies show considerable variability with the definition of cauda equina syndrome and inclusion criteria, documentation of presenting variables, length of followup, and interpretation of long-term results of treatment. Several anatomic and physiologic factors possibly contribute to the outcome. It appears that there are few objective measures of predicting the likelihood of functional recovery supported by the literature.

Pearls: Cauda equina syndrome is a surgical emergency. Although deficits present before surgery may not resolve even after timely and adequate decompression, there is certainly no upside to delaying the decompression.

Outcome of Cervical Spine Surgery

Complications and mortality associated with cervical spine surgery for degenerative disease in the United States. Wang MC, Chan L, Maiman DJ, Kreuter W, Deyo RA. *Spine*. 2007;32:342–347.

Context: The number of hospital admissions and surgical procedures for degenerative conditions of the cervical spine has increased. There have been few studies evaluating the incidence of complications and mortality after surgery for degenerative conditions of the cervical spine.

Study Design and Results: The authors reviewed the complications associated with surgery for herniated cervical discs, cervical spondylosis, and cervical spinal stenosis using the data from the Nationwide Inpatient Sample, a stratified 20% subsample of inpatient admissions to hospitals in the United States. The majority of patients were 35 to 49 years of age with 13% 65 years or older. The incidence of surgery for patients with a herniated disc was seen to be lower among older patients, whereas the rates of

surgery for patients with spondylosis and stenosis increased with increasing age. Overall, complications occurred in 3.9%; among patients who had surgery for spondylosis with myelopathy, the complication rate was 6.5%. The complication rates of posterior fusion and combined anterior and posterior fusion were 10.5% and 9.0%, respectively. In-hospital mortality was 0.14% overall, and 0.44% among patients undergoing posterior fusions. The highest relative risk of complications occurred in patients older than 74 years (odds ratio [OR] 4.1; after posterior or combined fusion, 2.6 – 2.9). The odds ratio is an estimate of relative risk. An odds ratio greater than 1.0 signifies an association between the exposure and disease, and of course, the larger the number the stronger the association. Mortality also was highest in patients older than 74 years (OR, 18.6) and patients with myelopathy (OR, 4.1).

Conclusions: Age, diagnosis, and surgical procedure significantly impact the rates of complications and mortality after surgery for degenerative conditions of the cervical spine.

Comments: Although not reported here, there can be considerable geographic variability in the type of surgery performed for a given condition, and, therefore, the relative incidence of complications for a given diagnosis also may be related to geography. Although the database provides information for a very large population, administrative variability in reporting the number and diagnosis of comorbidities and complications can introduce bias into the results.

Pearls: Although age greater than 74 years places a patient at a relatively greater risk for complications and mortality after surgery for degenerative conditions of the cervical spine, surgery still may be preferred based on a personal assessment of the risks and benefits of the alternatives.

Acute Spinal Cord Injury

The impact of methylprednisolone on lesion severity following spinal cord injury. Leypold BG, Flanders AE, Schwartz ED, Burns AS. *Spine*. 2007;32:373–378.

Context: The North American Spinal Cord Injury Study (NASCIS) trials advocated the use of methylprednisolone in acute, nonpenetrating spinal cord injuries at an initial dose of 30 mg/kg over 1 hour followed by 5.4 mg/kg/hour for the remainder of 24 hours for patients presenting within 3 hours of injury and for 48 hours for patients presenting between 3 and 8 hours from injury, not from the time of presentation. Since the publication of these trials, additional evidence and reevaluation of the initial data have rendered the treatment controversial. It has not been evaluated whether high-dose methylprednisolone has an effect on MRI characteristics of spinal cord injury.

Study Design and Results: This study retrospectively reviewed the MR images of 82 patients who were treated for complete (American Spinal Injury Association A) spinal cord injury. Forty-eight were treated with high-dose methylprednisolone. Intramedullary hematoma was seen in 91.2% of patients who were not treated with methylprednisolone, and in 66.7% of patients treated ($p = 0.04$). There was no difference in the presence or degree of spinal cord edema between treatment groups.

Conclusions: High-dose methylprednisolone given according to NASCIS guidelines for complete spinal cord injury may decrease the extent of spinal cord hematoma.

Comments: The significance of these findings regarding the clinical outcome and potential for neurologic recovery was not reported. All patients were found to have complete injury by the American Spinal Injury Association scale. Although the use of high-dose methylprednisolone is controversial, there may be a more significant effect in patients with incomplete injury.

Pearls: High-dose methylprednisolone remains controversial even in patients with incomplete spinal cord injury and does not seem to affect the presence or amount of spinal cord edema seen on MRI after complete spinal cord injury. To prevent malpractice liability exposure in a setting such as this (where protocols are controversial and the stakes are high), it is probably best to practice in compliance with some published standard, or to justify deviations from them in notes made in the medical record.

Degenerative Disc Disease

Disc degeneration in low back pain: a 17-year follow-up study using magnetic resonance imaging. Waris E, Eskelin M, Hermunen H, Kiviluoto O, Paaanen H. *Spine*. 2007;32:681–684.

Context: Although intervertebral disc degeneration occurs as a normal part of the aging process and is seen even among individuals without low back pain, its role in the development of symptomatic disease is controversial. One aspect that is unknown is whether disc degeneration in adolescence and young adulthood predicts the occurrence of spinal disorders and surgery in the future.

Study Design and Results: This is a prospective, cohort study evaluating the clinical and MRI characteristics of patients followed 17 years after initial evaluation for back pain at 20 years of age. Twenty-seven of 32 patients (84%) reported recurrent low back pain during the intervening period. All patients showed signs of degenerative discs at followup compared with 69% of patients at initial presentation. The total number of discs found to be degenerative increased from 21% at initial presentation to 60% at 17 years followup. At followup, 59% of all degenerative discs were

herniated compared with only 9% of well-hydrated, normal discs. Only two patients with degenerative discs underwent surgery.

Conclusions: Low back pain and disc degeneration in adolescence were strongly correlated with progression of disc degeneration but not with spinal surgery.

Pearls: Consider the data from the other perspective: 16% of patients who had back pain in adolescence and went on to have evidence of disc degeneration at 17 years followup nonetheless did not have recurrent back pain. Considering that the risk of an episode of symptomatic back pain during that 17-year period for even a random group is almost 100%, these data—viewed from this angle—questions the idea that the disc may not play the central role in low back pain attributed to it by physicians and lay people.

Degenerative Disc Disease

Occupational and genetic risk factors associated with intervertebral disc disease. Virtanen IM, Karppinen J, Taimela S, Ott J, Barral S, Kaikkonen K, Heikkilä O, Mutanen P, Noponen N, Männikkö M, Tervonen O, Natri A, Ala-Kokko L. *Spine*. 2007;32:1129–1134.

Context: Disc disease is a common condition in which mechanical and inflammatory factors have been implicated. Occupational exposures, such as whole-body vibration, and defects in the genes encoding collagen and certain interleukins have been investigated for their influence in the development of disc disease. The interdependence of these factors has not been studied.

Study Design and Results: Polymorphisms in the COL9A3, COL11A2, IL1A, IL1B, IL6, MMP-3, and VDR genes were evaluated by polymerase chain reaction in 150 train engineers (who are thought to have high levels of long-term occupational whole-body vibration) and 61 mill workers (deemed to have no specific occupational exposure to whole-body vibration). Disc disease was found to be significantly more prevalent among train engineers than mill workers. Polymorphism of the IL1A gene which leads to increased expression of the inflammatory mediator IL-1 β was similarly associated with the presence of disc disease. The presence of this gene polymorphism and occupational whole-body vibration were additive for increased risk of disc disease.

Conclusions: Occupational whole-body vibration has an additive effect with genetic factors in contributing to risk of disc disease.

Pearls: Polymorphism of the IL1A gene leads to an increase in the expression of the inflammatory mediator IL-1 β and is associated with disc disease. Disc disease is more common in patients exposed to whole-body vibration in

their occupation. Taken together, it may not be hard to imagine that in the future people could be screened with genetic tests to assess their tolerance for occupational exposure to vibration.

Total Disc Replacement

Results of the prospective, randomized, multicenter Food and Drug Administration investigational device exemption study of the ProDisc-L total disc replacement versus circumferential fusion for the treatment of 1-level degenerative disc disease. Zigler J, Delamarter R, Spivak JM, Linovitz RJ, Danielson GO 3rd, Haider TT, Cammisa F, Zuchermann J, Balderston R, Kitchel S, Foley K, Watkins R, Bradford D, Yue J, Yuan H, Herkowitz H, Geiger D, Bendo J, Peppers T, Sachs B, Girardi F, Kropf M, Goldstein J. *Spine*. 2007;32:1155–1162.

Context: Spinal fusion is the current standard of care for surgical management of debilitating lumbar spondylosis. Total disc replacement has been touted as a “motion preserving” alternative to spinal fusion.

Study Design and Results: This is a Food and Drug Administration Investigational Device Exemption Study comparing the outcome of the ProDisc-L total disc replacement (Synthes Spine, West Chester, PA) with circumferential fusion. At 2 years followup, 91.8% of the patients who received the ProDisc-L reported improvements in the Oswestry Disability Index (ODI), 79.2% reported improvement in the Medical Outcomes Short Form-36 Health Survey (SF-36), a self-reported health-related quality of life questionnaire, and 91.2% reported equal or better neurologic status. The rate of failure was equivalent to that of the circumferential fusion group. At 2 years followup, 89.5% of patients who received ProDisc-L had an improvement in range of motion at the operated level, with 93.7% remaining within a normal functional range of motion mean of 7.7°. At 2 years, 81% of patients who received the ProDisc-L said they would have the same surgical treatment again. All results were statistically better for the patients receiving the ProDisc-L than for the patients who had fusion with the exception of the SF-36 and the question regarding whether the patient would undergo the same surgery.

Conclusions: Two-year outcomes for the ProDisc-L IDE study were superior to the results for circumferential fusion by outcome measures reported here.

Comments: The results of this study represent short-term outcomes of a new total disc replacement as an alternative to spinal fusion. Longer-term results are needed to determine the viability and longevity of total disc replacement.

Pearls: Investigational Device Exemption studies seek to prove only the noninferiority of a new device compared with the standard of care. Moreover, the theoretical

advantage to total disc replacement over fusion is maintenance of motion yet this will not necessarily be observable with a 2-year followup.

Cervical Epidural Steroid Injections

Cervical transforaminal epidural steroid injections: more dangerous than we think? Scanlon GC, Moeller-Bertram T, Romanowsky SM, Wallace MS. *Spine*. 2007;32:1249–1256.

Context: Although there have been no randomized controlled trials supporting the efficacy of epidural steroid injections for cervical radiculopathy, the number of injections performed annually has nearly doubled since 1998. Not only have the benefits of this approach been unproven, there have been few reports discussing the incidence and type of neurologic complications of transforaminal cervical epidural steroid injection.

Study Design and Results: This study reports the results of an anonymous survey sent to all physician members of the American Pain Society. There was a 21.4% response rate. Seventy-eight major neurologic complications were reported including: 30 cases of brain or spinal cord infarction, five deaths, three each of high spinal anesthesia and transient ischemic attack, and individual neurologic complications. Complications were reported when steroids were used alone or in combination with local analgesics.

Conclusions: Severe neurologic complications following cervical epidural steroid injections have been seen. The number and type of complications may have been underestimated secondary to the low response rate to the survey.

Comments: Epidural steroid injections are performed for diagnostic and therapeutic reasons. Although the pathogenesis of radiculopathy may have an inflammatory contribution, the efficacy of steroid injections has not been proven. Injection techniques about the cervical spine are not without danger.

Pearls: The paucity of trials regarding epidural steroid injections—a treatment modality better suited to a

placebo-controlled, double-blinded randomized controlled study than perhaps any other in orthopaedic surgery—may reasonably support the inference that this method is not effective: namely, that trials were attempted but in the absence of a positive effect shown, did not make it into publication.

Biomechanics of the Intervertebral Disc

The response of the nucleus pulposus of the lumbar intervertebral discs to functionally loaded positions.

Alexander LA, Hancock E, Agouris I, Smith FW, MacSween A. *Spine*. 2007;32:1508–1512.

Context: Positional changes of the lumbar spine in flexion and extension can lead to changes in the morphologic features of disc herniations and symptoms. Typical MRI studies of the lumbar spine are limited to a supine evaluation which does not necessarily reflect the functional pathology of disc disease.

Study Design and Results: MRI was performed in 11 healthy volunteers in the following positions: standing, supine, prone in extension, and sitting upright, in flexion, and in extension. The position of the nucleus pulposus in the sagittal plane was measured. The nucleus pulposus migrated posteriorly when subjects were seated upright and in flexion. The supine and prone extension positions did not displace the nucleus as far posteriorly. These effects were most pronounced at the L4-L5 and L5-S1 discs.

Conclusions: These results offer radiographic support for clinical findings of posterior disc displacement in the seated and flexed positions that is relieved when extended or supine.

Comments: The nucleus pulposus displaces to a more posterior position in the disc when seated and flexed forward.

Pearls: The lowest category of work demands according to Federal guidelines is “sedentary.” Nonetheless, this study and others support the notion that patients with symptomatic herniated discs should avoid sitting.