

INTRAOPERATIVE SPINAL STIFFNESS MEASUREMENT IN MANAGEMENT OF SPINAL CANAL STENOSIS

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Abstract- In this study to determine whether spine stiffness is predictive of clinical results after lumbar spinal fusion for spinal stenosis, a total of 78 patients were measured intraoperatively with Kocher clamp manual distraction technique to determine motion segment stiffness then spinal fusion was performed for any loose segment. Statistical analysis revealed that stiffness measurement correlate with clinical results of surgery. During a minimum of 2 years follow up after surgery, patients who had loose motion segment before or after decompression and were fused had the same level of satisfaction with surgical results as patients without loose segments and fusion. We concluded that intraoperative spinal stiffness measurement provide a good indicator to spine fusion after lumbar canal stenosis surgery.

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Key words: Degenerative disc disease, joint instability, lumbar spine, motion segment, spinal diseases, spinal fusion

INTRODUCTION

The clinical entity "lumbar spinal stenosis" can be defined as a narrowing of the lumbar spinal canal, resulting in symptoms and signs caused by entrapment and compression of intraspinal vascular and nervous structures. Spinal instability can occur coincidentally with spinal stenosis or after decompressive surgery. Spinal instability is thought by some to cause chronic low back pain. Thus lumbar spine fusion is considered to be indicated in the treatment of a number of degenerative conditions including recurrent disc herniation, spinal stenosis, and degenerative spondylolisthesis (1, 2). However, a reliable method for measuring the instability associated with these diseases has not been previously reported. Such a device has recently been developed. The device, named the spinal stiffness

gauge (SSG), was then tested intraoperatively on 298 patients and found to be safe, easily performed, accurate, and reproducible (4). Lumbar MS stiffness, as measured with the SSG, showed differences in sex, degrees of disc degeneration, age, and predecompression and postdecompression lumbar spine surgery.

A prospective follow-up study of patients who had intraoperative measurement of spinal instability before and after decompression of spinal canal was designed to assess patients satisfaction with the results of surgery comparing presence of intraoperative instability and fusion of the unstable segment with other patients.

MATERIALS AND METHODS

From December 1994 to April 2001, intraoperative MS stiffness was measured on 78 patients at the time of lumbar surgery, using Kocher clamp manual distraction between each motion segment before and after each level decompression (stepwisely) of lumbar vertebrae by single spine surgeon at spine department of Sina Hospital of

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Tehran University of Medical Science. We obtained informed consent from all patients.

The surgeon then made the decision to fuse or do not fuse the spine based on the instability measurement at the time of surgery. Patients were defined as “loose” when they had a predecompression or posttdecompression instability in each MS as determined by abnormal movement at any MS. If there was any abnormal movement before or after decompression, fusion was performed. Instrumentation was performed when there was increasing instability after two level decompressions.

Patients were categorized according to the standard criteria: excellent: minimal to no pain, no further treatment required, and return to usual work and recreational activity; good: minimal pain requiring no treatment, considerably better with respect to work and recreational activity than before surgery, but not normal; fair: patient requires non-narcotic pain medication periodically and is better than before surgery but has alteration of lifestyle, work, or recreational activity to a significant degree; and poor: patient had a reoperation at the same level, a treatment failure requiring ongoing medical treatment or use of narcotic medication, or no improvement in function or quality of life compared with preoperative status, in the patient’s opinion. Excellent and good results were considered satisfactory outcomes, whereas fair and poor results were recorded as unsatisfactory outcomes. Leg and back pain were evaluated by visual analog scale (VAS) before and after operation.

Statistical methods included data analysis of one way ANOVA and Fisher’s exact test, using SPSS version 10.01. A result was considered statistically significant if $P \leq 0.05$.

RESULTS

A total of 53 from 78 patients (21 males and 32 females) were followed for a minimum of 2 years after surgery (73%) to determine satisfactory or unsatisfactory outcome. The remaining 26 patients were lost to follow up. The mean age of the patients was 56.1 years. Twelve patients (18%) (4 males and 8 females) were fused and 41 patients were not fused.

The causes of spinal stenosis of these patients were congenital type of stenosis (10 cases) and 43 cases of degenerative spondyloarthropathy. Cases of spinal stenosis with spondylolisthesis were excluded from the study. The mean area of decompression was 2.3 levels in “nonfused” patients and 2.8 levels in “fused” patients.

After minimum 2-year follow up (mean 31.9 months), claudication, leg numbness and leg pain had reduced after operation ($P < 0.05$), but back pain had not any significant change after operation. Findings showed an excellent or good result in 75% of patients followed up for an average period of 32 months. There was not any significant difference of age, sex, causes, mean area of decompression and clinical findings between fused or nonfused patients (all P values were greater than 0.05). There were one spinal instability before decompression and 11 cases (20%) of segmental instability (perception of any abnormal movement intraoperatively) after decompressive surgery.

Posterior fusion was performed on these patients with spinal instability. Posterior instrumentation with Cotrel-Dobusset system (Sofamor Danek) was performed on 9 patients (18%). A Fisher's exact test of 53 patients with "loose" MS or stiff MS revealed that there was not any significant difference of patient satisfaction between those patients who were surgically fused compared with those patients who were not fused (Table 1, $P = 0.80$).

There were three cases of spinal retrolisthesis, two of nonfused patients and one of fused patients. There was not any significant difference between fused or non fused patients ($P = 0.85$). There was not any significant difference of satisfaction in patients who were had instrumented or non-instrumented fusion ($P = 0.45$). There was not any proportion of spinal stenosis.

Table 1. Satisfaction of “Loose” patients who were fused versus “stiff” patients who were not fused

Fusion	Satisfaction				Total
	Poor	Fair	Good	Excellent	
Fused	2	8	16	15	41
Not fused	1	0	6	5	12
Total	3	8	22	20	53

DISCUSSION

In this article, the results of a minimum 2-year follow-up of decompressive laminectomy with or without fusion for lumbar spinal canal stenosis are reported based on intraoperative manual instability testing. Decompressive laminectomy without spinal fusion had been the first choice of surgical treatment for degenerative spinal stenosis in the authors' institution. Findings in a previous study had shown an excellent or good result in 82% of 118 patients followed up for an average period of 7 years, 2 months (5). In this study we had 75% good or excellent results. Although the authors would have liked to address questions of whether small versus large decreases in stiffness after decompression were related to satisfactory or unsatisfactory patient outcomes, limitations of the study prevented this.

In spite of few cases of this study, it is clear that in cases which fusion of destabilized MSs were performed, results were similar to other cases that were not destabilized at any time (before or after surgery). Some studies had shown that although the surgeon initially hypothesized that "loose" patients with a destabilized MS unit would have more satisfactory outcomes if surgically fused, the results suggest that "loose" patients who were not fused had better outcomes. Fusion results appear more satisfactory when a specific diagnosis is made that is related to definable instability (7, 8). The fact that the surgeon already selected out some patients for fusion or non-fusion status, regardless of Kocher clamp instability measurements, causes a problem with objectively analyzing the patient distribution. For solving this problem the authors omitted canal stenosis with spondylolisthesis from the study. The results of spinal surgery show worse outcomes in fused versus unfused patients (9).

These results bring into question whether or not fusion should be the recommended procedure for any patients without intra-operative instability testing. Although radiographs were not a part of the follow-up procedure to confirm a well-healed fusion for all patients, several studies have shown that the presence of a radiologic bony union has no impact on clinical outcome and that patients with pseudarthrosis experience satisfactory postsurgical results (10, 11). The results of this study contribute to the literature

demonstrating intraoperative decision to fuse vertebra base on visible spinal instability. Fusion results appear more satisfactory when a specific diagnosis is made that is related to definable instability (12).

In one study, however, the number of resected segments (multiple laminectomy) and the increased sagittal rotation at the disc in laminectomized vertebra were found to be preoperative factors predisposing the poor results (13).

Both of these factors were thought to be correlated with postoperative spinal instability. Multiple structural damage of the posterior element in the vertebra caused by the multilevel laminectomy and increased sagittal rotation may have stimulated nerve endings in and around the fibrous tissue of the disc and facet joint and may have caused low back pain (14).

Spinal instability itself is also said to be associated with severe low back pain (15). Increased segmental motion of the vertebra may have caused not only low back pain but also disc herniation several years after decompressive laminectomy without fusion. Even with a less than ideal study design, the results convey important information. The data collected from this study show similar results after fusion of "loose" patients which means fusion of vertebra did not produce bad outcome after true instability. This is one of the few studies that data have been gathered and assessed using intra-operative spinal stiffness measurements. To more fully understand the clinical usefulness of the spinal stiffness measurements, a prospective, randomized trial should be conducted to determine if spinal stiffness influences clinical outcome of spinal surgery.

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