Treatment of Cervical Myelopathy in Patients with the Fibromyalgia Syndrome:

Outcomes and Implications

RUNNING TITLE: CERVICAL MYELOPATHY AND FIBROMYALGIA

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Abstract

Objective: Some patients with fibromyalgia also exhibit the neurological signs of cervical myelopathy. We sought to determine if treatment of cervical myelopathy in patients with fibromyalgia improves the symptoms of fibromyalgia and the patients' quality of life.

Method: A non-randomized, prospective, case control study comparing the outcome of surgical (n=40) versus non-surgical (n=31) treatment of cervical myelopathy in patients with fibromyalgia was conducted. Outcomes were compared using SF-36, Screening test for Somatization, HADS, MMPI-2 scale 1 (Hypochondriasis), and self reported severity of symptoms one year after treatment.

Results: There was no significant difference in initial clinical presentation or demographic characteristics between the patients treated by surgical decompression and those treated by non-surgical means. There was a striking and statistically significant improvement in all symptoms attributed to the fibromyalgia syndrome in the surgical patients but not in the nonsurgical patients at one year following the treatment of cervical myelopathy, ($p \leq 0.018$-0.001, Chi square or Fisher's exact test). At the 1 year follow-up, there was a statistically significant improvement in both physical and mental quality of life as measured by the SF-36 score for the surgical group as compared to the nonsurgical group, (Repeated Measures ANOVA $p < 0.01$). There was a statistically significant improvement in the scores from Scale 1 of the MMPI-2 and the Screening Test for Somatization Disorder, and the Anxiety and Depression scores exclusively in the surgical patients, (Wilcoxon signed rank, $p<0.001$)

Conclusion: The surgical treatment of cervical myelopathy due to spinal cord or caudal brainstem compression in patients carrying the diagnosis of fibromyalgia can result in a significant improvement in a wide array of symptoms usually attributed to fibromyalgia with attendant measurable improvements in the quality of life. We recommend detailed neurological and neuroradiological evaluation of patients with fibromyalgia in order to exclude compressive cervical myelopathy, a potentially treatable condition.

Key words: cervical myelopathy, fibromyalgia, surgery, treatment outcome, case control study

Introduction

Fibromyalgia is a syndrome characterized by diffuse chronic pain [6,9,43,45]. The American College of Rheumatology has established diagnostic criteria for fibromyalgia that include a history of unexplained pain of three months duration, widespread distribution of pain involving both sides of the body above and below the waist and the presence of 11 or more of 18 specified symmetrical tender points [45]. The overall prevalence of fibromyalgia, as defined above, is 2% of the U.S population with a prevalence of 3.4% among women and 0.5% among men [6,9,46]. By these estimates, approximately six million people suffer from fibromyalgia in the United States alone.

The diagnostic criteria, although controversial, have been useful in distinguishing fibromyalgia from other chronic pain states, but they have not advanced the understanding of its etiology. Accordingly, fibromyalgia remains a syndrome and not a disease. In addition to widespread pain, patients complain of symptoms ranging from overwhelming fatigue that is exacerbated by exertion, to headache, dizziness, cognitive difficulties, instability of gait, limb numbness and paresthesiae [6,9,14,43]. Some physicians have come to view the syndrome as a somatization disorder because of these numerous and apparently unrelated complaints and because fibromyalgia fails to fit a biomedical cause-effect model [4,16].

Many of the symptoms reported by fibromyalgia patients are identical to those reported by patients diagnosed with two well defined neurological disorders: Chiari 1 malformation or cervical myelopathy due to spinal stenosis, (spondylotic cervical myelopathy) [1,13,29]. We previously reported the radiological and neurological findings in non-randomly selected patients with fibromyalgia, documenting the presence of cervical myelopathy and cervical spinal cord compression in a cohort of 270 patients [17]. A subset of this cohort underwent treatment of cervical myelopathy by surgical or nonsurgical means. The outcome of the treatment of cervical myelopathy with regards to quality of

life issues and in particular with regard to the symptom complex of the fibromyalgia syndrome is the subject of this report.

Materials and Methods

The requirements for patient inclusion in this study were:

1) a diagnosis of fibromyalgia

2) objective neurological evidence for cervical myelopathy

3) neuroradiological evidence for cervical spinal cord compression either on the basis of congenital or spondylotic cervical stenosis or brain stem compression due to tonsillar ectopia (Chiari 1 malformation).

In every case, the diagnosis of fibromyalgia had been previously established by the patient's rheumatologist (66% of patients), neurologist or primary care physician. We did not routinely confirm the diagnosis at our institution. Our focus was on the diagnosis and treatment of cervical myelopathy and its impact on a symptom complex not normally associated with cervical myelopathy.

Cervical myelopathy is a clinical diagnosis based on history and neurological examination. It is not a radiological diagnosis. The diagnosis of cervical myelopathy was made only in the face of symptoms *and* signs of disturbed function of the cervical spinal cord and/or caudal brain stem in accordance with the currently published literature [1,7,8,11,12,13]. Neurological signs consistent with cervical myelopathy included hyper-reflexia in the upper or lower extremities, hypo-reflexia in the upper extremities in conjunction with hyper reflexia in the lower extremities, positive Hoffman sign, inversion of the periosteal reflex, positive Romberg sign, impaired tandem walk, disdiadokokinesia and dysmetria. The finding of muscular weakness or sensory disturbance was not

sufficient to make the diagnosis of myelopathy as these findings can be quite subjective. Patients were not randomized to surgical or nonsurgical treatment as the standard of care for cervical myelopathy due to neuraxis compression is surgical decompression [1,13,38]. Rather, patients were allocated to surgical or nonsurgical treatment in accordance with current clinical practice [1,13,38].

At the time of initial evaluation, patients completed a questionnaire detailing their symptoms, current medications and past medical consultations. Each patient also completed a diagram depicting the distribution of their body pain. Patients were evaluated by a neurologist (AS) and/or a neurosurgeon (DSH) who recorded the findings on a standardized form in order to insure that every patient was evaluated in the same manner. Patients were interviewed by a psychologist, (YSZ, KK), in order to help determine the patients psychological readiness for surgical intervention. Psychometric instruments completed included:

1) a SF-36 health questionnaire [44]
2) Hospital Anxiety and Depression Scale, (HADS), a 14-item self report instrument designed to measure depression and general anxiety in medical patients [18,47].
3) MMPI-2, Scale 1 (Hypochondriasis), designed to measure a pattern of excessive somatic concern [10]. Items from this scale were administered in an effort to assess patients concerns over their physical health.

4) Screening Test for Somatization Disorder, a 7-item screening test designed to identify the presence of somatization disorder [33]

Follow-up was by combination of mail-in questionnaire and direct examination and interview. Every 3 months, surgical and non-surgical patients were sent a survey packet which included a questionnaire so they could indicate worsening, improvement or resolution of each of 20 common preoperative symptoms, (symptom inventory). A diagram depicting the distribution of body pain was also completed with each questionnaire. The number of body regions in which the patient experienced pain was tabulated. Every patient who underwent surgery was re-examined one month following surgery and completed a symptom inventory questionnaire at that time as well. Appropriate radiological studies were repeated in conjunction with the 1 month follow-up in the surgical group in order to gauge the effectiveness of surgical decompression. The SF-36, HADS, Scale 1 of the MMPI-2 and the Screening Test for Somatization Disorder were repeated in conjunction with the 1 year follow-up.

All data were gathered prospectively and entered into a relational database, (MS Access, Microsoft Corporation, Redmond, WA). Patient questionnaires were not reviewed by the treating neurosurgeon nor did he have any role in data entry or data analysis. Statistical analysis was performed by a biostatistician at the Rush University Medical Center, (MM). The study protocol was approved by the IRB of Rush Presbyterian St. Luke's Hospital and Rush Medical College and informed consent was obtained from each patient.

Surgical treatment

Patients were offered surgical decompression if the following criteria were met:

1)the patient's complaints were consistent with cervical spinal cord or caudal brain stem compression, (i.e. limb numbness or paresthesiae, hand weakness or clumsiness, instability of gait, pain, urinary urgency/frequency, facial sensory loss or pain, vertigo/dizziness exacerbated by neck movement).

2) the neurological examination was indicative of myelopathy and localized to the cervical spine or caudal brainstem.

3) the finding of spinal cord or caudal brain stem compression on MRI of the brain or cervical spine and/or on intravenous contrast infused CT scan of the cervical spine.

4) psychological assessment which suggested that the patient could withstand the emotional stress of surgery and that the patient understood that the goal of surgery was the treatment of cervical myelopathy and not the treatment of fibromyalgia.

Surgical treatment consisted of decompression of the cervical spine or foramen magnum by means of anterior discectomy and instrumented fusion, posterior cervical laminectomy with or without instrumented fusion or suboccipital decompression and duraplasty as indicated by the site of greatest spinal cord compression demonstrated on neuroradiological imaging.

Nonsurgical treatment

Nonsurgical treatment consisted of neck immobilization using a soft collar, physical therapy for posture and body mechanics training, ergonometric job site evaluation and symptomatic treatment of pain using membrane stabilizing agents such as gabapentin. (Patients frequently presented already having been prescribed narcotics, muscle relaxants, antidepressants, hypnotics, and non-steroidal anti-inflammatory drugs.) Occasionally, a 5 day course of corticosteroids was prescribed.

Patients were offered nonsurgical treatment as the sole option or as a prelude to surgical intervention if:

1) the patient's complaints were consistent with cervical spinal cord or caudal brain stem compression

2) the neurological examination was indicative of myelopathy and localized to the cervical spine or caudal brainstem

3)the finding of spinal cord or caudal brain stem compression on MRI of the brain or cervical spine and/or on intravenous contrast infused CT scan of the cervical spine and that the mechanism of spinal cord compression appeared amenable to conservative measures such as neck immobilization and cervical realignment by means of postural training, (e.g. the spinal cord compression was most severe with the cervical spine positioned in flexion or extension and was mild with neck in the neutral position).

4) psychological assessment which suggested that the patient might not withstand the emotional stress of surgery or that the patient did not understand that the goal of surgery was the treatment of cervical myelopathy and not the treatment of fibromyalgia.

5) patient declined surgery.

The patients that are the subjects of this report were selected from a larger cohort exclusively because they had responded to every questionnaire over a one year period of time. These patients do not differ from the larger untreated cohort with regards to any demographic parameter, the prevalence of individual symptoms or the prevalence of individual neurological signs[17].

Radiological Imaging

Every patient underwent MRI of the brain with special attention to the foramen magnum, MRI of the cervical spine and CT scan of the cervical spine. The imaging techniques have been previously reported [17]. For the purpose of determining the position of the cerebellar tonsils, the lower lip of the foramen magnum was defined as extending from the lowest cortical bone of the clivus anteriorly (basion) to the lowest cortical bone at the opistion posteriorly on the mid sagittal MRI image. The position of the most caudal point of the tonsil(s) relative to the inferior lip of the foramen magnum was measured from the midsagittal MRI slice, as is the convention [3]. A position rostral to the plane of the foramen magnum was given a negative value in mm. Location of the cerebellar tonsil(s) within the foramen magnum was given a value of 0. Caudal displacement was expressed in mm with a positive value. MRI scan of the cervical spine was performed in order to identify any extrinsic or intrinsic spinal cord lesion capable of causing myelopathy. CT imaging of the cervical spine was performed following intravenous infusion of 150 ml of non-ionic contrast (300mg of iodine/ml) over 2 minutes. Contiguous, axial sections, 3 mm in thickness were obtained from the level of the mid posterior fossa to the first thoracic vertebra. For the initial set of images, the patient's

head was positioned in the head-holder such that the neck would be in the neutral or slightly flexed orientation as is the convention for both MRI and CT imaging. The gantry angle was selected in order to obtain images perpendicular to the spine at each level. A second set of images was obtained with the patient's shoulders elevated on a pad so as to extend the neck. The gantry angle was altered to obtain images perpendicular to the spine at each level despite the exaggerated lordosis attendant on neck extension. The mid-sagittal antero-posterior dimension of the spinal canal was determined at the level of the intervertebral disc space on both neutral and extended neck images [34]. The actual diameter available to accommodate the spinal cord, dura mater and cerebrospinal fluid was determined by measuring the distance between the posterior most projection of the intervertebral disc anteriorly and the ligamentum flavum or lamina posteriorly as determined by which structure was most contiguous to the dorsal surface of the dura.

MRI and CT images were individually scanned into a Pentium III personal computer using a Umax power look III scanner, (Umax Technologies Inc., Freemont CA). One of three independent observers, unrelated to the medical evaluation or treatment of the patients and unaware of any clinical neurological findings, made measurements of the position of the cerebellar tonsils and the mid-sagittal antero-posterior spinal canal diameters using SigmaScan Pro software, version 5.0, (SPSS, Richmond CA). Measurements of the mid-sagittal antero-posterior spinal canal diameter were made such that the largest possible diameter was recorded so as not to overstate the degree of stenosis.

Statistical analysis

Baseline data was compared between the surgical and non-surgical groups using several different techniques, depending on the nature of the data. Age, duration of illness, number of symptoms, number of painful body regions, and SF36 composite scores were all compared using independent t-tests. Data are presented as mean ± standard deviation. The presence or absence of several signs and symptoms was compared using either Chi-squared tests or Fisher's exact tests. Since a multitude of signs and symptoms were compared, a more conservative type I error rate was considered ($\alpha = 0.025$). Those data are presented as the number who reported the presence of the sign or symptom and the percentage of the surgical or non-surgical group. Baseline Depression, Anxiety, MMPI, Somatic scores, and SF 36 subscales were of a more ordinal nature, and therefore presented as median and (25^{th}, 75^{th}) percentiles, and compared using Mann-Whitney tests.

To compare follow-up data, Wilcoxon Signed rank tests were used to compare baseline to one-year follow-up for Depression, Anxiety, MMPI, somatic scores and subscales of the SF36. The rate of improvement on each symptom was compared between the surgical and non-surgical groups using either Chi-square test or Fisher's exact test, depending on the expected cell counts. Again, since we were comparing so many symptoms, a significance level of 0.025 was used. The Physical and Mental components of the SF36 were compared using Repeated Measures ANOVA, with the baseline and one year follow-up as the within person variable and the surgical group and the non-surgical group as the between person variable.

Since the mid-sagittal antero-posterior spinal canal dimensions in neutral and extension are correlated, a MANOVA was run to determine if the mean dimension at each intervertebral disc level differed between the surgical and non-surgical groups. If the MANOVA revealed a significant difference in the mean antero-posterior dimensions, independent t-tests adjusted with a Bonferroni correction for multiple comparisons were run to determine if the difference was detected in the neutral or extended neck position. With the exception of signs and symptoms, all tests were run at the nominal 0.05 significance level. Data was analyzed using SPSS v. 11.5 (Chicago, IL), or S+ v. 6.2 (Insightful Corp. Seattle, WA)._

Results

Initial evaluation

Forty patients underwent surgical treatment and 31 patients underwent nonsurgical treatment of cervical myelopathy. Despite the non-randomized nature of the cohorts, the surgical and nonsurgical groups did not differ with regard to age, sex or duration of symptomatic illness. Sixty-five percent of patients in both groups reported antecedent craniospinal trauma, (Table1). There was no statistically significant difference in the prevalence of symptoms as reported by patients in the surgical and non-surgically treated groups, (Table 2). Patients in both groups had multiple symptoms, (mean +/-SD: 24.6+/-4.8 surgical group, 24.6+/-4.5 non-surgical group). The most common complaints included headache, neck pain, back pain, limb pain, photophobia, phonophobia, clumsiness, instability of gait, cognitive impairment, (short term memory loss, word finding difficulty and decreased concentration), and fatigue exacerbated by exertion.

Patients in both groups reported worsening symptoms following neck extension, (90% non-surgical group, and 88% surgical group). Patients in the nonsurgical group described pain in 8.175 (+/-3.64) body regions as determined from their pain diagram. Patients in the surgical group described pain in 7.545 (+/-4.22) body regions. This difference was not significant, ($p=0.59$, 2 tailed t-test). There was no difference between the two groups in the prevalence of neurological signs at the time of their initial examination, (Table 3). The most common neurological findings included upper thoracic sensory level to pin or cold stimulus, hyper-reflexia, inversion of the radial periosteal reflex, Hoffmann sign and positive Romberg sign. There was no difference between the two groups in the median scores from Scale 1 of the MMPI-2 or the Screening test for Somatization Disorder at the time of initial evaluation, (Table 4). There was no difference between the two groups in the median baseline anxiety or depression score (HADS), ($p= 0.892$ and 0.862 respectively, Mann-Whitney test), (Table 5). Patients in both groups scored in the range consistent with mild anxiety and depression. There was no difference in the baseline SF-36 scores between the two groups when considering individual subscales and the composite scores, (Table 6).

MRI of the brain was unremarkable with the exception of low lying cerebellar tonsils. In the surgical group cerebellar tonsils were on average 3mm +/-5mm below the level of the foramen magnum. In the nonsurgical group cerebellar tonsils were on average 0.4mm +/-4mm above the level of the foramen magnum. This difference was statistically significant ($p<=0.01$, 2-tailed t test). The mid-sagittal spinal canal diameters as measured on CT scan of the cervical spine with the neck in neutral or extended position are shown in Table 7. Mild to moderate spinal canal stenosis was noted in both groups of patients

with the neck imaged in a neutral position. Stenosis became more severe with the neck positioned in extension. The reduction in mid-sagittal spinal canal diameter following neck extension was significant in the surgical group, ($p <= 0.02$ and 0.01, 2-tailed t-test respectively at C5/6 and C6/7). The reduction in mid-sagittal canal diameter was not statistically significant in the nonsurgical group. Multivariate tests showed a difference in the mean antero-posterior spinal canal diameter at C5/6 and C6/7 between the surgical and non-surgical groups, ($p=0.014$ and 0.005 respectively). After adjusting for multiple comparisons, the difference was statistically significant in both the neutral and extended neck position. The mid-sagittal spinal canal dimensions as measured on MRI scan were not significantly different between the two groups at any spinal level.

Follow-up

At the 30 day follow-up, (surgical group only), there was an improvement in the neurological findings. Improvement in tandem walk (88%), Romberg sign (80%), sensory level (53%), position sense (63%), clonus (82%), Hoffman sign (60%), inversion of periosteal reflex (32%) and hyperreflexia (35%) were noted in patients manifesting these findings prior to surgery. In three patients, hyperreflexia was noted to be more prominent after surgery. Otherwise no worsening of the neurological examination was noted. (Table 8)

At the 6 month follow-up, as determined from the self-report questionnaire, the percentage of patients reporting improvement of each symptom was greater for the surgical group as compared to the nonsurgical group, ($p <= 0.01$-0.001, Fisher's exact test, data not shown). At 1 year, the percentage of patients reporting symptom improvement in the surgical group remained greater than in the nonsurgical

group, ($p <= 0.018$-0.001, Fisher's exact test), (Table 9). At 1 year, the patients in the nonsurgical group reported pain in 7.54 body regions while those in the surgical group reported pain in 4.95 body regions. This difference was statistically significant ($p <= 0.005$, 2 tailed t-test).

At the 1 year follow-up, there was a statistically significant improvement in both physical and mental quality of life, as measured by the SF-36 score for the surgical group as compared to the nonsurgical group, (Repeated Measures ANOVA $p < 0.01$ for both (Table 6)). Mann-Whitney tests show higher quality of life for each of the subscales at one year for the surgical group compared to the non-surgical group ($p <= 0.033$-0.001) with the possible exception of body pain. An intra-group analysis showed a statistically significant improvement in the median subscale scores among the patients in the surgical group with the exception of role emotional, (Wilcoxon-signed rank $p <= 0.039$-0.001). There was no statistically significant change over time for the patients in the nonsurgical group, (test results not shown, but estimated medians and inner quartile ranges are shown in Table 6). There was no change in the scores from Scale 1 of the MMPI-2 or the Screening Test for Somatization Disorder at one year compared to baseline for the nonsurgical patients**,** (Wilcoxon Signed rank $p = 0.69$ and 0.147, respectively). There was an improvement in the scores from Scale 1 of the MMPI-2 and the Screening Test for Somatization Disorder in the surgical patients, (Wilcoxon signed rank, $p<0.001$ and $p=0.001$ respectively), (Table 4). There was no difference in the median depression score, (Wilcoxon signed rank test $p=0.152$) or the anxiety score, (Wilcoxon signed rank test $p=0.822$) for the nonsurgical patients at one year compared to baseline. However, there

was a statistically significant improvement in the median depression and anxiety scores for the surgical group, (Wilcoxon signed rank test p<=0.001), (Table 5).

Discussion

We have previously described the neurological and neuroradiological findings in a cohort of 270 non-randomly selected fibromyalgia patients. Clinical evidence for cervical myelopathy due to spinal cord or caudal brain stem compression was surprisingly common [17]. The question was raised as to whether, despite the similarities in symptoms, the presence of cervical myelopathy in this cohort was a mere coincidence or whether in this cohort, cervical myelopathy was the underlying cause of the patients' symptoms. Was myelopathy simply missed, misdiagnosed as fibromyalgia or is cervical myelopathy perhaps causally related to the fibromyalgia syndrome in some patients?

We treated a cohort of patients for cervical myelopathy and recorded their outcome with regard to the symptom complex of fibromyalgia and a number of outcome measures geared to assess their quality of life and emotional well-being. Surgical and nonsurgical treatments were prescribed in accordance with current neurosurgical practice [1,7,13,38]. The patients were not randomly assigned to treatment categories because the optimal treatment for cervical myelopathy due to spinal cord compression is felt to be surgical decompression [1,7,11,12,13,26,29,38]. Nevertheless, there was no significant difference in clinical presentation or demographic characteristics between the patients treated by surgical decompression and those treated by non-operative means. Patients in both groups had multiple somatic complaints and could be classified as somatizers on the basis of Scale 1 of the MMPI-2 and the Screening Test for Somatization Disorder. This supports a

contention shared by many physicians who do not recognize fibromyalgia as a diagnosis or use it as a diagnosis to indicate underlying psychological conflicts as a cause of physical complaints. Many of the patients' complaints are not commonly associated with cervical myelopathy, e.g. fatigue, cognitive disturbance, depression, irritable bowel syndrome, nausea and intolerance to cold. Most other symptoms could be explained on the basis of cervical spinal cord or cervico-medullary compression but had been attributed to fibromyalgia in these patients. There was no difference between the two groups in the prevalence of neurological findings attributable to cervical myelopathy with the possible exception of positive Romberg sign which was more common in the surgical group, ($p=0.047$). There was no difference between the two patient groups with regards to the SF36, HADS, Scale 1 of the MMPI-2 and Screening Test for Somatization Disorder scores at the time of initial evaluation. The radiological studies indicated that the severity of spinal stenosis was greater in the surgical group. This finding is not surprising as the decision to proceed with surgery was generally based on the severity of spinal cord compression. There was a significant worsening in the spinal stenosis with the neck positioned in extension in the surgical patients. Increased spinal canal stenosis was also noted in the nonsurgical group but was not as severe. This finding is consistent with the patient reports of worsening symptoms following activities that require neck extension and with the observation of worsening pyramidal tract findings following neck extension. Cervical stenosis was recognized on both intravenous infused CT scan of the cervical spine and on MRI scan. While CT with intravenous contrast infusion is not frequently used to image the cervical spine, it has certain advantages over MR imaging. These advantages include better resolution of bony anatomy and lack of exaggeration of spinal

canal stenosis [19,20,21,35,37,41]. In addition, dynamic imaging of the spine in the axial plane using MRI has certain shortcomings; sagittal images, (which are inferior to axial images for the assessment of stenosis), are almost exclusively used [21,31,32]. These shortcomings relate to the relationship between the extended or flexed neck and the surface magnetic coils, and are avoided by using CT technology [21,32]. Conversely, CT is inferior to MRI for imaging the spinal cord itself [28]. The use of CT with intravenous contrast enhancement for the purpose of imaging cervical disc herniation or stenosis has been previously described [19,20,21,27,37,39,41]. The extent of tonsillar herniation was also greater in the surgical group. Symptomatic brain stem compression due to tonsillar herniation does not respond well to non-operative management. Therefore, symptomatic tonsillar herniation is likely to lead to surgical decompression.

There was a striking improvement in all symptoms attributed to the fibromyalgia syndrome in the surgical patients but not in the nonsurgical patients at one year following the treatment of cervical myelopathy. This observation was true even of symptoms not commonly associated with cervical myelopathy, e.g. fatigue, fatigue on exertion, short term memory loss, impaired concentration and confusion, anxiety, depression, irritable bowel syndrome, nausea and intolerance to cold. Improvement in gastro-intestitinal and thermoregulatory symptoms may reflect improved post-surgical function of the autonomic nervous system. Improved cognition and affect may be the consequence of an enhanced sense of well-being, diminished medication use or the direct result of improved function of the reticular activating system. There was a statistically significant improvement in pain as gauged from the number of painful body regions described by the patients in the surgical group one year following treatment. These symptomatic

improvements translated into an improved quality of life for the surgical patients as measured by the SF36, a questionnaire that has been validated in the evaluation of patients with cervical spondylotic myelopathy [22]. Based on the scores for Scale 1 of the MMPI-2 and the Screening Test for Somatization Disorder, patients in the surgical group no longer could be characterized as hypochondriachal somatizers. These results suggest that elevated score on tests of affect and somatization in a sub-sample of medical patients do not indicate psychogenesis but rather reflect the degree of emotional distress they experience as a result of an underlying medical/neurological condition or actual symptoms experienced directly due to an underlying neurological condition. These findings would argue for the careful selection of psychometric research instruments and cautious interpretation of their results when studying fibromyalgia patients.

There are research findings suggesting that fibromyalgia may be a neurological disorder characterized by "central sensitization". Abnormalities in pain processing [5,23], central pain modulation [25,28] and secondary hyperalgesia [2] have been reported. There are also reports of reduced thalamic blood flow [24,30], and elevated levels of nerve growth factor [15] and the neurotransmitter substance P [36,42] in the cerebrospinal fluid of fibromyalgia patients. Thimineur et al reported an elevation of thermal perception thresholds in patients with Chiari 1 malformation or cervical spinal stenosis in association with chronic pain as compared to chronic pain sufferers who did not have any evidence of neurological disease[42]. They also reported a higher prevalence of fibromyalgia, chronic regional pain syndrome and tempero-mandibular joint syndrome in patients with Chiari 1 malformation as compared to chronic pain sufferers with no evidence of central nervous system disease. These investigators postulate an impairment of the descending

inhibitory projections from the rostral ventral medulla to the spinal cord dorsal horn and trigeminal nucleus caudalis as the mechanism for the hyperalgesia [40].

Conclusion

The surgical treatment of cervical myelopathy due to spinal cord or caudal brainstem compression in patients carrying the diagnosis of fibromyalgia can result in a significant improvement in a wide array of symptoms. Minimizing those symptoms translates into a measurable improvement in quality of life. A detailed neurological examination should be incorporated into the evaluation of every patient considered to have fibromyalgia. The finding of cervical myelopathy warrants radiological investigation to exclude a treatable cause. More intriguing, in view of these results, is the possibility that, in some patients, cervical myelopathy may be the underlying cause of the fibromyalgia syndrome. A large scale study to determine the prevalence of cervical myelopathy in a randomly selected group of fibromyalgia patients is warranted.

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Table 1: Demographics

	Surgical group (n=40)	Nonsurgical group (n=31)	p-value
Age (years)	44.6 (sd 11.8)	41.4 (sd 11.2)	0.25
Sex (% female)	34 (85%)	28 (90%)	0.72
Duration of illness (years)	5.9 (sd 4.5)	7.4 (sd 5.5)	0.24
Craniospinal trauma	26 (65%)	20(64%)	0.85
Number of symptoms	24.6 (sd 4.8)	24.6 (sd 4.5)	0.97
Painful body regions	7.5 (sd 4.2)	8.2 (sd 3.6)	0.59

Table 2: Symptom prevalence at baseline in the surgical and non-surgical groups.

Symptom	Surgery n (%)	Non-surgery n (%)	p-value
Fatigue	39 (98%)	31 (100%)	> 0.999
Fatigue after exertion	40 (100%)	31 (100%)	----
Decreased memory	38 (95%)	27 (87%)	0.393
Difficulty concentrating	39 (98%)	31 (100%)	> 0.999
Disorientation	21 (53%)	17 (55%)	0.845
Body Pain	36 (90%)	31 (100%)	0.126
Headaches	36 (90%)	27 (87%)	0.722
Decrease in strength	34 (85%)	31 (100%)	0.032
Decrease grip strength	30 (75%)	26 (84%)	0.398
Gait instability	35 (88%)	28 (90%)	> 0.999
Depression	20 (50%)	17 (55%)	0.812
Blurred/Double vision	23 (58%)	21 (68%)	0.463
Irritable bowel syndrome	27 (68%)	26 (84%)	0.170
Limb numbness	15 (60%)	18 (58%)	0.808
Limb paresthesiae	31 (78%)	23 (74%)	0.785
Photophobia	34 (85%)	25 (81%)	0.753
Dizziness	26 (65%)	24 (77%)	0.302
Chronic Nausea	12 (30%)	14 (45%)	0.188
Clumsiness	30 (75%)	24 (77%)	0.813
Cold intolerance	28 (70%)	28 (90%)	0.037

Table 3: Prevalence of neurological signs in the surgical and non-surgical groups.

Neurological Sign	**Surgical** n (%)	**Non-surgical** n (%)	**p-value**
Occipital tenderness	10 (25.0%)	4 (12.9%)	0.186
Facial Hypesthesia	7 (17.5%)	2 (6.5%)	0.165
XII CN	1 (2.5%)	1 (3.2%)	> 0.999
Absent gag reflex	15 (37.5%)	7 (22.6%)	0.178
VI CN	2 (5.0%)	0 (0%)	0.501
Nystagmus	4 (10.0%)	2 (6.5%)	0.690
Dysmetria	8 (20.0%)	4 (12.9%)	0.429
Disdiadokokinesia	5 (12.5%)	2 (6.5%)	0.457
Tandem Walk	8 (20.0%)	2 (6.5%)	0.104
Romberg sign	15 (37.5%)	5 (16.1%)	**0.047**
Ataxia	3 (7.5%)	1 (3.2%)	0.627
Heel/Shin	5 (12.5%)	3 (9.7%)	> 0.999
Thoracic sensory level (cold, pin)	35 (89.7%)	29 (93.5%)	0.687
Impaired position sense (feet)	8 (20.0%)	3 (9.7%)	0.233
Ankle clonus	11 (27.5%)	8 (25.8%)	0.873
Positive Hoffman sign	10 (25.0%)	9 (29.0%)	0.703
Reflex recruitment	22 (55.0%)	13 (41.9%)	0.275
Worsening with neck extension*	36 (90.0%)	26 (83.9%)	0.441
Weakness	7 (17.5%)	8 (25.8%)	0.395
Hyper-reflexia	27 (67.5%)	20 (64.5%)	0.792
Hypo-reflexia	10 (25.0%)	8 (25.8%)	0.938

*=Examination of pyramidal tract functions worsens with the neck positioned in extension

Table 4: Median, innerquartile range and range of Scale 1 MMPI-2 and Screening Test for Somatization Disorder (Somatic) scores at the time of initial evaluation and at the 1 year follow-up.

Test	Surgical	Non-surgical
Baseline MMPI	**55** (47, 68) [36, 105]	**57** (49, 66) [38, 95]
One-year MMPI	**40** (32, 48) [0, 85]	**52** (44, 62) [30, 81]
Wilcoxon Signed Rank p-value	$p < 0.001$	$p = 0.069$
Baseline Somatic	**3** (1, 3) [0, 7]	**3** (2, 4) [1,6]
One-year Somatic	**2** (1, 2) [0, 4]	**2** (1, 4) [0, 7]
Wilcoxon Signed Rank p-value	$p = 0.001$	$p = 0.147$

Table 5: Median, innerquartile range and ranges of Hospital Anxiety and Depression Scale (HADS) scores at the time of initial evaluation and at 1 year follow-up

Factor	Surgical	Non-surgical
Baseline depression	8 (6, 13) [2, 19]	8 (5, 13) [2,18]
One-year depression	5 (2, 9) [0, 17]	8 (5, 11) [0,19]
Wilcoxon Signed Rank p-value	$p < 0.001$	$p = 0.152$
Baseline anxiety	8 (6, 13) [1, 21]	11 (6, 13) [1,21]
One-year anxiety	5 (2, 9) [0, 14]	9 (7, 12) [0, 19]
Wilcoxon Signed Rank p-value	$p < 0.001$	$p = 0.822$

Table 6: Median and innerquartile ranges of SF-36 scores at the time of initial evaluation and at the 1 year follow-up.

	Surgical N=40	Non-surgical N=31	Repeated Measures ANOVA
Physical Component Score	25.4 ±7.2	25.2 ± 8.0	
Physical Component (1 year)	36.1 ± 12.7	28.5 ± 9.6	0.009
Mental Component Score	40.7 ± 12.0	41.1 ± 11.3	
Mental Component (1 year)	49.3 ± 9.1	41.1 ± 11.1	0.008
Subscales			Mann-Whitney group comparisons
Physical Functioning	35 (25, 50)	45 (20, 55)	0.507
Physical Functioning (one year)	70 (50, 89)	45 (25, 70)	0.003
Role Physical	0 (0, 0)	0 (0, 0)	0.866
Role Physical (one year)	0 (0, 100)	0 (0, 25)	0.035
Body Pain	22 (12, 41)	31 (12, 41)	0.874
Body Pain (one year)	41 (31, 62)	41 (22, 52)	0.071
General Health	30 (20, 44)	25 (15, 35)	0.286
General Health (one year)	52 (34, 72)	30 (15, 47)	< 0.001
Vitality	10 (1, 25)	10 (5, 20)	0.865
Vitality (one year)	40 (15, 64)	15 (5, 35)	0.003
Social Functioning	31 (25, 47)	38 (13, 50)	0.444
Social Functioning (one year)	63 (40, 100)	50 (13, 63)	0.002
Role Emotional	66 (0, 100)	33 (0, 100)	0.797
Role Emotional (one year)	100 (42, 100)	33 (0, 100)	0.033
Mental Health	64 (41, 80)	56 (40, 80)	> 0.999
Mental Health (one year)	76 (68, 88)	60 (44, 76)	0.003

Table 7: Spinal canal measurements in centimeters as measured at the level of the individual disc spaces on CT scan.

Spinal level	Non-surgery	Surgery	MANOVA p-value	Independent t-test (adjusted p-values)
C2/3			0.247	
Neutral	1.40+/-.2	1.33+/-0.15		
Extension	1.41+/0.21	1.36+/-0.19		
C3/4			0.381	
Neutral	1.29+/-0.16	1.25+/-0.21		
Extension	1.26+/-0.23	1.19+/-0.34		
C4/5			0.177	
Neutral	1.28+/-0.18	1.23+/-0.15		
Extension	1.23+/-0.27	1.13+/-0.18		
C5/6			0.014	
Neutral	1.25+/-0.18	1.12+/-0.19		0.044
Extension	1.16+/-0.21	1.02+/-.18		0.032
C6/7			0.005	
Neutral	1.38+/-0.18	1.21+/-0.24		0.016
Extension	1.23+/-0.19	1.07+/-0.18		0.018
C7/T1			0.304	
Neutral	1.60+/-0.21	1.55+/-0.19		
Extension	1.50+/-0.28	1.51+/-0.23		

Table 8: Neurological signs at 30 days in patients who had undergone surgery (n=40).

Sign	Present at Baseline	30 day improved /resolved	30 day same	30 day worse
Occipital tenderness	10 (25.6%)	3 (30%)	5 (50%)	2 (20%)
Facial Hypesthesia	7 (17.5%)	5 (83%)	1 (17%)	0 (0%)
XII	1 (2.5%)	1 (100%)	0 (0%)	0 (0%)
Absent gag reflex	15 (37.5%)	0 (0%)	13 (100%)	0 (0%)
VI	2 (5.0%)	1 (50 %)	1 (50%)	0 (0%)
Nystagmus	4 (10.0%)	2 (50 %)	2 (50%)	0 (0%)
Dysmetria	8 (20.0%)	5 (63%)	3 (37%)	0 (0%)
Disdiadokokinesia	5 (12.5%)	4 (100%)	0 (0%)	0 (0%)
Tandem Walk	8 (20.0%)	7 (88%)	1 (12%)	0 (0%)
Romberg	15 (37.5%)	12 (80 %)	2 (14%)	1 (6%)
Ataxia	3 (7.5%)	2 (67%)	1 (33%)	0 (0%)
Heel/Shin	5 (12.5%)	2 (40 %)	3 (60 %)	0 (0%)
Sensory level Pin, temperature	35 (89.7%)	16 (53%)	13 (43%)	1 (4%)
Position Sense	8 (20.0%)	5 (63%)	3 (37%)	0 (0%)
Clonus	11 (27.5%)	9 (82%)	2 (18%)	0 (0%)
Hoffman	10 (25.0%)	6 (60%)	3 (30%)	1 (10%)
Recruitment	22 (55.0%)	7 (32%)	14 (64%)	1 (4%)
Weakness	7 (17.5%)	7 (100%)	0 (0%)	0 (0%)
Hyper-reflexia	27 (67.5%)	9 (35%)	14 (54%)	3 (11%)
Hypo-reflexia	10 (25.0%)	1 (12.5%)	6 (75%)	1 (12.5%)

Table 9: Number of patients who reported symptom at baseline and who reported improvement or worsening at the 1 year follow-up. The number of patients may differ from the number of patients in the cohort as not every patient reported every symptom. The p-value relates to the difference in the number of patients reporting symptom improvement in the surgical (S) vs. the non-surgical (NS) groups.

	S Group			**NS Group**			
Symptom	N	improved	worse	N	improved	worse	p
Fatigue	39	23 (59%)	4 (10%)	31	3 (10%)	5 (16%)	< 0.001
Exercise on exertion	40	20 (50%)	3 (8%)	31	2 (6%)	6 (19%)	< 0.001
Decreased memory	38	26 (68%)	2 (5%)	27	3 (11%)	7 (26%)	< 0.001
Impaired concentration	39	31 (79%)	1 (3%)	31	4 (13%)	7 (23%)	< 0.001
Disorientation	21	18 (86%)	0 (0%)	17	5 (29%)	2 (12%)	0.002
Body Pain	36	22 (61%)	1 (3%)	31	5 (16%)	9 (29%)	< 0.001
Headaches	36	26 (72%)	0 (0%)	27	4 (15%)	6 (22%)	< 0.001
Decreased strength	34	23 (68%)	2 (6%)	31	3 (10%)	8 (26%)	< 0.001
Decreased grip	30	21 (70%)	1 (3%)	26	2 (8%)	6 (23%)	< 0.001
Impaired balance	35	25 (71%)	4 (11%)	28	4 (14%)	4 (14%)	< 0.001
Depression	20	12 (60%)	0 (0%)	17	3 (18%)	3 (18%)	0.018
Blurred Vision	23	18 (78%)	0 (0%)	21	4 (19%)	1 (5%)	< 0.001
Irritable bowel syndrome	27	18 (67%)	3 (11%)	26	3 (12%)	7 (27%)	< 0.001
Limb numbness	25	16 (64%)	0 (0%)	18	0 (0%)	5 (28%)	< 0.001
Limb tingling	31	19 (61%)	0 (0%)	23	2 (9%)	5 (22%)	< 0.001
Photophobia	34	20 (59%)	2 (6%)	25	2 (8%)	4 (16%)	< 0.001
Dizziness	26	21 (81%)	0 (0%)	24	4 (17%)	2 (8%)	< 0.001
Nausea	12	12 (100%)	0 (0%)	14	6 (43%)	1 (7%)	0.003
Clumsiness	30	20 (67%)	0 (0%)	24	2 (8%)	6 (25%)	< 0.001
Intolerance to cold	28	17 (61%)	0 (0%)	28	4 (14%)	5 (18%)	< 0.001
Painful body regions	40	4.95 ± 3.79		31	7.54 ± 3.81		<0.005