Cervical spondylotic myelopathy refers to spinal cord dysfunction, the clinical presentations of which range from mild axial neck pain to gross sensory loss, motor weakness, spastic gait, fine motor impairment, and loss of sphincter control.\(^7,10,19\) Cervical spondylotic myelopathy is the most common cause of acquired spastic paresis in adults older than 55 years.\(^4,6,10,16\) The most common cause of CSM is age-related cervical spinal stenosis\(^1\) with slow disease progression deteriorating in a stepwise fashion.\(^5,12\)

Patients typically report hand clumsiness, worsening handwriting, difficulty with grasping and holding objects, diffuse numbness in the hands, and increasing difficulty with balance and ambulation.\(^2,10,16\) Physical examination may reveal unsteadiness, broad-based gait, increased muscle tone, weakness and wasting of the upper and lower limbs, and diminished sensation to light touch, temperature, proprioception, and vibration.\(^16\) Importantly, muscle weakness may be difficult to appreciate due to increased muscle tone, yielding seemingly normal strength on neurological examination. Also, pain is not a dominant feature of cervical myelopathy although patients may complain of axial or radicular symptoms. Sphincter disturbances may develop late in the disease course, although fecal or urinary incontinence is unusual.\(^16\) Despite significant advancements in diagnostic modalities the diagnosis of CSM is based on symptoms, along with a compatible clinical examination.\(^18\) However, due to the subtle and varied presentations of CSM, a high index of suspicion for the diagnosis is required.\(^16\)

When myelopathy is considered, MRI is mandatory to confirm the diagnosis, establish the cause, and assess the degree of spinal cord compression and cord signal changes.\(^5,13\) Although the correlation between high-intensity signal change and preoperative deficits or postoperative recovery is controversial, it certainly identifies pathologi-
cal changes within the cord that should alert the treating physician. Because the damage that occurs to the cervical spinal cord is in many cases irreversible, previous authors have advocated early diagnosis and surgical decompression even in cases of mild myelopathy to prevent further neurological deterioration.

The purpose of this study was to determine whether the diagnosis of patients presenting with typical symptoms and signs of CSM is delayed, and to analyze the factors contributing to such a delay, when present.

**Methods**

The medical records, including all community clinic visits, of 146 patients who underwent operation for CSM at our spine surgery unit between January 2009 and December 2010 were analyzed retrospectively. All cervical degenerative pathological conditions were included in the study. Data were collected from the date of the first documented CSM signs or symptoms until the day of surgery. The study population was composed of 42 patients for whom complete documented medical records were available. The diagnosis of CSM was based on a triad of 1) compatible clinical complaints; 2) neurological examination suggestive of myelopathy; and 3) a cervical MRI study showing spinal cord compression. Patients were excluded from the study for the following reasons: 1) they were suffering from other neurological diseases (for example, amyotrophic lateral sclerosis, Parkinson disease, multiple sclerosis, or prior cerebral vascular attack); 2) they presented with CSM due to neoplastic disease, trauma, or infection; 3) they had previously undergone an operation for CSM; or 4) their clinical data collection was incomplete.

Following chart review, phone interviews were conducted with all patients to complete any missing information and corroborate relevant clinical milestones. Collected data included demographic information, number of physician visits, time delay from the first myelopathic complaint to diagnosis, specialty of the physician who had documented the initial complaint and physician specialties encountered along the diagnostic process, components of the diagnostic workup, alternative diagnoses entertained, and treatments offered and received prior to surgery. The severity of CSM prior to surgery was assessed using the Nurick grading system (Table 1).

All physician visits were counted except for a return visit following referral for lab and imaging studies, which was not counted as an additional visit. The study received approval of the hospital’s ethics committee.

**Data Analysis**

Because only 42 patients had complete medical information out of 146 who underwent operation, we determined the randomness of the groups by comparing their demographic data—age, sex, and their Nurick score, where we found no significant difference between patients (p = 0.0749, 0.7109, and 0.0753, respectively).

Descriptive statistics are given as the mean ± SD for age and time to diagnosis. Physician specialty at initial visit and patient symptoms are presented by way of frequency distributions. In addition, the Spearman coefficient was calculated to assess the correlation between time to diagnosis and patient’s age. All statistical analyses were performed using SAS for Windows version 9.2.

**Results**

One hundred forty-six patients had undergone an operation for degenerative CSM at our spine unit between January 2009 and December 2010. Complete (hospital and community) medical information and diagnostic workup were available for 42 of these patients, who composed the study population. The following results and conclusions pertain to this group of patients, which included 27 men and 15 women with a mean age of 52.5 ± 12.6 years (range 20–77 years).

The mean time to diagnosis of CSM from the first physician visit was 2.2 ± 2.3 years (range 1.7 months–8.9 years), during which patients had a mean of 5.2 ± 3.6 physician visits due to CSM-related complaints (Table 2).

The initial physician visit after symptom onset was to a family practitioner in 69% of cases and to an orthopedic surgeon in an additional 21.4%. Only 9.6% of first physician visits were to other disciplines such as the emergency department or to an internal medicine specialist. Of note, none of the patients were examined by a neurologist or a neurosurgeon at first.

On the second physician visit, patients were most commonly examined by an orthopedic surgeon (48.8%) or by a family practitioner (26.8%). This time, only 9.8% of patients were evaluated by a neurologist and 2.4% by neurosurgeons, whereas 12.2% of the patients were examined by practitioners from other specialties (for example emergency medicine physicians, ENT experts, urologists, and others).

On the third physician visit, patients were examined by orthopedic surgeons (38.5%), neurologists (25.6%), neurosurgeons (18%), or family practitioner (12.8%), as well as physicians from other disciplines (5.1%). Figure 1 summarizes the distribution of patient visits by physician specialty.

The most common diagnoses given were carpal tunnel syndrome (43.1%) and cervical disc radiculopathy.
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without neurological deficit (35.7%). Additionally, other nonspecific, generalized diagnoses (for example, cervicalgia, upper-limb pain, general medical examination, backache, and so on) were documented. The workup suggested for further evaluation of the patients generally included upper-limb EMG (83.7%), cervical spine CT (63.1%), and bone scan (35.8%). Of all cases examined, only a single orthopedic surgeon on a single patient’s first visit referred the patient for a cervical spine MRI examination. Only 2 physicians (1 trainee in emergency medicine and 1 anesthesiologist working in a pain clinic) referred 2 additional patients for cervical spine MRI on their second visit.

When reviewing the total number of physician visits, 37.3% were to orthopedic surgeons, 30.9% were to family physicians, 16.4% were to neurologists, and only 8.2% were to neurosurgeons, with 7.2% to other disciplines. Conversely, the diagnosis of CSM was most frequently made by neurosurgeons (38.1%), followed by neurologists (28.6%), and far less commonly by orthopedic surgeons (19%), family physicians (4.8%), and other disciplines (9.5%). Figure 2 shows percentages for clinic visits and diagnosis reached in patients with CSM, categorized by physician specialty.

Uniformly, neurological examination performed by a family practitioner or a community-based orthopedic surgeon included only motor strength and light touch sensation, if performed at all. History taking directed at cervical myelopathic signs and symptoms, such as walking difficulties and hand clumsiness, was not documented in any of the visits other than the last, when the diagnosis was ultimately made. Similarly, only on that final visit was a neurological examination, oriented at CSM-like walking pattern, muscle tone, reflexes, and pathological reflexes, conducted.

On admission to surgery, myelomalacia was evident on the MRI studies of 40% of patients, and cervical myelopathy with a mean Nurick grade of 2.9 ± 0.53 was documented. The lag period from diagnosis to surgery averaged 2.1 ± 1.1 months.

At the time of diagnosis the most common symptoms were as follows: upper-limb paresthesia (85.7%), unbalanced gait (66.6%), upper-limb weakness (61.9%), neck pain (59.5%), lower-limb paresthesia (50%), lower-limb weakness (42.8%), impaired motor coordination (35.7%),

| TABLE 2: Characteristics in 42 patients with CSM* |
|-------------------|-------|
| Characteristic     | Value |
| no. of patients   | 42    |
| age in yrs        | 52.5 ± 12.6 |
| sex; no. (%)      |        |
| M                 | 27 (64) |
| F                 | 15 (36) |
| time to diagnosis in yrs | 2.2 ± 2.3 |
| no. of physician visits before diagnosis | 5.2 ± 3.6 |
| Nurick score      | 2.9 ± 0.53 |

* Unless otherwise specified, values are expressed as the mean ± SD.

![Fig. 1. Bar graph showing distribution of patients by clinic visits and physician specialty.](image)
and urinary incontinence (16.6%). Figure 3 shows patients’ symptoms on admission for surgery.

Discussion

The natural history of CSM is characterized by progressive neurological deterioration. Clarke and Robinson documented that 75% of patients exhibit episodic stepwise progression; 20% show slow, steady progression; and 5% have a rapid onset of symptoms. Previous studies have emphasized the importance of early diagnosis and treatment of cervical myelopathy. Indeed, Ebersold et al. showed that the only significant variable predictive of outcome is the duration of disease before surgical treatment. Hence, early rather than late surgery is therefore desirable, with the best results obtained in those who received decompression within 6–12 months after the onset of symptoms. Because spinal cord damage tends to be irreversible, early surgery prevents neurological deterioration. Conversely, patients in advanced stages of the disease are less likely to regain neurological function following surgery.

Wiberg, who followed patients for 2–8 years after surgery, showed that decompression is successful in arresting the progression of CSM in 95% of patients.

To understand our results better, one should appreciate that Israel has a modern medical system. The following facts were used to compare the Israeli medical system to that of the OECD: the life expectancy of Israeli citizens ranked fourth in the world in 2010 (82 vs 79.5 years average in the OECD), and infant mortality in Israel is low (3.8/1000 births compared with 4.4 in the OECD). These epidemiological parameters in addition to the high ratio of physicians in the population (3.36/100,000 vs 3.4 in Germany and 2.4 in the US) attest to the quality of the Israeli health care system. Public health expenses, however, are only two-thirds of the OECD average.

It should also be noted that in this system patients may directly schedule a visit to their family practitioner or to an orthopedic surgeon, yet they need to be referred to a neurologist or to a neurosurgeon by a family practitioner or another specialist.

Given this hierarchy, 90.4% of patients with myelopathic complaints presented first to their family practitioner or to an orthopedic surgeon. However, none were correctly diagnosed and were given nonspecific treatment for pain, and they also received physiotherapy. On the second visit, in which almost 50% of the patients were examined by an orthopedic surgeon, the 2 most common diagnoses given were either carpal tunnel syndrome or cervical disc radiculopathy without neurological deficit (although only sensation and muscle strength were tested). At this time point, upper-limb EMG, cervical CT, and bone scintigraphy were the modalities most frequently used for patient evaluation. It was only after a further delay that patients were referred to a neurologist or a neurosurgeon, which established the diagnosis of cervical myelopathy in the majority of cases (66.7%), and first referred the patients to a cervical spine MRI study.

The importance of performing a cervical MRI study for persistent neck or arm pain of more than 2–3 months’ duration, worsening of symptoms, or neurological deficit was bolstered by Emery. Indeed, cervical MRI is considered the gold standard imaging modality for securing a diagnosis of CSM. Herein we show that 70% of referrals for a cervical MRI study were given by neurologists and neurosurgeons. In contrast, family practitioners failed to refer even a single patient for cervical MRI, despite seeing 69% and 27% of patients with appropriate complaints on their first and second physician visits, respectively. Community-based orthopedic surgeons contributed only 19% of cervical MRI referrals although they assessed 37.3% of patients with CSM. Moreover, this limited amount of MRI studies was performed only after exhausting the spectrum of relatively low-cost studies such as cervical spine radiography, EMG, bone scan, and CT scan. Although each
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of these studies by itself is far less costly than is a single MRI scan, their “stand-alone” sensitivity and specificity for the diagnosis of cervical myelopathy is very low.\(^1\) Not only this, but because these examinations are usually performed sequentially, and considering that their total cost approximates that of an MRI examination, money is ultimately not saved but rather time is wasted.

Several factors may contribute to the diagnostic delay in cases of CSM that we have documented, the most notable of which are low MRI and physician availability, surmounted by lack of suspicion on the part of the primary care physician.

At the time of data collection, only 10 MRI machines were available in Israel (that is, 1 machine per 750,000 citizens), whereas the comparable ratio in Western countries was 5- to 20-fold higher (1/145,000 citizens in Germany and 1/40,000 citizens in the US).\(^1\) Moreover, the majority of MRI units are located in the central, urban areas of the country where the waiting time for an examination is 2–4 weeks, extending up to 1–3 months in the more rural periphery. Surprisingly, these wait estimates are not much different from those documented in France (a 32-day expected wait, on average, for an MRI examination in urban areas compared with a 75-day delay in the rural periphery). The fact that the average wait for an MRI examination in Israel and Western Europe is similar suggests that the paucity of MRI units is not the culprit for the diagnostic delay in cases of CSM in our study.

Another potential factor in diagnostic delay is physician availability. However, waiting times are reasonable, averaging a mere 0.7 days for a family physician and 7, 16.9, and 30 days for orthopedic surgeons, neurologists, and neurosurgeons, respectively; thus physician availability is not playing a major role in the diagnostic delay in cases of CSM.\(^1\)

One of the main obstacles in diagnosing CSM is the lack of pathognomonic signs and symptoms, necessitating a high index of suspicion to entertain the diagnosis.\(^1\) That being the case, signs of myelopathy on physical examination are highly specific once they appear.\(^1\) It stands to reason that a neurological examination geared to elucidating signs of myelopathy should be conducted, at a minimum. However, questions pertaining to symptoms of CSM and a dedicated neurological examination for this entity were lacking in our review of the patients’ charts up to the final visit, at which the diagnosis was ultimately made. Therefore, it seems that lack of awareness on the part of family practitioners and orthopedic surgeons in the community is the main reason for the significant delay in the diagnosis of CSM in our study.

In summary, we show that delayed diagnosis of patients with CSM in the community is a frequent occurrence of major concern, and consequently patients are referred for surgery at an advanced stage of the disease, at which point they are suffering from severe, often irreversible neurological damage. It may be argued that the swift diagnosis of CSM attained by neurologists and neurosurgeons in the present study should be attributed mostly to the referral of patients with more severe clinical presentations to these specialists rather than to the physicians’ expertise in this entity. However, because history and examination geared to CSM was lacking in the majority of the records from family physicians and orthopedic surgeons, it may be assumed that lack of clinical awareness on the part of these practitioners was the major contributory factor to the average diagnostic delay of 2.2 years.

Our study has several drawbacks, including the small number of patients and the fact that complete data were available for only 42 of 146 patients who received surgical management in the study period. This mode of data collection, taken together with the lack of documentation of baseline myelopathic signs and symptoms by nonneuro-
logically oriented specialists, did not allow us to evaluate the effect of diagnostic delay on the neurological decline. Finally, although the study was conducted in Israel and undoubtedly reflects the shortcomings of the local health care structure, the epidemiological data presented above shows that it is a modern system, on a par with its Western counterparts. A larger-scale study and the performance of similar studies in other countries are mandatory.

Conclusions
The present study shows that the diagnosis of CSM and referral of patients to surgery is delayed among family practitioners and community-based orthopedic surgeons in Israel. The continuing education of these primary care physicians is imperative to increase awareness and promote early referral to surgery, in an attempt to prevent irreversible neurological damage.

Disclosure
Dr. Regev is a consultant for Medtronic Spine.

Author contributions to the study and manuscript preparation include the following. Conception and design: Behrbalk. Acquisition of data: Behrbalk. Analysis and interpretation of data: Behrbalk. Drafting the article: Behrbalk. Critically revising the article: all authors. Approved the final version of the manuscript on behalf of all authors: Behrbalk.

References

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