INTRODUCTION
Degenerative cervical spinal disease is common, with some form of spondylosis demonstrated radiographically in over 80% of patients older than 55 years (Teresi et al., 1987). Debilitating manifestations include: upper and lower extremity weakness, spasticity, and gait abnormalities. The natural course of severe cervical spondylotic myelopathy is dismal, with up to 75% of patients showing progressive deterioration. Pre- and post-operative clinical and radiologic data have been described, yet these reports have been largely subjective (Guidetti and Fortuna, 1969). Objective evaluations of functional outcomes of cervical spondylosis have not been performed. The purpose of this investigation was to objectively assess outcomes in surgically treated patients with cervical myelopathy.

METHODS
Nine patients (58 years ± 10) undergoing surgery for cervical spondylotic myelopathy were tested preoperatively, and at 6 weeks and 6 months, postoperatively. The surgery decompressed the spinal cord and exiting nerve rootlets. Five subjects with able bodies (57 years ± 7) acted as controls. Objective tests for elbow and ankle spasticity and maximum active torques were quantified on a dynamometer. Spasticity, characterized as a velocity dependent resistance to passive stretch, (Lance, 1980) was measured with a KinCom isokinetic dynamometer (Engsberg et al., 1999, 2001). The spasticity assessment was performed for the ankle plantarflexors and elbow flexors bilaterally as follows. The subject sat on the KinCom dynamometer and had his/her ankle (or elbow) joint axis aligned with the center of the KinCom lever arm. Ankle dorsi- and plantarflexion (elbow flexion and extension) range of motion limits were established. The subject was instructed to remain as relaxed as possible as the joint was rotated passively by the dynamometer from a plantarflexed (elbow flexed) to a dorsiflexed (elbow extended) position. Tests were conducted at speeds of 10, 30, 60, 90, and 120 °/s at the ankle and elbow joints, bilaterally. Work was calculated for each speed and plotted against velocity. The slope of the work-velocity curve, as determined by linear regression, was the measure used to quantify spasticity.

Strength tests were similar to the spasticity tests except that they were designed to measure the maximum active resultant torque-generating capacity that the subject could produce (Engsberg et al., 1999, 2001). The subject actively moved his/her ankle (elbow) from end-range ankle dorsiflexion (elbow flexion) to end-range plantarflexion (elbow extension), and vice versa, to obtain maximum concentric contractions of the ankle and elbow extensors and flexors, bilaterally. Movement speed was 10 °/s. Three to five repetitions of each movement were performed to permit the subject to achieve his/her best performance; however, only the test indicating the greatest amount of torque produced was used in the analysis. The strength variable was the maximum torque normalized by dividing by subject mass.

A gait analysis was also performed. Three-dimensional kinematic gait data were collected with a six-camera Hi-Res Motion Analysis Corporation system (60 Hz). Three 2.5-cm diameter spherical reflective surface markers were placed on each of the feet, legs, thighs, pelvis, and trunk. Each subject walked barefoot at a self-selected pace along a 9 meter walkway. Three trials were collected at each visit. Location-time data for each surface marker, for each trial, were tracked and converted to 3D coordinates. The tracked data were then loaded into KinTrak software to produce segment and joint kinematic data as a function of the gait cycle. The 3D kinematic variables analyzed were maximum ankle dorsiflexion, knee flexion angle at initial contact, and average trunk flexion angle. Gait speed was also determined. Paired and unpaired t-tests
determined significant differences (p<0.05) within and between groups.

RESULTS
No significant differences existed between any of the pre- and postoperative measures. Dorsiflexion strength was significantly less than able-bodied values (*) across all test sessions. Elbow flexion maximum was significantly less than able-bodied controls at pre- and 6 weeks postoperative, but not at 6 months postoperative. Elbow extension strength was only less than able-bodied values, preoperatively. Gait speed was not different from able-bodied at any of the test points, while maximum dorsiflexion angle, and knee flexion angle at initial contact were not different at 6 months postoperative. Average trunk flexion angle was significantly greater than able-bodied at 6 months, postoperative.

Table 1. Objective results for surgical and able-bodied groups. * Significantly different from able-bodied (p<0.05)

<table>
<thead>
<tr>
<th></th>
<th>PF Spast</th>
<th>Elb Flex Spast</th>
<th>PF Max</th>
<th>DF Max</th>
<th>Elb Flex Max</th>
<th>Elb Ext Max</th>
<th>Gait Speed</th>
<th>Gait DF Max</th>
<th>IC Knee Flex</th>
<th>Av. Trunk Flex</th>
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<tbody>
<tr>
<td></td>
<td>J/s</td>
<td>J/s</td>
<td>Nm/kg</td>
<td>Nm/kg</td>
<td>Nm/kg</td>
<td>Nm/kg</td>
<td>cm/s</td>
<td>Deg</td>
<td>Deg</td>
<td>Deg</td>
</tr>
<tr>
<td>Preop</td>
<td>0.015 (0.015)</td>
<td>0.004 (0.005)</td>
<td>0.54 (0.30)</td>
<td>0.37 (0.09)*</td>
<td>0.51 (0.17)*</td>
<td>0.46 (0.07)*</td>
<td>92 (40)</td>
<td>1 (3)</td>
<td>14 (7)*</td>
<td>15 (8)*</td>
</tr>
<tr>
<td>Postop 6wks</td>
<td>0.015 (0.009)</td>
<td>0.004 (0.009)</td>
<td>0.54 (0.19)</td>
<td>0.37 (0.09)*</td>
<td>0.54 (0.19)*</td>
<td>0.50 (0.17)</td>
<td>94 (42)</td>
<td>0 (4)*</td>
<td>12 (7)*</td>
<td>14 (10)</td>
</tr>
<tr>
<td>Postop 6 mo</td>
<td>0.022 (0.020)</td>
<td>0.000 (0.003)</td>
<td>0.62 (0.27)</td>
<td>0.40 (0.07)*</td>
<td>0.60 (0.14)</td>
<td>0.49 (0.17)</td>
<td>94 (33)</td>
<td>1 (4)</td>
<td>11 (7)</td>
<td>14 (7)*</td>
</tr>
<tr>
<td>Able-bodied</td>
<td>0.006 (0.007)</td>
<td>0.004 (0.005)</td>
<td>0.67 (0.08)</td>
<td>0.53 (0.14)</td>
<td>0.80 (0.23)</td>
<td>0.69 (0.18)</td>
<td>121 (32)</td>
<td>5 (2)</td>
<td>4 (3)</td>
<td>5 (5)</td>
</tr>
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</table>

DISCUSSION
The surgical management of cervical spondylotic myelopathy has been controversial with reports that up to 30% of patients deteriorate after the surgery. No objective data has been reported on this population of patients. Results indicated there was no significant deterioration following surgery. For elbow flexion and extension, the maximum values that were significantly less than the able-bodied group prior to surgery were not different at 6 months postoperative. Knee flexion angle and initial contact was also no longer significantly different from able-bodied at 6 months postoperative. These results could be interpreted as an improvement. Additional patients are required to further confirm or refute the results.

REFERENCES

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