
Objective: To assess survival in patients with nontraumatic spinal cord lesions (SCL).

Design: Retrospective cohort study.

Setting: Spinal department at a rehabilitation hospital in Israel.

Participants: Patients with nontraumatic SCL (N=1085) admitted between 1962 and 2000.

Interventions: Demographic, clinical, and mortality data were collected from hospital charts and from the Population Registry of the Israel Ministry of Internal Affairs.

Main Outcome Measures: Survival rates and mortality risk factors. Measures were estimated by using the product limit (Kaplan-Meier) method and the Cox model.

Results: Maximal survival time was 57 years. Median accumulated survival time was 24 years. Survival was significantly affected by lesion etiology, age, gender, severity of lesion, and recent decade of lesion onset; survival tended to be shorter in patients with higher level SCL. We found no significant difference between the effects of risk factors on mortality in nontraumatic SCL and traumatic SCL, other than the effect of age at lesion onset, which was a greater risk factor in the latter group.

Conclusions: The survival rate of patients with nontraumatic SCL has improved significantly in Israel in the last decade. The survival rates of a mixed nontraumatic SCL population are similar to those of traumatic SCL but may differ in specific etiologic age groups.

Key Words: Mortality; Rehabilitation; Risk factors; Spinal cord lesions; Survival rates.

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SURVIVAL OF PATIENTS WITH spinal cord lesions1-5 (SCL) has improved greatly in the last few decades. The survival rate was found lower than it was for the general population, but it has increased with time. Although many SCL cases are nontraumatic, most information about SCL outcomes is from studies of patients with traumatic SCL. Nontraumatic SCL made up 25% of total SCL cases studied in Italy and Germany.6-7 35% of cases in England,6 46% in Fiji,9 and 65% of cases we screened for this study.

Nontraumatic SCL may have various underlying pathologies. Among these are anatomic abnormalities of the spinal cord and nervous system that may be present at birth: neoplastic, degenerative, or vascular processes that usually appear during adulthood and may develop over time and conditions of unknown origin that cause myelopathy and may have unexpected courses. The pathology of nontraumatic SCL may be insidious, and its clinical presentation may progress slowly, as frequently happens with benign tumors or spinal stenosis. Or, it may appear suddenly and surprisingly, at a late period, as happens in some cases with acute disk protrusion. The pathology itself, however, may be rapidly progressive, as with some spinal infections. The prognosis of patients with nontraumatic SCL may be poor, as in cases of spinal metastatic tumors, or in deteriorating diseases such as amyotrophic lateral sclerosis. But these cases are rare in most series that have described nontraumatic SCL; those studies usually included patients who were selected for some rehabilitation program. The prognosis in these series is therefore relatively favorable.6-13

Despite the large number of patients with nontraumatic SCL, information about their survival rate is sparse, and the literature lacks large series with survival analyses of such patients. What few studies10-13 that have been done show that younger people and women survive longer; however, patients with multiple sclerosis (MS) or spinal astrocytoma, but not patients who have undergone removal of a spinal ependymoma, have survival rates that are lower than the general population.

To expand knowledge about survival of patients with nontraumatic SCL, we examined retrospectively survival rates in a relatively large group of such patients. We also investigated associations of survival with mortality risk factors and epidemiologic data of the patients. To our knowledge, this is the first such study in Israel.

METHODS

Of the 1117 patients with nontraumatic SCL who were treated between 1962 and 2000 at Loewenstein Rehabilitation Hospital, the premier referral center for rehabilitation medicine in Israel, 1085 patients participated in this study. Thirty-two patients with missing clinical data were excluded. Survival rates and the factors that affect those rates were examined and compared with those of 250 previously studied patients with traumatic SCL who were treated between 1962 and 1992 and whose mean age was 34.5 years at injury. The male-to-female ratio in the traumatic group was 3.3:1; the SCL level was cervical in 35.4%, thoracic in 32.4%, and lumbar in 31.2%. Frankel grade on admission to rehabilitation was A in 29.6%, B in 16.8%, C in 40%, and D in 13.6% of the patients with traumatic SCL.

Demographic and clinical data, such as age at lesion onset, gender, lesion etiology, lesion level and severity, and the decade in which the SCL occurred, were collected by reviewing the hospital charts. Mortality data were collected from the Population Registry of the Israel Ministry of Internal Affairs. The study was carried out between December 2000 and May 2001. The time from SCL onset (the earliest event related to the
SCL in a patient’s hospital records) to death or end of follow-up covered a maximum period of 57 years. Survival rates were estimated by using the Kaplan-Meier method, and differences between subgroups were analyzed by log-rank test (univariate analysis). The Cox proportional hazards model was used to determine the probability of mortality (hazard) in the presence of specific risk factors, such as the etiology of nontraumatic SCL, age at SCL onset, gender, severity of neurologic deficit, SCL level, and decade in which lesion onset occurred (multivariate analysis).

The severity of neurologic deficit below the SCL level was graded according to Frankel et al. The relationship of Frankel grades and the decade of lesion onset was examined with the Pearson chi-square test. The Cox model was used to compare nontraumatic and traumatic SCL, involving a combination of the present nontraumatic SCL data set and a previously studied traumatic SCL data set, with an indicator variable for traumatic versus nontraumatic SCL. Data were analyzed with the SPSS, version 11.

**RESULTS**

**Demographic and Clinical Data**

One hundred thirty-four of the patients in the study were admitted between 1962 and 1970, 208 between 1971 and 1980, 294 between 1981 and 1990, and 449 between 1991 and 2000. The mean age ± standard deviation at lesion onset was 47.8 ± 17.2 years (range, 0–82 y). Five hundred ninety-nine (55.2%) were men and 486 (44.7%) were women.

Lesion etiology was spinal stenosis in 24.1% of the cases, disk protrusion in 14.6%, MS in 21.8%, tumors in 20.3% (meningioma, 8.9%; ependymoma, 2%; astrocytoma, 1.3%; schwannoma, hemangioma, and others, 8.1%), myelitis (myelopathy of unknown origin) in 6.5%, infection in 4.7% (mainly tuberculosis and Staphylococcus aureus), and other in 8% of the cases.

Average age at lesion onset was 59 years for spinal stenosis, 50 years for tumors, 48 years for disk protrusion, 48 years for infection, 41 years for myelitis, and 33 years for MS.

The cervical spinal cord was affected by 32% of the lesions (150 upper and 197 lower cervical), the thoracic by 45.2% (131 upper and 359 lower thoracic), and the lumbar by 22.8%. Sixty-two percent of the lesions from spinal stenosis were cervical, 60% resulting from disk lesions were lumbar, and 60% to 70% because of myelitis, tumors, infection, and MS were thoracic. At their first admission, 2.9% of patients had complete lesions (Frankel grade A) and 97.1% had incomplete lesions (13.1% grade B, 46.6% grade C, 37.4% grade D).

**Outcomes**

Mortality data were found for 1066 of the 1085 patients with nontraumatic SCL. Six hundred seventy-one (63%) were still complete lesions (Frankel grade A) and 97.1% had incomplete lesions (13.1% grade B, 46.6% grade C, 37.4% grade D).

**Table 1: Survival in SCL Subgroups**

<table>
<thead>
<tr>
<th>Affecting Factor</th>
<th>Median Survival (y)</th>
<th>SE</th>
<th>P</th>
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<tbody>
<tr>
<td>Age at lesion onset (y)</td>
<td></td>
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<tr>
<td>&lt;20</td>
<td>52.9</td>
<td>12.1</td>
<td>.001</td>
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<tr>
<td>20–40</td>
<td>33.8</td>
<td>1.6</td>
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<td>40–60</td>
<td>22</td>
<td>1.9</td>
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<tr>
<td>&lt;60</td>
<td>13.6</td>
<td>0.7</td>
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<tr>
<td>Gender</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>22.9</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>26.4</td>
<td>2.0</td>
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<tr>
<td>SCL etiology</td>
<td></td>
<td></td>
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<tr>
<td>Herniated disk</td>
<td>29.0</td>
<td>1.9</td>
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<tr>
<td>Spinal stenosis</td>
<td>17.6</td>
<td>1.35</td>
<td></td>
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<tr>
<td>Tumor</td>
<td>18.5</td>
<td>1.6</td>
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<tr>
<td>Infection</td>
<td>28.9</td>
<td>10.3</td>
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<tr>
<td>Myelitis</td>
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<tr>
<td>MS</td>
<td>28.8</td>
<td>1.96</td>
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<tr>
<td>Admission Frankel grade</td>
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<td></td>
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</tr>
<tr>
<td>A</td>
<td>1.42</td>
<td>.013</td>
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<tr>
<td>B</td>
<td>22.1</td>
<td>4.6</td>
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<tr>
<td>C</td>
<td>22.5</td>
<td>1.95</td>
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<tr>
<td>D</td>
<td>26.4</td>
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<td>Decade of SCL onset</td>
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<tr>
<td>Before 1971</td>
<td>25.5</td>
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<tr>
<td>1971–1980</td>
<td>22.7</td>
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<td>1981–1990</td>
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<td>1991–2000</td>
<td>&gt;10</td>
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<td>SCL level</td>
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<tr>
<td>Cervical</td>
<td>22.7</td>
<td>2.1</td>
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<tr>
<td>Thoracic</td>
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<tr>
<td>Lumbar</td>
<td>27.7</td>
<td>1.9</td>
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*Sixteen-year survival ± SE was 54.1% ± 12% for patients with Frankel grade A on admission.

Eighteen-year survival was 55.6% ± 4.8% between 1981 and 1990.

Ten-year survival was 82% ± 6.3% between 1991 and 2000.

Factors with potentially concomitant effects. The effect of the various factors that may predict survival are discussed later. In all cases, we controlled for other potentially affecting factors. The mortality risk for patients with disk protrusion, spinal stenosis, and tumors (mostly benign) was lower than that for patients with myelitis or MS (table 2).

**Age effect.** The mortality risk was 1.06 times higher for every additional year of age at lesion onset (table 2).

**Gender effect.** The hazard associated with male gender was 1.33 times higher than that associated with female gender (table 2).

**Effect of lesion severity.** The mortality risk in patients with Frankel grades of A, B, or C at admission was 1.49 times higher than that in patients with a Frankel grade of D (table 2).

**Effect of decade during which lesion onset occurred.** The risk for mortality decreased over decades. However, the decrease was statistically significant only during the last decade. The risk of mortality for those with SCL onset between 1991 and 2000 was only 50% as high as the mortality risk before 1971 (table 2). The frequency of less severe lesions also increased each decade. Frankel grade D was found in 27.5% of the patients with lesion onset before 1971, in 35.2% with lesion onset between 1971 and 1980, in 41.4% with lesion onset between 1981 and 1990, and in 43.1% with lesion onset between 1991 and 2000 (P < .005).

**Effects of SCL level.** The overall SCL level effect on the hazard was not significant (table 2). However, higher SCL levels tended to be associated with shorter survival. The risk of
The median survival of patients with traumatic SCL (studied earlier in the same century) was longer than that of the nontraumatic SCL patients (36.5y vs 24y). When controlling for age at lesion onset, gender, Frankel grade, SCL level, and decade of SCL onset, no differences were detected between the mortality risks of traumatic and nontraumatic SCL. When controlling also for the interactions between these factors and the group of traumatic or nontraumatic SCL, the only difference between the mortality risks of traumatic and nontraumatic SCL was that of age at lesion onset ($P = .006$). Thus, only age at lesion onset is a greater risk factor in traumatic SCL than in nontraumatic SCL.

### DISCUSSION

With the increase in public and professional awareness of the role of rehabilitation in the treatment of SCL, admissions of nontraumatic SCL are increasing in our practice by 50% every decade, and outcome measures in this population deserve particular attention. Estimations of survival in patients with nontraumatic SCL are important in the assessment of medical outcomes for the planning of medical and social services and for the information patients want about their prognoses. However, little is known about the survival of these patients. Therefore, after showing the traumatic SCL survival rates in Israel are comparable to those in other developed countries, we investigated survival after nontraumatic SCL in Israel.

The study population was heterogeneous. As in previous studies of traumatic SCL, the current study included patients who sustained SCL over decades; age at lesion onset and severity of SCL varied, and conditions were presumably stable and not expected to change, or to change in time because of neurologic complications or recovery. It is possible that the relatively mild nature of the spinal cord damage in nontraumatic SCL in this study reduced the hazardous effects that exist in higher lesions. High cervical lesions that might have influenced survival were not distinguished in this analysis. However, the proportion of these lesions in this study was similar to their proportion in our previous study on traumatic SCL. Therefore, it is unlikely that differences between high and low cervical lesions explain the difference in the effect of SCL level between traumatic and nontraumatic SCL.

Another factor that affected survival in patients with both nontraumatic and traumatic SCL is the decade of lesion onset, although the effect on survival in nontraumatic SCL reached statistical significance only in the last decade (table 2).
provement in survival over time may be related both to the higher life expectancy of the general population and to improved SCL care. Although part of the marked increase in survival with lesion onset during the recent decade may be the result of an increase in admissions of patients with milder nontraumatic SCL, lesion onset in this decade was an independent factor that decreased the risk for mortality in nontraumatic SCL patients.

Age at lesion onset was a greater risk factor in traumatic than in nontraumatic SCL. This may mean that at a younger age, as is characteristic of patients with traumatic SCL, every additional year increases the risk to a greater degree than it does at an older age. Nevertheless, there was no significant difference between the effects of gender, Frankel grade, SCL level, and decade of SCL onset on hazard in traumatic versus nontraumatic SCL. Patients with mixed nontraumatic SCL may have the same survival time as that of traumatic SCL patients with matched risk factors, although survival may differ in specific etiologic subgroups.

Although previous studies, as well as this one, provide abundant information about the survival of populations with SCL and its risk factors, the information should be used carefully when attempting to predict the survival of individual patients. The average survival time in a given population is sometimes used to make such a prediction, after being controlled for hazard factors relevant to the patient. However, the patient for whom survival prediction is required is almost never average, all of his/her relevant characteristics should be considered to minimize mistakes. Ignoring the year of lesion onset, for example, may result in underestimation of how long the patient may survive.

Risk factors that are difficult to quantify, such as the quality of medical care and the social attitudes that a patient may be facing, may also affect the survival of SCL patients. Patients with access to better medical and social care probably have a better chance of surviving. Furthermore, survival estimated on the basis of average medical care outcomes may fall short of the survival expected when good medical care is provided. Such underestimation may deny the patient compensation and financial resources and thereby shorten survival, which may have been longer with more expensive medical care. This notion may find support in a 1999 report by DeVivo et al that implied (although not explicitly claim) that economic restrictions on rehabilitation decreased the survival time of SCL patients who were treated in a group of hospitals.

A social attitude reflected in a lower value ascribed to living with disability may affect negatively the efforts that caregivers, family, and patients are ready to invest to prevent complications of SCL and to prolong life. Such an attitude may therefore be a risk factor independent of medical and economic factors.

The ideas of caregivers about a patient’s life expectancy may also be a risk factor. In patients with traumatic and with certain nontraumatic SCL, the caregivers’ expectation of early death may add to the risk inflicted by the specific SCL etiology. Such concepts are influenced by interpretations of published survival data; therefore, such data should be interpreted with great care until further research makes possible the reasonable quantification of all the relevant hazards.

CONCLUSIONS

The survival time of patients with nontraumatic SCL has significantly improved in Israel over the last decade; despite their relatively old age, these patients may survive for many years. Survival is affected mainly by nontraumatic SCL etiology and severity, age at lesion onset, and gender. Except for age at lesion onset, which is a greater hazard in traumatic than in nontraumatic SCL, the effect of other risk factors on survival does not differ between these groups. Further research is required to assess survival in the various nontraumatic SCL etiologies.

References


Supplier

a. SPSS Inc, 233 S Wacker Dr, 11th Fl, Chicago, IL 60606.