Cervical spine fractures in the elderly

Factors influencing survival in 65 cases

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To evaluate whether a cervical spine fracture increases the death risk in elderly patients, and to define risk factors, we studied the survival of 65 patients (26 women) with a mean age of 77 (66–99) years. 8 of the patients were tetraparetic. In 35 patients, the upper cervical spine was fractured. 7 patients suffered from ankylosing spondylitis. Severe co-morbidity was present in 16.

Survival status and the date of death were retrieved from the government official personal registry. The expected survival was calculated from data retrieved from the Swedish National Board of Health and Welfare. Variables having a possible relation with survival (i.e., a p-value < 0.10 when entered into a Kaplan-Meier survival analysis) were used in a Cox multiple regression survival analysis.

53 (24–105) months after injury, 25 of the 65 patients had died. The survival was significantly lower than the expected values. Severe co-morbidity (risk ratio: 5,6), neurological injury (6,4), high age (1,1), and ankylosing spondylitis (5,5) proved to be significant risk factors for death. Thus, a cervical spine fracture may lead to earlier death in a patient with a severe co-morbidity. A neurological complication constitutes a risk also for a previously healthy individual. Patients having ankylosing spondylitis (with increased death risk) run a higher than normal risk of sustaining a cervical spine fracture.

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Submitted 98-10-10. Accepted 99-05-26

It is a common experience that some elderly patients with a cervical spine fracture die soon after their injury.

Various associations between injury and increased mortality have been identified in various types of fractures in the elderly. In femoral neck fractures, there is an increased mortality soon after the injury, indicating either that the fracture in itself causes premature death or that patients with an increased mortality sustain the fracture (Schrøder and Erlandsen 1993, Lu-Yao et al. 1994, Lüthje et al. 1995, Katelaris and Cumming 1996). In distal radius fractures, a similarly increased death risk is not seen (Cooper et al. 1993). In osteoporotic vertebral fractures, on the other hand, a continual deviation from values expected occurs during several years after the injury (Cooper et al. 1993). However, there are very few reports in the literature discussing survival after cervical spine fractures in the elderly.

We retrospectively evaluated whether cervical spine fracture carries an increased risk of death in patients over 65 years of age, defined risk factors influencing the survival, and evaluated the relative effects of these risk factors.

Patients and methods

The series consisted of the 65 consecutive patients (26 women) older than 65 years of age treated for cervical spine fractures in the Departments of Orthopedics and Neurosurgery at Uppsala University Hospital between 1988 and 1994 (Table 1). The hospital is a tertiary referral center with a population base of approximately 1/5 of the 9 million inhabitants of Sweden. The mean age was 77 (66–99) years. 39 of the patients were neurologically intact, Frankel E, whereas 17 were Frankel D, 7 were Frankel C, and 1 was Frankel B (Frankel et al. 1969). It was not possible to establish the Frankel grade for 1 patient. In the statistical analysis, this variable was dichotomized into non-walkers, Frankel A to C, and walkers, Frankel D and E.

Table 1. General table

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	72	M	1	u	0	2	C	1	85	700	b, e	1643	1
2	74	M	1	l	0	1	D	1	205		d	717	1
3	75	F	1	u	0	2	E	1	65	300	c	875	1
4	83	F	2	u	0	2	E	1	195	200		888	1
5	83	M	2	u	0	2	D	1	170	100	o	716	1
6	81	F	1	u	0	3	E	1	130	0	m	783	1
7	74	M	2	u	0	2	E	1	90	100		890	1
8	90	M	2	u	0	2	D	1	320	2200		20	0
9	86	M	1	l	0	3		1	170	100	b	23	0
10	80	M	1	l	0	3	E	0				57	0
11	75	M	1	u	0	3	E	1	75	150		23	0
12	75	F	1	l	0	2	E	1	105	200		1073	1
13	82	M	2	u	0	2	E	1	40	150		1566	1
14	79	M	2	u	0	2	E	1			o	1691	1
15	76	M	2	l	1	2	D	1	265	1200		1701	1
16	74	F	1	u	0	3	E	1	160	150		1842	1
17	84	F	2	u	0	2	E	1	55	0		647	0
18	82	M	2	u	0	3	E	1	220		a	881	0
19	93	M	1	l	0	1	E	1	228	550		1080	1
20	76	F	1	u	0	2	E	1	175	300		1819	1
21	75	M	2	l	1	2	D	1	225	1400	f	207	0
22	79	M	1	l	0	1	D	0			f, b	1219	1
23	88	F	2	l	0	2	E	0				449	0
24	71	F	2	u	0	2	E	1	25	0		1182	1
25	68	M	1	l	0	1	D	1	110	300		1591	1
26	89	F	2	u	0	2	E	1	95	150		1130	1
27	80	M	2	u	0	3	E	1	120	100	j	1310	0
28	87	M	2	l	0	3	E	1	105	700		1194	1
29	76	M	1	u	0	2	D	1			o	166	0
30	85	M	1	u	0	2	E	1	160	1050	d, k	2268	1
31	66	F	1	l	0	1	D	1	325	1100	b	3156	1
32	70	M	1	l	0	1	E	0				2516	1
33	70	F	1	u	0	1	E	1	135	150		2274	1
34	67	F	1	l	0	2	D	0				1256	0
35	77	M	1	l	0	2	D	1	170	700	i	3049	1
36	74	M	2	l	0	3	D	1	115	1400	l	2108	0
37	70	M	1	l	1	2	C	1	190	2200	b	58	0
38	66	F	1	u	0	2	E	0			o	2659	1
39	76	M	1	l	0	2	D	1	195	800		1989	1
40	77	M	1	l	1	1	C	1	255	250	h	310	0
41	76	M	2	l	1		C	1	300	750	b, k	795	1
42	82	M	1	l	0	1	D	1	65	250		882	1
43	76	M	1	l	0	1	D	1	130	2100		1475	1
44	66	M	1	l	0	4	D	1	220	800	d, b	1514	1
45	81	F	2	u	0	2	E	0			o	909	0
46	87	F	2	u	0	1	E	0				2060	0
47	76	F	1	u	0	2	E	0			o	2197	0
48	81	F	2	u	0	1	C	1	50	20	o	904	0
49	67	M	2	u	0	2	E	0				2249	1
50	71	F	2	u	0	2	E	1	90	100		1967	1
51	72	F	2	u	0	2	E	1	170	450		2063	1
52	71	F	2	u	0	1	E	1	195	600	n	1953	0
53	69	F	1	l	0	1	E	1	145	3100	g	2736	1
54	71	F	1	u	0	1	E	1	215	200		2375	1
55	89	M	2	l	0	3	D	1			a	2	0
56	94	F	2	u	0	2	E	0				1083	1
57	99	M	2	u	0	2	E	0			o	420	0
58	79	M	1	l	0	3	E	0			c	10	0
59	76	F	2	l	1	2	E	0				1003	1
60	74	M	1	u	0	2	E	1	145	125	j	1941	1
61	80	M	1	l	0	3	C	1	135	200		35	0
62	69	M	1	u	0	3	E	0				986	1
63	69	F	1	u	0	2	E	0				909	1
64	69	M	2	l	1	2	B	1	245	1500	b	115	0
65	79	M	2	l	0	3	C	1	145	500	a	77	0

Legends to the general table

A Patient number
B Age
C Gender
D Trauma energy
  1 Low
  2 High
E Level of injury
  u upper cervical spine, C1–C2
  l lower cervical spine, C3–C7
F Ankylosing spondylitis
  1 yes
  0 no
G Preinjury morbidity (ASA class)
H Neurological injury (Frankel grade)
I Operated
  1 yes
  0 no
J Operation time, min
K Blood loss, mL
L Complications
  a Cardiovascular
  b Respiratory failure
  c Stroke
  d Kidney failure
  e Gastrointestinal
  f Myelopathy
  g Rhizopathy
  h Dural tear
  i Vascular
  j Redisplacement
  k Infection
  l Thromboembolism
  m Local pain
  n Skin ulceration
  o Non-union
M Follow-up time, days
N Censored
  1 yes
  0 no

Table 2. The American Society of Anesthesiologists' (ASA) Physical Status Classification (Owens et al. 1978)

Class 1	A normally healthy patient
Class 2	A patient with a mild systemic disease
Class 3	A patient with a severe systemic disease that is not incapacitating
Class 4	A patient with an incapacitating systemic disease that is a constant threat to life
Class 5	A moribund patient who is not expected to survive 24 hours with or without operation

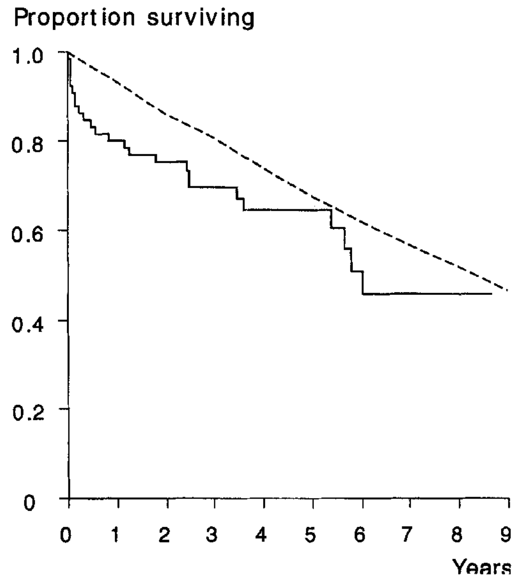
Everything more forceful than a fall at the same level was defined as high-energy trauma; there were 35 patients with high- and 30 with low-energy trauma. Upper cervical spine injury (C1–C2) was present in 35 patients, whereas the lower cervical spine was fractured in 30. 7 of the patients suffered from ankylosing spondylitis.

Co-morbidity was estimated with the American Society for Anesthesiologists' (ASA) Physical Status Classification (Table 2) (Owens et al. 1978). There were 15 grade 1, 34 grade 2, 14 grade 3, and 1 grade 4. It was not possible to retrospectively establish the ASA class for 1 patient. In the statistical analysis, this variable was dichotomized into "healthy" patients, ASA 1 and 2, and "unhealthy" patients, ASA 3 or above.

49 of the 65 patients were operated on with internal fixation, whereas 16 had closed treatment. Complications occurred more often after operative than after closed treatment, the commonest being respiratory insufficiency, cardiovascular complications, kidney failure, and stroke. Disturbance in bone healing of the fracture/fusion was also frequently seen. In the statistical analysis, this variable was dichotomized, whether a complication had occurred or not.

Follow-up was performed on average 53 (24–105) months after the injury. Survival data were obtained from the government official personal registry. Information on the expected survival in the general population was retrieved from the Swedish National Board of Health and Welfare and the expected survival in the particular study population was calculated.

To identify factors with a possible relation to survival, each available patient-related variable (Table 1) was independently entered into a



Kaplan-Meier survival plot for time compared to the expected survival in the actual patient group based on official survival statistics indicating an increased mortality after cervical spine fractures in patients over 65 years of age. The relative decrease in the slope of the fracture group curve between 1 and 5 years after the injury is probably due to the fact that the subgroup of patients with an increased morbidity, and increased death risk, died in the early phase. The patients still alive more than 1 year after the fracture may thus represent a healthier subgroup with decreased death risk.
——— patients, - - - - - background population.

Kaplan-Meier survival analysis. Factors with a p-value less than 0.10 (log-rank test) were defined as having a possible association to survival. These factors were then entered in a Cox multiple regression survival analysis. Factors of no significance were then excluded in a stepwise fashion from the model. A p-value of 0.05 was considered significant. To validate our final model, we extended it by including previously excluded variables and interaction terms. However, extension of our final model did not change the parameter estimates significantly.

Results

At follow-up, 25 patients had died, whereas 40 were alive. There was a significant difference between the observed and expected survival (Figure).

Table 3. The possible risk factors for death included in the Cox regression analysis—i.e., patient-related factors with a p-value < 0.10 in the Kaplan-Meier analysis

Possible risk factors ($p < 0.10$)	P-value
ASA score ≥ 3	0.0005
Frankel grades A–C	0.0004
Age (1-year increase)	0.002
Gender	0.1
Complication	0.06
Trauma grade (high vs. low energy)	0.06
Ankylosing spondylitis	0.08

Table 4. Factors related to death in the Cox regression analysis

	Risk ratio	95 % CI		P-value
ASA ≥ 3	5.6	2.2	14	< 0.001
Frankel grades A–C	6.4	2.1	20	0.001
Age (1-year increase)	1.1	1.0	1.2	0.001
Ankylosing spondylitis	5.5	1.4	22	0.02

Several factors had a possible association with survival (Table 3).

The Cox regression survival analysis revealed co-morbidity (expressed as ASA ≥ 3), neurological injury (Frankel A–C), age, and the presence of ankylosing spondylitis as significant risk factors for death (Table 4).

Discussion

The initial fall in the cumulative survival curve during the first 1/2 year and the deviation from expected values clearly indicate that elderly people show an increased death rate after a cervical spine fracture. The relative fall in the slope of the cumulative survival curve between 1 and 5 years after the injury may be due to the fact that the patients with an increased death risk died shortly after the accident. The patients still alive after 1 year thus may represent a healthier subgroup with a relatively lower death risk. However, the curve is based on only a few subjects in this period and thus the slope must be interpreted with caution.

We found an increased death risk with increasing age. However, in the absence of neurological injury, a cervical spine fracture seems to be a trivial injury with little tissue damage or bleeding, and a small trauma response. Surgical treatment does not involve an extensive soft tissue dissection, is usually short with minor blood loss, and the patients can be mobilized quickly. Even the patients who were not operated on were immediately mobilized.

Why then is there an increased death risk after cervical spine fractures in the elderly? 3 hypotheses can be advanced. The injury will be detrimental to an already unhealthy individual with a high death risk, the injury in itself and/or its consequences will cause premature death in previously healthy subjects, or unhealthy subjects with an increased death risk run a higher risk than the average individual of sustaining a cervical spine fracture. We have found evidence supporting all three hypotheses.

One way to express preinjury co-morbidity is in terms of anesthesia risk (i.e., ASA class; Owens et al. 1978). We found a clear relationship between a high ASA class and dying from the cervical spine fracture, which supports the first hypothesis. Patients suffering from a preinjury condition, if it is severe enough, will die even sooner.

The second hypothesis of premature death in previously healthy subjects is supported by the fact that the risk factor entailing the greatest risk fo death is neurological injury, which is a consequence of the fracture. The reason is obvious: a severe neurological injury is associated with chronic dysfunction of most organ systems. Mental depression, poor circulatory and respiratory status, chronic obstipation, chronic urinary infection, pressure sores, osteoporosis, etc, to mention only a few. Moreover, in a previously healthy elderly patient these complications are difficult to cope with which is reflected by a high death rate.

Ankylosing spondylitis correlates with an increased death risk. This condition is associated with both an increased risk of spinal fracture (Myllykangas-Luosujarvi et al. 1998), and a neurological complication of the injury (Olerud et al. 1996), and an increased risk of death (Kovarsky 1977, Lehtinen 1993, Callahan and Pincus 1995, Myllykangas-Luosujarvi et al. 1998). Ankylosing spondylitis is a collagenosis (i.e., a generalized rheumatic disease) affecting the whole organism, not only the spinal column. The condition is chronic and involves several organ systems leading to poorer tolerance of trauma. The patients may have poor nutritional and respiratory status, and are frequently on chronic medication with steroids or NSAIDs. The general stiffness in the chest may also lead to difficulties in clearing the airways when the patient becomes immobile with a spine fracture, even in the absence of a neurological injury.

In conclusion, cervical spine fracture is associated with increased risk of death in the elderly population. Preinjury co-morbidity, severe neurological injury, increased age, and the presence of ankylosing spondylitis constitute risk factors.

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