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Functional outcome 5 years after non-operative treatment of type A spinal fractures

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Abstract This study was conducted to study the functional outcome after non-operative treatment of type A thoracolumbar spinal fractures without neurological deficit. Functional outcome was determined following the International Classification of Functioning, Disability and Health, measuring restrictions in body function and structure, restrictions in activities, and restrictions in participation/quality of life. All patients were treated non-operatively for a type A thoracolumbar (Th11-L4) spinal fracture at the University Hospital Groningen, The Netherlands. Thirty-three of the eighty-one selected patients agreed to participate in the study (response-rate 41%). Respondents were older than non-respondents (mean 50.5 years vs. 39.2 years), but did not differ from each other concerning injury-related variables. Patients with a neurological deficit were excluded. Treatment consisted either of mobilisation without brace, or of bedrest followed by wearing a brace. Restrictions in body function and structure were measured by physical tests (dynamic lifting test and bicycle ergometry test); restrictions in activities were measured by means of questionnaires, the Roland Morris Disability Questionnaire (RMDQ) and Visual Analogue Scale Spine Score (VAS). Restrictions in participation/quality of life were assessed with the Short Form 36 (SF-36) and by means of return to work status. Thirty-seven per cent of the patients were not able to perform the dynamic lifting test within normal range. In the ergometry test, 40.9% of the patients performed below the lowest normal value, 36.4% of the patients achieved a high VO_2-max. Mean RMDQ-score was 5.2, the mean VAS-score was 79. No significant differences between patients and healthy subjects were found in SF-36 scores, neither were differences found between braced and unbraced patients in any of the outcome measures. Concerning the return to work status, 10% of the subjects had stopped working and received social security benefits, 24% had arranged changes in their work and 14% had changed their job. We conclude that patients do reasonably well 5 years after non-operative treatment of a thoracolumbar fracture, although outcome is diverse in the different categories and physical functioning seems restricted in a considerable number of patients.

Keywords Spinal fractures · Non-operative treatment · Functional outcome · RMDQ · VAS · SF-36 · Exercise test

Introduction

With respect to the patients' status after treatment of a spinal fracture, literature mostly focuses on radiological aspects. However, the result of a spinal fracture and its treatment can be seen much more widely than radiological results alone, for example in terms of remaining back pain or exercise tolerance, referred to as functional outcome. Although most patients are more concerned about disability than about radiological results, literature concerning functional outcome after a spinal fracture is scarce. Recent work shows that patients treated operatively for a spinal fracture have an almost equal functional outcome as healthy people [10]. However, in our clinic spinal fracture patients are more often treated non-operatively than operatively [14]. This study describes the functional outcome (measured by questionnaires and physical tests) of patients treated non-operatively for a thoracolumbar spinal fracture.

Materials and methods

Patients

Patients treated non-operatively for a type A (Comprehensive Classification [11]) thoracolumbar spinal fracture (Th10-L4) between 1993 and 1998 in the University Hospital Groningen, aged between 18 and 60 (at the time of injury) and without neurological deficit, were included. Exclusion criteria were spinal disorders in their medical history, pathological fractures and insufficient command of the Dutch language.

Within these criteria, a group of 81 patients was identified, to whom a letter was sent asking to take part in the study. Thirty-two persons did not respond despite several attempts to contact them, eight patients did not want to join and eight patients did not show up at several appointments. Eventually, 33 patients participated in the study (response rate = 41%). Details of the study group ($n = 33$) are: mean age at the time of examination 50.5 years (SD 11.6, range 27–67); mean follow-up time 5.3 years (SD 1.7, range 3–8); 20 patients were male, 13 patients were female. Co-morbidity was: one patient suffered from diabetes mellitus, two patients suffered from cardiovascular disease and two patients suffered from chronic obstructive pulmonary disease (COPD). Etiological factors were traffic accidents ($n = 12$), sports ($n = 4$) and falls ($n = 17$). Fracture levels are shown in Table 1; most fractures (64%) occurred at the thoracolumbar junction (Th12/L1), the greater part (82%) was classified as type A1.1 and A1.2 (Table 2) [11].

No difference was found in gender, follow-up, co-morbidity or fracture severity between respondents and non-respondents; respondents, however, were older than non-respondents (50.5 years vs. 39.2 years)($P < 0.001$).

Table 1 Fracture level

Level	*n*
Th11	3
Th12	11
L1	10
L2	7
L3	1
L4	1

The study protocol was approved by the Medical Ethics Committee of the University Hospital Groningen (Nr. 99/12/206).

Treatment

Treatment was initialized in our hospital, and continued in the outpatient clinic or in a rehabilitation centre. Treatment varied and consisted of mobilisation without brace (n = 15, "unbraced group"), or 2–6 weeks of bedrest (or strykerframe) followed by a three-point reclination brace ($n = 18$, "braced group"). Comparing both groups, patients did not differ in number, age, gender or follow-up.

The decision for brace application was made by a senior staff member: A2 and A3 type fractures were braced, more severe type A1.2 and A1.3 fractures (e.g. those with a large anterior wedge angle) were also braced. By protocol, patients were seen in the outpatient clinic by the surgeon and the rehabilitation specialist after 6 weeks and 3, 6, 9, 12 and 24 months. Patients were mobilised with the guidance of a physiotherapist or an occupational therapist, mobilisation was also conducted by protocol. After three months weight bearing exercises were introduced. The brace was worn for 9 months, the first 6 months night and day, the last 3 months only in the daytime. Patients were allowed to drive a car or ride a bicycle after 3 and 9 months, respectively.

Table 2 Comprehensive Classification in 33 patients

Class	Sub class	*n*
A1	A1.1	12
	A1.2	15
	A1.3	0
A2	A2.1	2
	A2.2	1
	A2.3	0
A3	A3.1	2
	A3.2	0
	A3.3	1

Functional outcome

In this study functional outcome was defined according to the International Classification of Functioning, Disability and Health (ICF) by three distinct entities: restrictions in body function and structure, restrictions in activities, and restrictions in participation/quality of life [2, 21].

Restrictions in body function and structure

Dynamic lifting tests as well as an ergometry exercise test were carried out to measure restrictions in body function and structure.

Dynamic lifting test:

Patients are asked to lift a box containing a weight from the floor to a 75 cm-high table four times in 20 s. The starting weight for men is 5.85 kg, for women 3.6 kg. After this exercise the patient rests for 20 s. After each break, the patient decides whether to go on with a heavier weight (men 4.5 kg more, women 2.5 kg more), or to stop. The test is stopped when the cardiac frequency rises above the personal maximum value (maximum cardiac frequency = {220-age}×0.85), when the personal maximum lifting weight is achieved (maximum weight = 0.6×body-mass), when the patient cannot complete the exercise within 20 s, or when the patient wants to stop for any other reason [12]. The highest lifted weight is called the maximum lifted load. This load is compared to the National Institute for Occupational Safety and Health (NIOSH) norm, which is the maximum occupational load people are allowed to lift (14.8 kg) [23].

The loading-degree is then calculated according to the formula:

$$\text{loading-degree} = \frac{\text{maximum lifted load}}{14.8\,\text{kg}}.$$

Twenty-seven patients (82%) carried out the test. Three patients did not participate in the test because their cardiac frequency in rest exceeded 90 beats/min (bpm) or their diastolic blood pressure in rest exceeded 100 mm Hg. Two patients did not participate because of cardiovascular medication usage, one patient did not participate for other reasons.

Ergometry test:

The relative VO_{2max} (maximum oxygen uptake in milliliters/minute kg) was calculated after a sub-maximal bicycle ergometry test (excalibur 600 sport, LODE). The starting load at 60 revolutions per minute is 50% of the lean body mass (LBM) during 2 min. The load is raised to 150, 200 and 250% of the LBM with a 2-min interval until the cardiac rate is 120 bpm or more. When the cardiac rate is 120 bpm, the load is not raised further, and at this load 6 min of exercise follow. The VO_{2max} is then calculated according to the following formula [1]:

$$\text{for men}: \quad VO_{2\,\max} = \frac{(174.2 \times \text{load} + 4,020)}{(103.2 \times \text{cardiac rate} - 6299)},$$

$$\text{for women}: \quad VO_{2\,\max} = \frac{(163.8 \times \text{load} + 3,780)}{(104.4 \times \text{cardiac rate} - 7514)}.$$

Twenty-two patients (67%) did the ergometry test. Five patients did not participate because of the reasons mentioned above (cardiovascular), six patients didn't participate for other reasons.

A more detailed description of the tests used has been published before [10]. Results of both tests were compared to normal values [1, 12].

Restrictions in activities

Restrictions in activities were measured by two disease-specific questionnaires; the Roland Morris Disability Questionnaire (RMDQ) and the Visual Analogue Scale Spine Score (VAS). The Dutch version of both questionnaires was used.

The RMDQ has been used extensively before to measure restrictions in activities due to back pain. The form consists of 24 statements concerning back-related activities, which can be ticked as positive (restricted) or negative (not restricted). Scores can vary from 0 to 24, a lower score indicating less impairment [16–18].

The VAS, developed to be used with spinal fracture patients, asks the patient to rate the functional outcome in 19 items on a 10 cm visual scale. The patient's perception of pain and restriction in activities related to back-problems is measured. Higher scores represent better results, converted to percentages of the maximum score (0–100). In previous studies, it has proved to be a reliable and valid instrument [8, 10, 14].

Restrictions in participation/quality of life

The Dutch version of the RAND 36-item health survey Short Form 36 (SF-36) and the return to work status were used to assess restrictions in participation/quality of life.

The Short Form 36 scale contains nine sub-scales measuring: physical functioning, social functioning, role restriction due to physical problems, role restriction due to emotional problems, mental health, energy and vitality, pain, general perception of health and change in health over the past year. Scores can vary from 0 to 100, higher scores indicate better results [6, 13, 22]. Resulting scores were compared to normal data (healthy subjects, age 18–64 years) [7].

To assess return to work status, patients were asked about employment in the past and at present.

Statistical analysis

Statistical analysis was carried out with SPSS 11.0 (SPSS inc. Chicago, IlL, USA). For the total study group, RMDQ, VAS and SF-36 scores were compared to literature using the Student *t*- test. To compare the braced and the unbraced group, results were tested non-parametrically by means of the Wilcoxon test. Correlation was tested using Pearson's correlation coefficient *r*. A *P* value of 0.05 was considered significant.

Results

Restrictions in body function and structure

Results of the dynamic lifting test and bicycle ergometry test, compared to normal values, are shown in Table 3 (for the total study group, the braced and the unbraced group).

In the total study group, 37% of the patients were not able to perform the dynamic lifting test within normal range. No differences were found between the braced and the unbraced group ($P=0.792$) .

In the ergometry test, 40.9% of the patients in the total study group performed below the lowest normal value, 36.4% of the patients achieved a high VO_{2max}. There was no significant difference between the braced and the unbraced group ($P=0.300$). For both tests, scores are corrected for age and gender.

Restrictions in activities

For the total study group, a mean RMDQ-score of 5.2 was found. The mean VAS-score was 79. No differences in mean RMDQ-score or mean VAS-score between the braced and the unbraced group were found ($P=0.442$ and $P=0.190$, respectively) (Table 4).

Table 4 Restrictions in activities as measured by the RMDQ and VAS for the total study group, the braced and the unbraced group

	Mean	SD	Range
RMDQ			
Total	5.2	5.9	0–17
Braced	4.4	5.5	0–17
Unbraced	6.1	6.4	0–17
VAS			
Total	79	19	36–100
Braced	82	19	39–100
Unbraced	75	19	36–97

Restrictions in participation/quality of life

Table 5 shows results of the SF-36 for the total study group, the braced and the unbraced group. Scores were compared to normal data; no significant differences in any of the sub-scales were found for neither group, or between groups. Correlation between RMDQ-scores, the ergometry test, the dynamic lifting test, VAS-scores, SF-36 physical functioning and SF-36 general health are shown in Table 6.

Before injury, 21 patients had paid work. At follow-up, 22 patients had paid work (three patients were in search of a job before injury, and were in paid work at follow-up). Two patients (10%) had stopped working and received social security benefits, five patients (24%) had arranged changes in the kind of work or in the intensity or duration of their work. Three patients (14%) had changed their job due to back-complaints.

Discussion

This study was developed to gain insight into the functional outcome in patients treated non-operatively for a thoracolumbar spinal fracture. In order to construct "outcome" in a broad manner, we used the concepts as described by the ICF of the World Health Organisation [2, 21]. To obtain subjective and objective data, questionnaires as well as physical tests were used; use of the latter is relatively unique in this field of research.

Table 3 Restrictions in body function and structure as measured by the dynamic lifting test (LD = loading degree) and ergometry test (VO_{2max} in ml/min kg), compared to normal data for the total study group, the braced and the unbraced group

		n	Mean	SD	Range	Under lowest N value (%)	Low VO_{2max} (%)	Medium VO_{2max} (%)	High VO_{2max} (%)
LD	Total	27	1.9	0.8	0.3–2.7	37.0	–	–	–
	Braced	15	1.9	0.9	0.3–2.7	40.0	–	–	–
	Unbraced	12	2.0	0.7	0.9–2.7	33.3	–	–	–
VO_{2max}	Total	22	34	12	16–65	40.9	13.6	9.1	36.4
	Braced	11	36	14	16–65	27.3	18.2	9.1	45.5
	Unbraced	11	32	11	20–59	54.5	9.1	9.1	27.3

Table 5 Restrictions in participation/quality of life as measured by the SF-36 (mean; (SD) range) for the total study group, the braced and the unbraced group

SF-36 sub-scale	Total	Braced	Unbraced
Physical functioning	80; (20) 25–100	84; (18) 50–100	76; (22) 25–100
Social functioning	85; (19) 38–100	83; (20) 38–100	86; (18) 63–100
Phys. role restriction	72; (39) 0–100	68; (39) 0–100	77; (41) 0–100
Emotion. role restr.	81; (32) 0–100	72; (40) 0–100	91; (15) 67–100
Mental health	79; (17) 24–100	75; (20) 24–100	83; (11) 64–100
Energy/vitality	69; (20) 20–100	68; (21) 35–100	71; (20) 20–100
Pain	78; (25) 0–100	82; (21) 22–100	73; (28) 0–100
General health	74; (15) 30–95	79; (9) 65–95	68; (19) 30–90
Change in health	54; (19) 25–100	58; (19) 25–100	48; (16) 25–100

Table 6 Correlation coefficient *r* between RMDQ, ergometry test, dynamic lifting test (dyn. lift test), VAS, SF-36 physical functioning (SF-36 phys.) and SF-36 general health (SF-36 gen.) γ significant at $P < 0.05$

	RMDQ	Ergometry test	Dyn.lift test	VAS	SF-36 phys.	SF-36 gen.
RMDQ	1.00	−0.37	−0.62 γ	−0.85 γ	−0.87 γ	−0.63 γ
Ergometry test	−0.37	1.00	0.38	0.26	0.41	0.33
Dyn. lift test	−0.62 γ	0.38	1.00	0.71 γ	0.59 γ	0.37
VAS	−0.85 γ	0.26	0.71 γ	1.00	0.71 γ	0.52 γ
SF-36 phys.	−0.87 γ	0.41	0.59 γ	0.71 γ	1.00	0.65 γ
SF-36 gen.	−0.63 γ	0.33	0.37	0.52 γ	0.65 γ	1.00

Restrictions in body function and structure

Results of the dynamic lifting test show that 37% of the patients were not able to perform this test within normal values, indicating that these patients have a lower physical capacity than healthy people. Almost equal results were found in the bicycle ergometry test, in which 41% of the patients achieved scores under the lowest normal value. Surprisingly, nearly the same proportion of patients achieved a high VO_{2max} (within a normal distribution). Although examination took place approximately 5 years after injury, and no further neurological deficit occurred, this still means that a large part of the study population is impaired in the light of restriction in body function and structure. No difference was found between the braced patients and the unbraced patients.

To our best knowledge, no other publication is available concerning VO_{2max} in non-operatively treated spinal fracture patients, which makes comparison to other series a delicate issue. Pulmonary function was studied by Schlaich et al. [19] in patients with an osteoporotic spinal wedge fracture. They found that the vital capacity (VC) and forced expiratory volume in 1 s (FEV_1), corrected for age and gender, were lower than in healthy subjects. According to the authors, this might be a result of spinal deformity (hyperkyphosis) which leads to disturbed mechanical function. Why so many patients in our series perform under normal values is unknown. It might be that pain leads to fewer leisure-activities, resulting in decreased functional capacity. However, this cannot be the only explanation, since remaining pain is not severe, considering the VAS, RMDQ and SF-36 scores found. Another possible explanation might be found in cognitive factors; as mentioned by Cox et al. [5] fear of refracture may lead to a less functional use of the back, which may result in a lower level of activity.

Restrictions in activities

Concerning restrictions in activities, a mean RMDQ-score of 5.2 was found and a mean VAS-score of 79. These findings indicate that patients are impaired and restricted in activities, but not in a severe manner. It should be kept in mind though, that only patients without neurological deficit were included. As in the physical tests, no difference was found between braced and unbraced patients, so it seems that brace-usage does not influence impairment in the long term. Weinstein et al. [24] reported a RMDQ-score of 13.2, measured 20 years after non-operative treatment for a thoracolumbar burst fracture. Comparison makes our results seem favourable. However, 22% of the patients had some neurological deficit in the afore-mentioned study. In a recent study, RMDQ- and VAS-scores in non-operatively treated patients were found to be 4.4 and 72.6 respectively [14]. These findings are comparable to our results. A RMDQ-score of 3.9 was reported recently in patients 3.7 years after non-operative treatment of a spinal fracture [25]. Knop et al. found a VAS-score of 66 for patients treated operatively for a spinal fracture at a follow-up of 23 months [8]. Our results seem better, though our longer follow-up time and the different treatment strategies do not make a comparison completely valid.

Restrictions in participation/quality of life

No significant differences between our population and healthy subjects were found concerning SF-36 scores, neither were significant differences found between braced and unbraced patients. Our results are more favourable than those reported by Kraemer et al. [9] in 1996. Comparing our study to Kraemer's paper, we cannot find an explanation for the higher scores found in our series.

Correlation coefficients of the different outcome measures were in some cases significant and fairly strong. Surprisingly, the ergometry test did not correlate with any of the other measures. The correlation coefficient of the RMDQ and dynamic lifting test was negative, indicating the lower the RMDQ (less impairment), the more weight was lifted. The same relationship was found between the VAS and SF-36 physical functioning on the one hand, and dynamic lifting test on the other: the higher VAS and SF-36 scores (fewer restrictions in activity), the more weight was lifted.

Only 10% of patients had stopped working due to back-problems associated with their spinal fracture. In a social security system like in the Netherlands, where patients receive substantial benefits in case of illness or disablement, a drop-out of 10% seems a good result. Thirty-nine per cent of the patients had changed their job or changed the intensity or duration of their work. These data might be influenced by the fact that respondents were quite old (mean age 50 years). In a study by Shen et al. [20] concerning patients treated non-operatively for a thoracolumbar burst fracture, 76% of the patients returned to their original employment and 8% stopped working. These results are comparable to ours. In a study by Reid et al. [15] (describing patients treated non-operatively for a thoracolumbar burst fracture without neurological deficit), 19% was unable to return to work. Two other studies (both concerning non-operatively treated thoracolumbar burst fractures without neurological deficit) show comparable return to work status: 95% and 87%, respectively [3, 4].

There are some limitations in this study. The low response rate may have biased our results despite the fact that no differences were found in gender, follow-up, comorbidity or fracture severity between respondents and non-respondents. Respondents were 11 years older than non-respondents. The difference in age does not seem to affect the physical capacity tests since results and normal values were corrected for age. In contrast, it might be that the return to work status would have been even better if younger patients had taken part in the study.

Another limitation of the study is the fact that we cannot prove that braced or unbraced patients have comparable outcomes. Our results show a trend that there are no differences in functional outcome between braced and unbraced patients. However, to answer this question properly, this issue should preferably be investigated in a randomized clinical trial.

Conclusions

Functional outcome in patients 5 years after non-operative treatment for a type A thoracolumbar fracture seems reasonably good, though diverse in the light of the ICF. In physical capacity tests a large part of patients seems restricted. On the other hand, patients are only mildly restricted in activities. No restriction is present concerning participation or the quality of life. Why patients perform less well than healthy people in physical tests remains unknown and should be studied in further research.

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