SPINE Volume 28, Number 22, pp 2491–2498

Active Intervention in Patients with Whiplash-Associated Disorders Improves Long-Term Prognosis

A Randomized Controlled Clinical Trial

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Study Design. Three-year follow-up of a prospective randomized trial in 97 patients exposed to whiplash trauma in motor vehicle collisions.

Objectives. To compare the long-term efficacy of active intervention with that of standard intervention and the effect of early *versus* delayed initiation of intervention.

Summary of Background Data. There is no strong evidence for many treatments for whiplash-associated disorders. Some studies provide weak evidence supporting active intervention.

Method. Patients were randomized to an intervention using frequent active cervical rotation complemented by assessment and treatment according to McKenzie's principles or to a standard intervention of initial rest, recommended soft collar, and gradual self-mobilization. To test the time factor, interventions were either made within 96 hours or delayed 14 days from collision. The effects of the two interventions and the time factor on pain intensity, cervical range of motion, and sick leave were analyzed at 6 months and 3 years. Cervical range of motion at 3 years was also compared with that in matched, unexposed individuals.

Results. Pain intensity and sick leave were significantly ($P < 0.05$) reduced if patients received active intervention compared with standard intervention. Delaying intervention 2 weeks did not affect outcome variables. However, at 3 years, only patients receiving early active intervention had a total cervical range of motion similar to that of matched unexposed individuals.

Conclusion. In patients with whiplash-associated disorders, active intervention is more effective in reducing pain intensity and sick leave, and in retaining/regaining total range of motion than a standard intervention. Active intervention can be carried out as home exercises initiated and supported by appropriately trained health professionals. [Key words: whiplash injuries treatment pain intensity range of motion sick leave] **Spine 2003;28; 2491–2498**

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Supported by the local research committee in southern Elfsborg County, the Swedish National Health Insurance, and the Vårdal Foundation.

Acknowledgment date: July 18, 2002. First revision date: February 4, 2003. Acceptance date: March 17, 2003.

The manuscript submitted does not contain information about medical device(s)/drug(s).

Institutional and Foundation funds were received to support this work. No benefits in any form have been or will be received from a commercial party related directly or indirectly to the subject of this manuscript.

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Swedish data indicate an increase in the number of whiplash injuries from motor vehicle collisions during the last decade.[1] Whiplash-associated disorders (WAD) remain one of the most troublesome consequences related to the use of the Swedish, and the world's, road network and account for a large proportion of medical disabilities.[1] Frequent clinical manifestations of WAD are neck pain, headache, shoulder pain, cognitive disturbances, and other psychological symptoms.[2,3] A recent study assessing the long-term effects of WAD resulting from a motor vehicle collision showed that 55% of the participants had residual sequelae 17 years later.[4]

Increasing knowledge of the injury mechanism will, it is hoped, lead to a decrease in new injuries, primarily through innovations in vehicle construction. Nonetheless, WAD will continue to occur until these preventive innovations have been completely implemented.

Consequent review of the studies concerning treatment of WAD has shown the majority to be of poor quality, making treatment recommendations difficult.[5] Studies concerning the negative prognosis of WAD associated with certain risk factors, should, however, enable the recognition and treatment of patients considerably earlier than in the past.[6–8] For patients with WAD, there is some evidence for greater short-term efficacy when active intervention is undertaken than with a standard intervention of initial rest, recommended use of a soft collar, and gradual self-mobilization.[9–12] Despite these studies, standard intervention was recommended to patients in Sweden during the 1990s.[13,14]

The aim of this study was to evaluate the long-term efficacy of active compared with standard intervention for patients with WAD and to investigate the importance of early *versus* delayed initiation of intervention.

Materials and Methods

From March 1995 to March 1996, consecutive patients exposed to whiplash trauma in motor vehicle collisions who sought health care were asked to participate in the study. The patients were referred to the study from the southern half of Elfsborg County in the southwestern part of Sweden—a mixture of urban, village, and rural populations. The study was single-blinded. Different personnel performed randomization, measurement, and intervention. The personnel who performed the measurements were unaware of intervention assignment, and those who randomized the patients were unaware of the outcome of initial measurements. The Ethics Committee of Göteborg University approved the study.

Selection of Patients. Physicians in 29 primary care units, three emergency wards, and several private clinics selected patients consecutively. The criteria for inclusion were exposure to whiplash trauma caused by rapid movements of the head resulting from acceleration forces in any vector produced in a motor vehicle collision. Cervical spine radiography was performed on all patients. Patients with cervical fractures or dislocations (WAD 4), neurologic deficit (WAD 3), head injury, previously known symptomatic chronic neck problems, alcohol abuse, dementia, serious mental diseases, or diseases that could be expected to lead to death before the study's completion were not included. Patients who could be randomized within 96 hours after collision were referred to the study.

Randomization of Patients. After initial measurements, patients were randomized to one of four intervention groups: active intervention initiated within 96 hours after collision (Group 1), standard intervention initiated within 96 hours (Group 2), active intervention initiated with a delay of 14 days after collision (Group 3), and standard intervention initiated with a delay of 14 days (Group 4). Sequentially numbered, opaque, sealed envelopes were used to conceal study group assignments. Patients in intervention Groups 3 and 4 received no intervention known to this study during the delay period of 14 days, apart from any instructions given by the physicians who initially referred them to the study.

Measurements. The patients were assessed at 6 months and 3 years for intensity of combined head, neck, or shoulder pain at the time of examination ("your pain now") with a Visual Analogue Scale (VAS).[15,16]

Cervical range of motion (CROM) was assessed by a medical laboratory technologist, registered nurse, or physiotherapist. A cervical measurement system (CMS, Kuntoväline Oy, Oltermanninlie 00620, Helsinki, Finland) was used to measure lateral flexion, extension/flexion, and rotation. The CMS uses an inclinometer to measure CROM in the sagittal and frontal planes, and a compass to measure cervical rotation.[17] At the follow-up visits, patients were asked to report the extent of sick leave due to WAD during the previous half year.[18] Furthermore, at the 6-month follow-up visit, patients were asked whether they had received additional interventions from sources outside the control of this study. The personnel who carried out the measurements and interviewed the patients were unaware of the patients' intervention group assignments.

Active Intervention. The active intervention is an active exercise protocol incorporating the idea of early and repeated movement based on Salter's work on continuous passive motion[19] and components consistent with McKenzie principles.[20] The active intervention consisted of two phases: (1) an initial phase given to all patients including information, postural control, and cervical rotation exercises; and (2) a second phase, if symptoms were unresolved, of evaluation and treatment according to McKenzie principles.[20] The same physiotherapist (M.R.) treated all patients receiving the active intervention, ensuring strict adherence to the protocol with no additional interventions. Treatment by the physiotherapist was terminated 6 weeks after the initiation of active intervention or earlier if symptoms resolved.

In the initial phase, guidelines were provided to encourage safe exercise at home while patients were taught to identify and heed signs (new or increased symptoms) that might aggravate the condition. Patients were instructed to perform gentle, active cervical rotational movements from the neutral position, 10 times in one direction and 10 times in the opposite direction. Movements were performed to maximum comfortable range every waking hour. Patients were instructed to perform exercises in the sitting position if tolerated. The unloaded, supine position was recommended if the sitting position proved too painful. If rotation exercises were not tolerated, intervention was not discontinued but adjusted by either reducing the amplitude of the movements, reducing the number of movements, or both.

If symptoms persisted 20 days after the motor vehicle collision, the patients were then reexamined using a dynamic mechanical evaluation according to the McKenzie system. The McKenzie system classifies spinal-related disorders on the basis of the mechanical (such as CROM) and symptomatic (such as pain) responses to repeated movements, positions, and activities derived from the history and assessment.[20] Treatment is predicated on these responses and emphasizes self-care. The program consisted of movements such as cervical retraction, extension, flexion, rotation, or lateral flexion, depending on which were beneficial and safe during the assessment.

Standard Intervention. Standard intervention consisted of written information on injury mechanisms, advice on suitable activities, and postural correction. This leaflet was used by the Neck Injury Unit, Orthopedic Clinic, Sahlgrenska University Hospital, Göteborg, Sweden. The advice provided in this leaflet was to rest the neck during the first weeks after trauma and that a soft collar could provide comfort as well as prevent the neck from excessive movements. However, no data were collected on the use of a collar. Furthermore, patients were instructed to perform active movements two or three times daily "a few weeks" after trauma. The recommended movements were elevation of shoulders, retraction of shoulder blades, rotation of torso, lateral flexion of the head, rotation of the head, and combined flexion-rotation of the head.

Unexposed Individuals. At the 3-year follow-up visit, all remaining patients were individually matched by gender and age with individuals unexposed to collision and without neck pain. Unexposed persons were students, teachers, office workers, and personnel working in health care. Inclusion criteria were absence of current neck pain, pain medication, major illnesses, history of neck operation, previous chiropractic or physical therapy to the neck, history of neck trauma requiring medical care, nervous tics, shoulder pain, and known cervical spondylosis or osteoporosis. No pregnant women were recruited. Informed consent was obtained from all individuals. The difference in cervical range of motion between patients and matched unexposed individuals was calculated.

Statistical Analysis. Analysis was by intention to treat. Differences in initial measurements between the four groups (Table 1) were analyzed with one-way analysis of variance (ANOVA) for continuous variables with equal variances between groups. Kruskal-Wallis one-way analysis of variance was used for continuous variables with statistically significant differences in variance between groups and for variables measured with an ordinal scale such as the VAS. Differences in variance between groups were tested using Bartlett's test for

Table 1. Baseline Values for Patients Analyzed at 6 Months

	Group 1	Group 2	Group 3	Group 4
Intervention	Active	Standard	Active	Standard
Intervention initiated	< 96 hours	< 96 hours	> 2 weeks	> 2 weeks
Number	21	23	22	22
Mean age-years (SD)	39 (16)	33 (11)	32 (12)	38 (14)
Sex (male/female)	8/13	8/15	8/14	5/17
Initial pain intensity*	37 (24,64)	30 (12,55)	35 (16,52)	39 (19,52)
	43 (24.4)	34 (23.8)	40 (25.8)	42 (29.1)
No initial pain†	1	2	0	1
Low initial pain‡	1	5	0	4
High initial pain§	0	0	1	2
Flexion‖	40.4 (17)	44.5 (14)	49.8 (13)	41.3 (17)
Extension¶	50.0 (17)	51.4 (16)	49.1 (16)	48.1 (18)
Flex. + Ext.**	90.4 (30)	95.9 (24)	98.9 (23)	89.4 (32)
Total Lat. Flex.††	65.2 (22)	66.2 (14)	64.2 (11)	53.7 (17)
Total Rotation‡‡	114 (38)	119 (21)	121 (24)	101 (31)
Total CROM§§	270 (81)	282 (50)	285 (49)	244 (75)

* Visual Analogue Scale (VAS) indicating levels of pain intensity. Length 0– 100 mm. Higher values indicate higher pain intensity. First line is median change in VAS (25th and 75th percentile). Second line is mean change (SD).
† Number of patients reporting 0 in VAS.
‡ Number of patients reporting 0–10 in VAS.
§ Number of patients reporting ≥90 in VAS.
†† Lateral flexion in the cervical spine. Mean values (SD).
‖ Flexion in the cervical spine. Mean values (SD).
¶ Extension in the cervical spine. Mean values (SD).
** Extension + Flexion in the cervical spine. Mean values (SD).
‡‡ Rotation in the cervical spine. Mean values (SD).
§§ Total cervical range of motion (CROM) in the cervical spine. Lateral flexion, extension/flexion, and rotation were combined. Mean values (SD).

homogeneity of variance. The chi-square test was used for dichotomous variables such as gender.

At the 6-month (Table 2) and 3-year (Table 3) follow-up visits, changes over time in CROM and the extent of reported sick leave during the previous half year were analyzed with a two-way ANOVA (Table 4). Friedmann's test was used for skewed data (Table 4). Change in pain intensity (VAS) was calculated by the raw differences between baseline and follow-up measurements. Furthermore, raw differences were transformed to "improvement," "worsening," or "unchanged" and given the values +1, -1, and 0, respectively. For changes in pain intensity, ANOVA and Friedmann's test were applied to raw differences (Table 4). Friedmann's test was also used to analyze transformed differences (Table 4).

Comparison in CROM between patients and unexposed individuals was made by Student's *t* test one sample (Table 5). To evaluate the effect of different interventions in restoring CROM compared with the unexposed individuals, two-way ANOVA was used (Table 6).

All *P* values less than 0.05 were considered statistically significant. The computer program Epi Info version 6.04c (CDC, Atlanta, Georgia, USA) was used for one-way ANOVA, Kruskal-Wallis one-way analysis of variance, Bartlett's test for homogeneity of variance, chi-square test, and Student's *t* test. The computer program SAS version 8 (SAS Institute Inc., Cary, NC, USA) was used for two-way ANOVA and Friedmann's test.

■ Results

Of 102 consecutive patients randomized, 5 patients were excluded when it was discovered that they did not fulfill the inclusion criteria (Figure 1). Of those patients, 2 had chronic neck pain and 3 had injury mechanisms other than motor vehicle collisions. Of the remaining 97 correctly included, 88 (91%) could be followed up at 6 months. Seventy-three (75%) participated in the 3-year follow-up visit. Dropouts are shown in Figure 1.

Baseline Differences

The small differences between the four groups in age, sex, initial pain intensity, lateral flexion, flexion, extension, flexion plus extension, rotation, or total CROM were not statistically significant (Table 1).

Treatment Sessions

Of the patients receiving active intervention, 2 received one instruction/treatment session, 13 received two sessions, and 10 received three sessions. The remaining patients received more than three sessions. The mean number of instruction/treatment sessions in the active intervention groups was 3.95. Symptoms persisting more than 20 days were seen in 63% (27/43) of patients in the active intervention group. They were reexamined and treated as described previously.

The numbers of patients receiving interventions from sources outside the control of this study did not differ statistically between the groups (Table 2).

Active versus *Standard Intervention*

Evaluation of the two interventions showed a reduction in pain intensity after 6 months (Table 2) and 3 years (Table 3) in all patients. However, the reduction of pain intensity was greater and the need for sick leave was lower for patients receiving active intervention than in those receiving the standard intervention (Table 4).

The short-term effect of active intervention on CROM was not significant (Tables 2 and 4). However, the 3-year follow-up visit showed a trend ($P = 0.06–0.08$) favoring

Table 2. 6-Month Follow-Up in Patients Exposed to Whiplash Trauma

	Group 1	Group 2	Group 3	Group 4
Intervention	Active	Standard	Active	Standard
Intervention initiated	< 96 hours	< 96 hours	> 2 weeks	> 2 weeks
Number	21	23	22	22
Mean days to follow-up (SD)	213 (41)	244 (100)	219 (48)	256 (77)
Change in pain intensity*	−27 (−14,−46) −29.6 (24)	−6 (+24,−16) +0.74 (30)	−11 (−5,−27) −15 (19)	−8.5 (−2,−13) −7.1 (22)
No pain at follow-up†	38% (8/21)	17% (4/23)	23% (5/22)	5% (1/22)
Low pain at follow-up‡	52% (11/21)	30% (7/23)	36% (8/22)	9% (2/22)
Sick leave days for all patients§	15.1 (42)	10.3 (22)	11.5 (38)	28.9 (51)
Sick leave days for patients 20–65 years§	17.7 (46)	10.7 (23)	13.8 (42)	31.8 (52)
Sick leave ≥30 days for all patients‖	2/21	3/23	1/22	6/22
Sick leave ≥30 days for patients 20–65 years‖	2/18	3/22	1/18	6/20
Change in flexion¶	+9.8 (18)	−1.1 (16)	+0.3 (17)	+8.0 (18)
Change in extension**	+8.4 (15)	+7.1 (14)	+8.2 (15)	+3.7 (16)
Change in flexion + Extension††	+18.2 (27)	+6.0 (22)	+8.5 (23)	+11.7 (28)
Change in total lateral Flexion‡‡	+10.1 (18)	+4.7 (16)	+7.3 (12)	+10.1 (18)
Change in total rotation§§	+23.6 (37)	+14.4 (37)	+7.5 (21)	+22.8 (25)
Change in total CROM‖‖	+51.9 (70)	+25.2 (62)	+23.3 (47)	+44.6 (59)
Received interventions from sources outside the control of this study¶¶	3/21	9/23	5/22	9/21

* First line is median change in Visual Analogue Scale (VAS) (25th and 75th percentile). Second line is mean change (SD). Negative values indicate a decrease in pain level.
† Proportion of patients reporting 0 in VAS.
‡ Proportion of patients reporting ≤10 in VAS (including those reporting 0).
§ Sick leave during the preceding 6 months as estimated by the patient. Mean number of working days (SD).
‖ Number of patients reporting sick leave ≥30 days during the preceding 6 months due to whiplash injury. (due to whiplash injury/no. of patients with sufficient data)
¶ Mean change (SD) in flexion in the cervical spine. Positive values indicate increased range of motion.
** Mean change (SD) in extension in the cervical spine. Positive values indicate increased range of motion.
†† Mean change (SD) in flexion + extension in the cervical spine. Positive values indicate increased range of motion.
‡‡ Mean change (SD) in lateral flexion in the cervical spine. Positive values indicate increased range of motion.
§§ Mean change (SD) in rotation in the cervical spine. Positive values indicate increased range of motion.
‖‖ Mean change (SD) in total cervical range of motion (CROM). Positive values indicate increased range of motion.
¶¶ Number of patients who received interventions from sources outside the control of this study. Data are missing from one patient in group 4.

Table 3. 3-Year Follow-Up in Patients Exposed to Whiplash Trauma

	Group 1	Group 2	Group 3	Group 4
Intervention	Active	Standard	Active	Standard
Intervention initiated	<96 hours	<96 hours	>2 weeks	>2 weeks
Number	18	21	18	16
Mean days to follow-up (SD)	1213 (110)	1240 (121)	1227 (129)	1234 (126)
Change in pain intensity*	−17 (−2,−28) −21 (27.6)	−5(+18,−23) −1.8 (29.7)	−15.5 (−8,−28) −15.8 (22.4)	−10 (+11,−20) −5.2 (27.3)
No pain at follow-up†	33% (6/18)	33% (7/21)	44% (8/18)	31% (5/16)
Low pain at follow-up‡	39% (7/18)	43% (9/21)	61% (11/18)	31% (5/16)
Sick leave days for all patients§	11.2 (44)	40.2 (71)	10.0 (42)	20.5 (50)
Sick leave days for patients 20–65 years§	13.6 (48)	42.2 (72)	12.9 (48)	21.9 (52)
Sick leave ≥30 days for all patients‖	1/17	6/21	1/18	3/15
Sick leave ≥30 days for patients 20–65 years‖	1/14	6/20	1/14	3/14
Change in flexion¶	+17.7 (18)	+6.2 (19)	+3.8 (21)	+5.9 (15)
Change in extension**	+8.9 (15)	+1.4 (15)	+6.9 (16)	+3.8 (15)
Change in flexion + extension††	+26.7 (27)	+7.6 (27)	+10.7 (30)	+9.7 (22)
Change in total lateral flexion‡‡	+8.8 (19)	−3.2 (18)	+4.2 (15)	+3.9 (13)
Change in total rotation§§	+25.6 (34)	+11.8 (32)	+10.7 (22)	+9.8 (17)
Change in total CROM‖‖	+61.1 (61)	+16.2 (67)	+25.6 (60)	+23.4 (43)
Received interventions from sources outside the control of this study¶¶	(Not asked for at 3-year follow-up)			

* First line is median change in Visual Analogue Scale (VAS) (25th and 75th percentile). Second line is mean change (SD). Negative values indicate a decrease in pain level.
† Proportion of patients reporting 0 in VAS.
‡ Proportion of patients reporting ≤10 in VAS (including those reporting 0).
§ Sick leave during the preceding 6 months as estimated by the patient. Mean number of working days (SD).
‖ Number of patients reporting sick leave ≥30 days during the preceding 6 months due to whiplash injury. (due to whiplash injury/no. of patients with sufficient data)
¶ Mean change (SD) in flexion in the cervical spine. Positive values indicate increased range of motion.
** Mean change (SD) in extension in the cervical spine. Positive values indicate increased range of motion.
†† Mean change (SD) in flexion + extension in the cervical spine. Positive values indicate increased range of motion.
‡‡ Mean change (SD) in lateral flexion in the cervical spine. Positive values indicate increased range of motion.
§§ Mean change (SD) in rotation in the cervical spine. Positive values indicate increased range of motion.
‖‖ Mean change (SD) in total cervical range of motion (CROM). Positive values indicate increased range of motion.
¶¶ Number of patients who received additional treatments from sources outside the control of this study.

Table 4. Differences in Outcome (*P* -values) Active Versus Standard Intervention

	6-Month Follow-Up		3-Year Follow-Up	
	ANOVA*	Friedmann†	ANOVA	Friedmann
Change in pain intensity‡	0.0004	0.0009 (0.019)	0.020	0.026 (0.028)
Sick leave days for all patients§	—	NS‖	—	0.030
Sick leave days for patients 20–65 years§	—	NS	—	NS (0.063)
Change in flexion¶	NS	NS	NS	NS
Change in extension**	NS	NS	NS	NS
Change in flexion + extension††	NS	NS	NS	NS (0.081)
Change in total lateral flexion‡‡	NS	NS	NS	NS
Change in total rotation§§	NS	NS	NS	NS
Change in total CROM¶¶	NS	NS	NS (0.092)	NS (0.062)

ANOVA, analysis of variance.
* In case of skewed data, the nonparametric test described by Friedmann was used.
† Friedmann's test is usually performed on raw data. In a visual analogue scale (VAS) it may also be performed on transformed data where improvement is coded as +1, worsening as −1, and unchanged as 0. The outcome of Friedmann's test used on transformed data is given within parentheses.
‡ Mean change in VAS.
§ Mean number of days on sick leave during the preceding 6 months as estimated by the patient.
‖ NS = Nonsignificant ($P > 0.05$). P values 0.05–0.1 presented in parentheses.
¶ Mean change in flexion in the cervical spine.
** Mean change in extension in the cervical spine.
†† Mean change in flexion + extension in the cervical spine.
‡‡ Mean change in lateral flexion in the cervical spine.
§§ Mean change in rotation in the cervical spine.
¶¶ Mean change in total total cervical range of motion (CROM).

active intervention over standard intervention (Tables 3 and 4). Patients receiving an early active intervention (Group 1) had a total CROM similar to unexposed individuals at the 3-year follow-up visit (Table 5). All other groups (Groups 2–4) had decreased CROM compared with matched unexposed individuals (Table 5). Active intervention significantly increased the chances for regaining/retaining CROM as measured by comparing patients with unexposed healthy individuals (Table 6).

The Importance of the Time Factor

The time factor, defined as initiating intervention immediately or with a delay of 14 days, did not by itself affect the outcome at either the 6-month or the 3-year follow-up visit.

Combining the intervention and the time factor in a two-way factorial design showed, at 6 months, an interaction between type of intervention and timing on the reduction of pain intensity ($P = 0.04$) and on the improvement of cervical flexion ($P = 0.01$). When active intervention was applied, it was better to receive it early. If standard intervention was given, it was better to receive it late. No interaction effect was found at the 3-year follow-up visit.

Comparison of the patients with individually matched unexposed control subjects showed a combined effect of timing and intervention on retaining/regaining CROM at the 3-year follow-up visit (Table 6). CROM was greater retained/regained when active intervention was received early and when standard intervention was received late.

No Initial Pain

Four of 97 patients (4.1%, 95% confidence interval 0.15–8.0%) had no initial pain (WAD 0, VAS 0 mm of maximum 100 mm). One patient in Group 1 had no pain at 6 months or at 3 years. The other 3 patients in Groups 2 and 4 had pain at 6 months (8–64/100), and 2 of them had pain at 3 years (50–51/100).

Table 5. Mean Differences in Cervical Range of Motion Between Patients and Unexposed Individuals

	Group 1			Group 2			Group 3			Group 4		
	M*	SD†	*P*‡	M	SD	*P*	M	SD	*P*	M	SD	*P*
Flexion	−3.3	15.4	NS§	−12.7	24.4	0.027	−10.0	14.4	0.009	−6.9	17.9	NS
Extension	−7.2	13.6	0.038	−20.8	20.5	0.0002	−10.8	22.7	NS	−6.3	20.0	NS
Flexion + extension	−10.6	25.4	NS	−33.5	38.6	0.0007	−20.8	33.1	0.016	−13.1	33.4	NS
Total lateral flexion	+13.6	26.7	0.045	−12.7	26.5	0.040	−1.4	18.3	NS	−7.3	17.8	NS
Total rotation	+4.6	20.9	NS	−17.1	34.6	0.034	−6.7	31.4	NS	−21.2	27.6	0.008
Total cervical range of motion	+7.7	60.6	NS	−18.1	44.3	NS	+0.4	31.0	NS	−24.2	56.1	NS

* Mean value of all differences; negative values indicate that patients had lower cervical range of motion than the unexposed individuals.
† Standard deviation.
‡ *P* -value obtained by Student's one way *t* -test.
§ No significance.

Table 6. Effect of Intervention and Time Factor, and Their combined Effect (*P*- Values) on Retaining/Regaining Cervical Range of Motion (CROM) When Comparing Patients at 3-Year Follow-Up with Unexposed Individuals

	Intervention*	Time†	Interaction‡
Flexion	NS§	NS	NS
Extension	NS	NS	NS (0,053)
Flexion + extension	NS	NS	NS (0.054)
Total lateral flexion	0.0042	NS	NS (0.063)
Total rotation	0.011	NS	NS
Total CROM	0.032	NS	NS

* Intervention = active intervention versus standard intervention.
† Time = <94 hours versus >2 weeks.
‡ Interaction = interaction between intervention and time.
§ NS = nonsignificant (P > 0.05). P -values 0.05–0.1 presented in parentheses.

■ Discussion

The main finding in this study was that active intervention in patients with WAD resulted in a significantly greater reduction in pain intensity, a greater chance to retain or regain CROM, and reduced sick leave compared with a standard intervention. These findings could have implications for the management of patients with WAD.

Methodologic Aspects

It was estimated that the majority of patients exposed to whiplash trauma in this area who fulfilled the inclusion criteria were included.[9] It is highly unlikely that patients randomized to standard intervention also received treatment outside the control of this study similar to the active intervention.[9]

The past decade has seen a tendency from parametric to nonparametric statistical methods in the analysis of VAS. However, opinions differ on comparing changes in VAS over time between groups. Some accept nonparametric methods applied to raw differences. Others state that common mathematical operations such as addition and subtraction are not defined in ordinal scales. Thus, raw changes in VAS were also transformed to −1, 0, or +1 as described previously. There is no international consensus in this matter; therefore, changes in VAS are analyzed using the parametric ANOVA and the nonparametric Friedmann's test applied to both raw and transformed differences, although the authors prefer the latter. When changes in VAS are compared, the results from all three statistical methods favor active intervention (Table 4).

The two-factor design not only divided patients into groups but also calculated *P* values using a two-way ANOVA or Friedmann's test. In these statistical tests, all four groups were used simultaneously in the calculation of any *P* value. Thus, the number used to calculate the *P* values in Table 4 were not 16 *versus* 21, or 18 *versus* 18, but simply 73. The two-factor design reduces the large numbers of patients required when several one-factor trials are used.

Evaluating the improvement of CROM in patients exposed to a whiplash trauma tells us whether the pa-

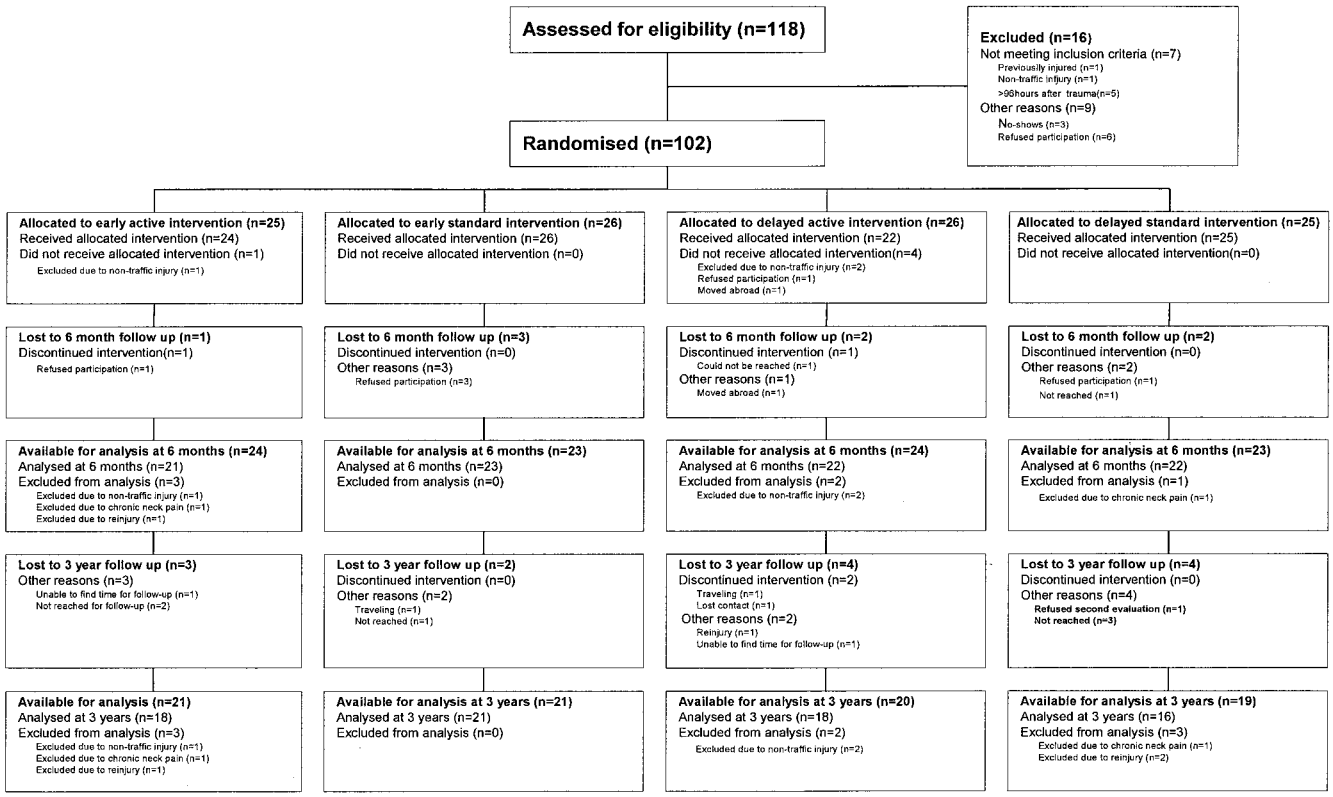

Figure 1. Participants' flow chart.

tient is better, but a group of unexposed individuals also tells us whether the patient is well. A group of unexposed individuals is the only way to estimate pre-injury CROM in injured patients. This comparison has a clinical value and was the motivation for introducing unexposed individuals at the 3-year follow-up visit.

Information to patients before inclusion was not controlled. If some patients randomized to standard intervention before inclusion had been given advice similar to that given in active intervention, it would have reduced our significant findings. This implies that differences between interventions might be even greater than those found in our study.

Exposure to Whiplash Trauma and No Initial Pain

A person exposed to a whiplash trauma who does not initially report symptoms may still bear a minor whiplash injury that might express symptoms later. At present, it is impossible to confirm or rule out an association between the trauma and delayed manifestations of WAD. Thus, we have chosen to include all patients exposed to a whiplash trauma (caused in a motor vehicle collision) attending the health care system. In our study, four patients were initially WAD 0, and three of them later experienced manifestations. Interestingly, the only person not experiencing delayed manifestations belonged to the group receiving early active intervention; the three others received the standard intervention.

Possible Mechanisms of Active Intervention

The most important elements of the active intervention were the high frequency and intensity of self-mobilization and the use of the McKenzie protocol for patients with unresolved symptoms. In short, the standard intervention emphasizes caution, whereas the active intervention encourages active movement.

To what extent chronic whiplash syndrome is functional (chronic illness behavior) or organic (persistent tissue injury) is unresolved. It was recently proposed in a clinical practice guideline that psychosocial factors may be present in delayed recovery.[21]

Because pain lacks an external convention of reference, it allows considerable room for interpretation, and thus the importance of cognitive processes in the pain experience is great.[22] When a patient is left unsupervised, an exaggerated negative response to pain may develop. The resulting pain-related fear is a strong factor in the development of illness behavior.[22–24] Prescribing immediate exercise within comfort limits may alleviate the fear of serious injury.[25,26] Continued supervision during the first weeks would provide ongoing reassurance of a satisfactory outcome, thus promoting wellness behavior. This interaction with a therapist who prescribed activity was unavailable in the standard intervention.

The organic aspect of WAD is dealt with by using rotational exercises in the acute stage and repeated movements or positions based on the McKenzie evaluation in the subacute stage. Movement encourages regional blood flow and facilitates the removal of exudate, thus allowing healing to occur by aiding nutrition of joint structures.[27,28]

It should be pointed out that neither fear avoidance behavior nor regional blood flow was measured in this study.

Why Cervical Rotation?

Studies indicate that upper limb pain and paresthesia in patients with WAD may arise from hyperalgesic cervical or brachial plexus nervous tissue.[29,30] Cervical spine rotation addresses this involvement by mobilizing the nerve structures on the contralateral side, thus preventing scar tissue from forming adhesions that will later cause dysfunction. Rotation avoids the longitudinal stress on the neural axis caused by flexion and lateral flexion.[31] Mobilization may also affect the possible inhibition of intraneural microvascular blood flow caused by compression.[32]

■ Conclusions

The active intervention addresses both the organic and the functional aspects of WAD, reducing cervical pain and the need for sick leave and restoring impaired CROM.

The main clinical implication is that patients with acute WAD 0, 1, or 2 should be instructed in self-mobilization as soon as possible. The emphasis should be on frequently repeated cervical rotation. Instructions should be repeated until comprehension and compliance is ensured. If symptoms persist more than 20 days after trauma, patients should be referred to a health professional educated in mechanical diagnosis and therapy according to the McKenzie system. These results may not apply to patients with WAD 3 and 4.

■ Key Points

- In a randomized controlled study, active intervention after a whiplash injury decreased neck pain and sick leave more than a standard intervention. Furthermore, early active intervention retained/regained cervical range of motion.
- The active intervention consisted of frequently repeated active cervical rotation followed, if needed, by assessment and intervention according to the McKenzie protocol.
- An average of four treatment sessions were needed with the active intervention.

Acknowledgments

The authors thank the staff at Sandared Primary Health Care Center for assessing and randomizing all patients; Måns Andréasson, RPT, Gothenburg, Sweden, for recruiting and measuring unexposed control subjects; and Joel A. Harrison, PhD, San Diego, California, USA, for valuable advice with the manuscript. They also thank the primary care units, emergency wards, and private clinics for referring patients.

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