

Long term Cervical Spine Distorsion (CSD) injuries after Rear End Car to Car collisions

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ABSTRACT

In this case-control study technical and medical circumstances of CSD Injury after rear-end car crashes are compared between patients showing different time spans to recover.

Drivers with CSD injuries are divided to patients showing symptoms for more than 6 weeks and up to 6 months (80 controls) and chronic patients suffering for more than 6 months (22 cases). Statistical Analysis is performed by applying Chi-Square and Mann-Whitney U-Test, documented are Odds Ratios with 95% Confidence-Intervals and p-values.

In general chronic CSD patients had been involved in biomechanically more complex Rear End accident situations, but significant higher frequencies are found for the factors low head-restraint positioning and psychological factors associated with the time to recover.

Keywords: WHIPLASH, ACCIDENT ANALYSIS, EPIDEMIOLOGY

AS CERVICAL SPINE DISTORTION INJURY is of significant importance among light casualties in traffic crashes that lead to high socio-economic costs (Holm, 1999, Versteegen 1998) circumstances for occurrence had been investigated for a long time. The real burden of injury is expressed in those patients where the CSD injury leads to the so-called "long-term suffering". But even the expression "long-term" is used for different time spans, reaching from more than 1 month to more than 24 months, whereas in the QTF scaling (Spitzer 1995) a time of more than 6 months is declared as chronic case. Occupant characteristics, seat characteristics and accident related factors contribute to the individual outcome of the occupants (Krafft 2002a,b, Jakobsson 2000, Suissa 2003, Scholten-Peeters, 2003). In detail first estimations regard the pulse characteristics, the change of velocity, individual biometric characteristics like gender, age, pre-existing degenerative changes of the cervical spine, socio-demographic and psychosocial factors, and seating posture as well as the impact direction as responsible for leading to different outcomes.

Within the EU Whiplash2 Project, a retrospective analysis of patients with CSD injuries suffering for more than 6 weeks had been performed. From this data material this embedded case-control study is derived to investigate factors associated with a time span of suffering between 6 weeks and 6 months and more than 6 months duration. In the following "Long-term patient" is used in a general (but not exactly defined) meaning, like found in other literature, and doesn't refer to any specific time span or definition for case and control in this study.

MATERIAL AND METHODS

Data material was provided by a big German Insurance Company. As being holder of about 10% of the German market and the claimant being independent of the insurance company of the accident causer representation should be given. Charts of patients with CSD injury after a rear-end collision were screened towards criteria like duration of at least 14 days and a sufficient documentation in terms of technical and medical information. 187 rear-end impacts from 2001 that led to at least one occupant suffering from CSD for more than two weeks could finally be analysed technically and medically. Another 21 files of patients suffering for more than 6 weeks from 2000 within a previous evaluation (Hell, 2003)) are added to enlarge the data material.

For this embedded case-control study only drivers are chosen. Criteria for defining the dataset within the medical investigation is first the diagnosis of CSD, further either absence from work or reduction of earning capacity or treatment and therapy for more than 6 weeks. Due to different information content and varying data quality those multiple criteria are chosen. Chronic suffering is defined as duration and presence of the mentioned criteria for more than 6 months. With the applied

criteria 102 crashes are found which lead to chronic (more than 6 months) symptoms in 22 cases leaving 80 controls with problems between 6 weeks and 6 months. The variables investigated and documented by technicians and physicians refer to three main categories, which are collision and vehicle related characteristics and medical and socio-demographic factors. Ordinal data are dichotomized for the final analysis. Statistical Analysis (SPSS 12.0 for Windows) is performed by applying Chi Square test for dichotomized variables, documenting Odds Ratios (OR) and 95% Confidence Intervals (95%CI) and by applying Mann Whitney U-test for the metric data, documenting p-values.

RESULTS

The analysis of the mentioned criteria is described in the following. The exact values are documented in Table 1. For the different Outcomes in terms of duration of symptoms, which leads to the classification of cases and controls, therapy as influencing factor is examined first. It can be seen that the cases are treated in the same way as the controls. No significant differences can be found in percentage of prescribed neck collar, physiotherapy, although showing higher values in the case group and rest is prescribed more frequently in the control group. Pharmaceutical therapy and psychosomatic therapy is seen more frequently in the cases. There are no hints that the therapy is the causative factor leading to the different outcomes. In addition the initial QTF distribution is investigated showing no difference between cases and controls.

COLLISION CIRCUMSTANCES:

A higher percentage of multiple collisions is seen in the case group compared to the controls with 32% and 23% respectively; however, the OR doesn't reach significance (OR:1,61; 95%CI [0,569; 4,545]). Multiple collisions are documented in the overall sample only if the rear end crash is preceding the following crashes. The speed change and accelerations are reconstructed by PC Crash in 21 crashes of this case-control study, including only 4 cases and 17 controls. Significant differences would therefore not be detectable due to low numbers. Here the comparison even shows that the values are reaching the same values of 19,42 km/h and 19,43km/h, respectively, as well as 5,50g for both groups.

Table 1 – distribution of characteristics and risks for chronic cases

	6 weeks to 6 months CONTROLS			chronic cases > 6 months CASES			CASE/ CONTROL OR	95%-Confidence- intervall	
	n	%	n miss	n	%	n miss		lower limit	upper limit
overall	80	100	0	22	100	0			
female	39	48,8	0	10	45,5	0	0,88	0,340	2,258
tow bar present	4	5,0	0	1	4,5	0	0,90	0,096	8,532
multiple collision yes	18	22,5	0	7	31,8	0	1,61	0,569	4,545
degree of vehicle damage (serious or severe)	20	25,3	1	8	36,4	0	1,69	0,617	4,609
low head-restraint position	19	40,4	33	9	75	10	4,42	1,057	18,486
accompanying injuries present	31	38,8	0	11	50,0	0	1,58	0,612	4,083
psychological factors	4	7,0	23	8	47,1	5	11,78	2,925	47,418
pre-existing/degenerative changes CS	23	33,8	12	10	47,6	1	1,78	0,659	4,800

	6 weeks to 6 months CONTROLS				chronic cases > 6 months CASES				p- value*
	Min	Max	mean	N miss	Min	Max	mean	N miss	
registration date [year]	1984	2001	1993,7	1	1988	2001	1995,2	1	0,146
tare weight [kg]	640	1725	1155,4	0	700	1834	1206,3	0	0,454
mass ratio striking/struck vehicle	0,55	1,89	1,1	0	0,63	9	1,5	0	0,526
delta v [km/h]	11,24	29,28	19,4	63	12,29	28,8	19,4	18	0,929
mean acceleration [g]	3,18	8,29	5,5	63	3,48	8,15	5,5	18	0,929
driver's age [y]	18	77	44,1	2	20	76	45,3	2	0,774

* Mann-Whitney U-Test, two sided

CAR CHARACTERISTICS:

The cases were involved in crashes that lead to slight vehicle damage only half as often as compared to the controls (9% and 18%). For the analysis slight and moderate degree of vehicle

damage is compared to severe and serious damage. The OR is 1,69 (95%CI [0,617;4,609]), indicating that the cases had been involved in more severe crashes. Only one patient of the cases and four controls were driving vehicles with tow bars, here a difference cannot be seen, but the vehicles driven by the cases are about 2 years newer than those driven by the controls (p-value 0,146). Further the cases show higher tare weight values and also higher mass ratios (striking/struck car), however significance is not reached. A low head restraint position is found in 75% of the cases and only 40% of the controls, if the position is documented at all. Although there are high numbers of missings the OR of 4,42 reaches just significance (95% CI [1,057;18,486]).

OCCUPANT CHARACTERISTICS:

Female gender as known risk factor cannot be confirmed with these results. In general the sample shows higher percentages of male drivers in both groups, but the OR for females within the cases and controls reaches 0,88 (95%CI [0,34; 2,258]). The average age lies at 44,1 years and 45,3 years for controls and cases, respectively. When it comes to terms of pre-existing degenerative changes the controls show a percentage of 34%, but the cases a higher percentage of 48%. The OR is 1,78, 95%CI [0,659; 4,800]. Accompanying injuries are seen more often in the cases. Psychological factors associated with the recovery time are documented in 47% of the cases but only 7% of the controls, leading to an OR of 11,78, 95%CI [2,925; 47,418]. This is a wide range for the CI and one shouldn't forget that a noticeable behaviour and suspected psychological influence on the recovery may be pre-existent patients' characteristics but may also develop due to the chronic symptoms.

DISCUSSION AND CONCLUSION

This analysis is performed to analyse if there are factors independent from therapy that contribute to the time of persisting symptoms or absence from work, especially in the time period after 6 weeks. It seems not just to classify all patients suffering for more than 1 month or 6 weeks and the like as chronic patients. Recovery happens gradually, and a stigmatisation towards classifying a patient too early as being a "long-term" or even chronic patient, might hinder amelioration. Especially here the mentioned psychological factors might play a role. They might not be causative for the chronic suffering, but may develop due to the suffering. Scholten-Peeters (2003) found strong evidence for no prognostic value for recovery after a high acute psychological response, whereas McLean (2004) and Hendriks (2005) found chronic symptoms only to be associated with psychological factors. Miettinen (2004) sees sociodemographic and psychosocial factors as having only limited prognostic value for long-term symptoms and Turner (2003) finds pre-accident psychiatric factors as having little prognostic value. Again associated problems in chronic patients are seen for social functioning, daily anxieties and satisfaction with different aspects of life (Sternier, 2004) and morbidity in whiplash patients as to be psychological and associated with litigation (Joslin, 2004). Within this study a significant association between psychological factors and chronic suffering for more than 6 months is found, but a causative value cannot be assigned. Age and gender as being associated (McLean, 2004, Sternier, 2003) cannot be found here, thus being concordant with the findings of Scholten-Peeters (2003). The crash pulse as being of influence (Krafft, 2002a, Folksam 2004) could not be evaluated here. The reconstructed files giving information about change of velocity and mean acceleration are too low in numbers. For the crash and car related factors the low head-restraint position, the higher degree of damage, the higher mass ratio between striking and struck car, newer and therefore assumable stiffer cars and a higher percentage of multiple collisions all seem to contribute to a classification of the crash as being more complex, more severe and as being more likely to show destructive potential in biomechanical terms. Thus even with the presented findings, the psychological factors might occur with chronic symptoms, and with the crash pulse being of equal value in these cases and controls, the crash might be experienced as more severe, which is postulated by Richter (2000) as being predictive for the prognosis. Here also the accompanying injuries show accordance. A not evaluated but maybe influencing fact may be the injuries of the passengers in their own or the opponents' cars contributing to the perception of the crash's severity.

In future even more focus shall be laid on protection systems, to avoid developing symptoms at first. But as seen in this analysis a standard rear-end collision without further impact precedes the patients suffering for more than 6 months after rear end impact only in about 70%. Regarding the head-restraint position surely more information must reach the vehicle drivers to position them in an appropriate position. But for seat manufacturers a task will be to enable an optimal position for all kinds of occupants as well. The possibly disadvantage of a stiff auto body, especially the rear end,

must be improved by car manufacturers to find a compromise between protection and destruction potential, or find a synergistic solution between seat and car deforming and energy absorbing behaviour. On the other hand a therapy that focuses on taking the patients' problems seriously, reassuring the patient that recovery can still happen even after a longer time period and interdisciplinary treatment might advance the healing process.

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