Development of chronic pain following severe accidental injury. Results of a 3-year follow-up study

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Abstract: OBJECTIVE: Motor vehicle accidents (MVA) and work-related injuries are two of the more common causes of chronic pain. Nevertheless, there is little evidence on predicting factors regarding the development of chronic pain following physical injury. METHODS: The present study investigated temporal associations between accident-related factors, psychological factors [symptoms of posttraumatic stress disorder (PTSD), anxiety, depression, coping], and the development of chronic pain in a sample of individuals who had sustained severe accidental injuries (N=90). Assessments were performed within 1 month of the accident, and at 6, 12, and 36 months post trauma. RESULTS: A total of 40 individuals (44%) reported accident-related pain 3 years after the accident. Individuals with chronic pain showed significantly more symptoms of PTSD, depression, and anxiety, more disability, and more days off work. Analysis of temporal associations between psychological variables and the development of chronic pain indicated that the separation of the pain from the nonpain group mostly occurred between 6 (T2) and 12 months (T3). Differences were much less pronounced at T1. CONCLUSION: The prevalence of chronic pain in severely injured patients 3 years after the accident is considerably high. The development of chronic pain is more related to psychological factors, particularly PTSD symptoms, in the aftermath of the accident, as compared to sociodemographic and accident-related variables at the time of the accident. These findings may be helpful to elucidate the problems in predicting chronic pain conditions in injured subjects and to recognize the onset of a chronic pain condition more reliably.

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Running head: Chronic pain in accident survivors.

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Abstract

Objective: Motor vehicle accidents (MVA) and work-related injuries are two of the more common causes of chronic pain. Nevertheless, there is little evidence on predicting factors regarding the development of chronic pain following physical injury. **Methods:** The present study investigated temporal associations between accident-related factors, psychological factors (symptoms of posttraumatic stress disorder (PTSD), anxiety, depression, coping) and the development of chronic pain in a sample of individuals who had sustained severe accidental injuries (N=90). Assessments were performed within 1 month of the accident, and at 6, 12 and 36 months post trauma. **Results:** A total of 40 individuals (44%) reported accident-related pain 3 years after the accident. Individuals with chronic pain showed significantly more symptoms of PTSD, depression, and anxiety, more disability, and more days off work. Analysis of temporal associations between psychological variables and the development of chronic pain indicated that the separation of the pain from the non-pain group mostly occurred between 6 (T2) and 12 months (T3). Differences were much less pronounced at T1. **Conclusion:** The prevalence of chronic pain in severely injured patients 3 years after the accident is considerably high. The development of chronic pain is more related to psychological factors, particularly PTSD symptoms, in the aftermath of the accident, as compared to sociodemographic and accident-related variables at the time of the accident. These findings may be helpful to elucidate the problems in predicting chronic pain conditions in injured subjects and to recognize the onset of a chronic pain condition more reliably.

Keywords: anxiety, accident, chronic pain, depression, posttraumatic stress disorder, trauma

Abbreviations:

CAPS = Clinician-administered PTSD scale, IES = Impact of event scale, SCL-90-R = Symptom checklist-90-R, HADS = Hospital anxiety and depression scale, MVA = Motor Vehicle Accident, ICU = Intensive Care Unit, GCS = Glasgow Coma Scale, ISS = Injury Severity Score, SOC = Sense of Coherence scale

Introduction

Chronic pain is recognized as a frequent and costly health problem. Epidemiological findings indicate a prevalence of chronic pain of up to 50% in community based samples [1]. Further, patients with chronic pain have been found to utilize health services up to five times more frequently than the rest of the population [2]. There is an increasing body of literature on prognostic factors of chronicity, particularly, in acute low back pain after work accidents [3] resulting in the concepts of red/yellow/blue/black flags [4]. Psychological and social factors, also labelled "yellow flags", have been found to be predictive for persistent pain and disability [5,6]. Among severely injured survivors of motor vehicle accidents (MVA) persistent symptoms are common. These symptoms often present as psychiatric disorders, such as posttraumatic stress disorder (PTSD), anxiety disorder or depression [7-9], but there is also a substantial portion of MVA survivors suffering from persistent pain. However, up to now research has paid sparse attention to the development and prediction of chronic pain in severely injured patients. Only few prospective studies on the prevalence and development of persistent pain in severely injured subjects have been conducted. Mayou et al. [10], for example, found 36% of seriously, and 20% of less seriously injured MVA victims suffering from pain 1 year after the accident. Similar to other studies investigating long-term sequelae in injured individuals, they found a high co-occurrence of psychiatric disorders like PTSD, affective and anxiety disorders and chronic pain [10-13]. Further, recent research indicates that patients suffering from chronic pain with co-morbid PTSD experience more intense pain, affective distress [11], and higher disability [12,13] than those without PTSD. There is some evidence that PTSD and chronic pain disorders after trauma have many common links. For instance, Sterling et al. [14] found that PTSD symptoms after motor vehicle collision predicted whiplash severity at 6 months. One of the main common pathways shared by both conditions may be a dysregulation within central stress response systems resulting in fundamental changes in neurobiological systems related to pain processing and stress [15].

However, the association between the development of chronic pain conditions and psychological problems in the aftermath of a traumatic event is still poorly understood [16]. Many studies investigating the relationship between chronic pain and PTSD are cross-sectional and thus cannot provide information on the temporal association between pain and PTSD symptoms. Thus, additional longitudinal data are needed. This report used data from a longitudinal study of severely injured accident survivors to assess the prevalence of, and potential predictors for the development of chronic pain in the aftermath of a severe accident. Secondly, the current study aimed to specifically examine the temporal relation between psychological factors (PTSD symptoms, anxiety, depression, coping) and the occurrence of chronic pain.

Method

Participants

Participants were consecutively recruited from the Department of Traumatology at the University Hospital of Zurich. All patients had sustained accidental injuries that caused a life-threatening or critical condition requiring their referral to the intensive care unit (ICU). Participants had to meet the following inclusion criteria: age between 18 and 70 years; sufficient command of German, and a clinical condition enabling participation in an extensive clinical interview within 1 month of the accident. Furthermore, an Injury Severity Score (ISS) [17] of 10 or more and a Glasgow Coma Scale (GCS) [18] score of 9 or more were required allowing to collect a sample of severely injured participants without severe traumatic brain injury. Patients suffering from any serious somatic illness, or who had been under treatment for any mental disorder immediately prior to the accident were excluded.

Procedure

All patients referred to the ICU were consecutively screened over a period of 18 months. 135 patients were eligible for the study, 14 (10.4%) refused to participate. Written informed consent was thus obtained from 121 patients. The initial interview (T1) was performed on average of 13 days (SD 7, min 3, max 29 days) after the accident. Follow-up interviews were conducted at six months (T2), 12 months (T3), and 36 months (T4) post accident and were performed by a trained and experienced interviewer. Thirty-one out of 121 patients (25.6%) were lost during the follow-up period (1 patient died, 1 returned to country of origin, 5 patients could not be retrieved, and 24 refused to participate). Thus, the final sample with complete longitudinal data comprised 90 patients.

Measures

For the assessment of PTSD symptoms, the Clinician-Administered PTSD Sale (CAPS) was administered [19] **by a trained and experienced interviewer**. This instrument allows quantification of the frequency and intensity of each of the 17 PTSD symptoms according to DSM-IV **[20] and has excellent psychometric properties [21,22]. Instructions for the clinician and interview procedures are identical with the original English version [23]**. A diagnosis of PTSD can also be made based on CAPS scores. **For statistical analyses the total score of the CAPS ranging from 0-128** was used. In addition to the CAPS, posttraumatic psychological symptoms were also assessed by using the Impact of Event Scale (IES), a 15-item

self-rating questionnaire comprising 2 subscales (intrusion: 7 items; avoidance: 8 items) [24]. The total scores range from 0 to 75.

The 90-item revised Symptom Checklist (SCL-90-R) [25,26] was used to assess a broad spectrum of psychological complaints. The SCL-90-R comprises nine subscales (somatization, obsessive compulsive, interpersonal sensitivity, depression, anxiety, aggression, hostility, phobic anxiety, paranoid ideation) and psychoticism and can be summarized in a single global distress index, the Global Severity Index (GSI). Possible GSI scores range from 0 to 4, with higher scores indicating a higher level of psychological and emotional distress. The SCL-90-R was not administered at T4, where it was - for pragmatic reasons - replaced by the Hospital Anxiety and Depression Scale (HADS).

For the assessment of anxiety and depression we used the Hospital Anxiety and Depression Scale (HADS) [27], a 14-item self-rating questionnaire. The HADS was developed to provide clinicians and scientists with a reliable, valid, and practical tool for identifying and quantifying the two most common forms of psychological disturbances in medical patients. The range for both scales (anxiety and depression) is 0 - 21; scores 8 - 10 indicate possible, scores > 10 indicate a probable depression or anxiety disorder.

The Sense of Coherence scale (SOC) [28] is a measure of an individual's resilience to stress and his or her capacity to cope with it. The 29-item version was used in this study. Individuals with high SOC scores are those likely to perceive stressors as predictable and explicable, have confidence in their capacity to overcome stressors, and judge it worthwhile to rise to the challenges they face. The scores range from 29 to 203.

The presence of accident related chronic pain, utilisation of health care, and disability was assessed by an experienced interviewer only at T4. The presence of persistent pain was assessed by the question whether or not the patient was still suffering from pain related to the accident. The possible answers were yes or no. Disability was assessed twofold: (1) the subjects were asked by the interviewer whether or not they felt themselves bodily disabled, and (2) they were asked if they received compensation by the accident insurance or not (occupational invalidity). Health care utilisation was determined by the question whether or not the patient used still any medical treatment (general practioners, psychological, physiotherapy or others) related to the accident. Additionally, the patients indicated if they were taking analgetics and/or psychotropics.
Time taken off work was calculated as the number of days of leave taken from the time of the injury (including time in the hospital), with a week off work equalling seven days of leave. The days on which the subjects worked at a reduced level were added to the total days of leave on a prorated basis.

Internal consistencies (Cronbach's alpha) of the instruments used in this study were comparable to those reported in the literature: CAPS total score: Alpha = .76, IES total score: Alpha = .90, SCL-90-R-

somatization: Alpha = .81, SCL-90-R GSI: Alpha = .96, HADS Depression: Alpha = .84, HADS Anxiety: Alpha = .87, SOC: Alpha = .89.

Statistical analyses

Group comparisons of dimensional variables were performed with independent samples t-tests or one-way ANOVA. For categorical variables chi-square or Fisher's exact test were used. To analyze the global relation between psychosocial variables, inpatient days and time off work with regard to the development of chronic pain a multivariate analysis of variance (GLM multivariate) for each assessment time point was calculated. **Additionally, to assess specific predictors for the development of chronic pain four logistic regression analyses were carried out (backward stepwise removal method for all independent variables of each one assessment time point with pain at T4 as dependent variable).**To clarify and illustrate the temporal course of the associations between relevant variables and chronic pain effect sizes (d) of the differences between the two groups (with/without pain) were calculated. This was done using Cohen's formula [29]: $d = (\text{mean}_{\text{patients with pain}} - \text{mean}_{\text{patients without pain}}) /$ **pooled** standard deviation. Effect sizes allow to compare measures with different continuous scales and are usually considered as small (d = 0.2), medium (d = 0. 5), or large effects (d = 0.8).

Results

Sample

Sociodemographic characteristics of the sample are presented in *Table 1*. Road traffic accidents were most frequent (53 patients; 58.9%), followed by sports and leisure-time accidents (19; 21.1%), accidents in the workplace (13; 14.4%), and household accidents (5; 5.6%). No significant differences in injury severity (ISS) were found between these four types of accident ($F = 0.247$, $df = 3; 86$, $p=.86$).

There were no significant differences between the 31 drop-outs and the 90 patients who participated in all four interviews with regard to sociodemographic and accident related variables, except for marital status (drop-outs: 21 single, 9 married, 1 divorced; sample: 34 single, 43 married, 13 divorced; $\chi^2=8.95$, $df=2$, $p<.05$). Particularly, no differences were found for the following scales assessed at T1: Injury Severity Score (ISS), Glasgow Coma Scale (GCS), Clinician-Administered PTSD Scale (CAPS-2), Impact of Event Scale (IES), Symptom Checklist (SCL-90-R), and Sense of Coherence scale (SOC).

Table 1

Prevalence of chronic pain

A total of 40 patients (44%) reported accident-related pain at 36 months after the accident (*Table 1*). Subjects with pain did not significantly differ from those without pain regarding age, sex, marital status, and accident-related variables (type of accident, ISS, GSC). However, patients suffering from chronic pain reported significantly more physical disability (χ^2=15.19, df=1, p<.001), occupational invalidity (χ^2=27.06, df=1, p<.001), and days off work (580 vs. 215 days, *Table 3*) compared to patients free of pain. Additionally, subjects with pain used medical treatment significantly more frequently (χ^2=13.61, df=1, p<.001).

Chronic pain and PTSD

Three years after the accident (T4), 4 participants (4.4%) met the criteria for full PTSD and 9 (10.0%) for subsyndromal PTSD (Patients were diagnosed with "subsyndromal PTSD" if they met criteria A (stressor criterion) and B (re-experiencing cluster) plus either C (avoidance cluster) or D (hyperarousal cluster), but not C and D [30]. All 4 patients diagnosed with PTSD and 8 of 9 with subsyndromal PTSD suffered from chronic pain (χ^2=14.01, df=1, p<.001).

Temporal associations between psychological variables, inpatient days, time off work and pain

To obtain a general view on the associations between relevant psychosocial variables (CAPS, HADS-anxiety and -depression, Sense of Coherence, SCL-90-R-somatization, SCL-90-R-GSI, Impact of Event Scale, inpatient days, days off work) and the development of persistent pain a multivariate analysis of variance (GLM multivariate) for each time point was conducted (see *Table 2*). The highest impact of the investigated psychosocial variables on the presence of persistent pain was found at T2 and T3 by explaining 33% to 35% (see *Table 2*) of the variance of chronic pain being present 3 years after the accident. Three years post accident (T4) totally 30% of this variance was attributable to all of the investigated psychosocial variables. Contrarily, when measured at T1, no significant contribution to variance explanation for pain at T4 was found (18.3%, *Table 2*). In the univariate analyses with t-tests significant differences were found between patients with and without pain in all investigated variables (*Table 3*). **In the logistic regression analyses with pain at T4 as dependent variable (see *Figure 1*) at T1 only the CAPS total score was found as significant predictor of persisting pain at T4 (odds ratio=1.05, p<.01). At T2 and T3 the number of inpatient days (odds ratio=1.02, p<.01, and odds ratio=1.01, p<.05) and SCL-90-R-somatization (odds ratio=5.57, p<.01, and odds ratio=7.82, p<.01) significantly predicted pain at T4, whereas at T4 the CAPS total score (odds ratio=1.08, p<.05) and number of days off work (odds ratio=1.003, p<.01) were significant predictors.**

Figure 1 presents the temporal course of the effect sizes (Cohen's d) of the differences between both groups regarding psychological variables, inpatient days, and time off work at different time points. Only for two variables differences were already detectable shortly after the accident (T1: CAPS total score: d=.66; SCL-90-R-somatization: d=.52). Six months (T2) and 1 year post accident (T3) effect sizes of the symptom scales increased to medium or large effects (T3: CAPS total score: d=.84; IES total score: d=.57; SCL-90-R GSI: d=.70; SCL-90-R-somatization: d=.96, HADS depression: d=.88; HADS anxiety: d=.54). Three years after the accident, effect sizes were comparable to the one year follow-up (T4: CAPS total score: d=.87; HADS depression: d=.74; HADS anxiety: d=.59; SCL-R-90 and IES not administered at T4). No difference was found regarding SOC at T1. However, differences in the SOC increased and at T4 pain-free individuals showed significantly higher scores (d=-.52). Whereas patients with and without pain did not differ in the length of stay at the Intensive Care Unit (T1: d=.09), they differed significantly in their inpatient days at the later assessments. The number of days off work differed substantially between groups at six months (T2: d=.98), with effect sizes continuously increasing (T4: d=1.13).

Table 2 and Table 3

Figure 1

Discussion

These data shed interesting light on the prevalence of chronic pain in the aftermath of a severe accident, as well as on the relation between chronic pain and different psychosocial variables. Similar to earlier studies [10], three years after a severe accident almost 45% of the injured subjects suffered from chronic pain. In this subgroup, significantly more patients were classified as physically disabled and used more frequently medical treatment compared to accident survivors without pain. The development of chronic pain was independent of the severity of injury (ISS, GCS), type of accident, age and sex. The latter finding is somewhat surprising, since many prior studies found significantly higher pain rates in female patients [1,31]. However, one explanation for this finding may be the high proportion of male patients, **which is typically found in samples** of severely injured accident survivors. In agreement with other studies, we found a strong association between chronic pain and PTSD. Of the 13 subjects diagnosed with PTSD or subsyndromal PTSD all but one suffered from chronic pain. **At T1 the CAPS total score and at T2 and T3 the number of inpatient days and SCL-90-R-somatization significantly predicted persistent pain at T4**. Analysis of the temporal association between

PTSD symptoms (CAPS and IES) and other psychosocial variables and the development of chronic pain, however, indicated that the development of both conditions is not a simple parallel process: the most pronounced differences between patients with and without pain could be detected between 6 and 12 months after the accident suggesting that both early onset and maintenance of psychological symptoms may be predictive for the development of chronic pain. About one third of the variance of the presence of chronic pain 3 years after the accident could be explained by psychosocial variables at 6 or 12 months post accident. Contrarily, no strong differences could be observed immediately after the accident (T1). This points to the possibility that there is a critical time window during which processes indicative for adverse developments take place, which has important implications for diagnostic and treatment issues.

However, in interpreting our findings, it is important to keep several limitations of this study in mind. First, the restriction of the sample for practical reasons to German speaking patients has been discussed as a potential source of bias [9]. By excluding participants who did not sufficiently speak the local language and thus might experience less integration and social support, we might have missed a group of patients with a higher risk of developing chronic pain. Secondly, we did not use more sophisticated instruments for the assessment of pain so that we cannot provide further information on, for example, pain severity and localization. However, pain severity is a multidimensional concept and is associated with many other factors, which may include distress, behavioural changes and so on. Ratings of pain can be affected by these factors. **Interestingly, at T4 only 27% of the chronic pain sample (see Table 1) were using analgesics, which raises the question about pain severity. However, we cannot explain this sufficiently since we did not assess pain severity/intensity. One possible explanation could be that pain intensity was low or varying so that patients did not use analgesics daily but only occasionally, which was not assessed in the interview**. The assessment of chronic pain in our study was performed by a clinically experienced interviewer and therefore appears to be considerably valid. **Third**, we did not use valid instruments to measure disability, enabling, for example, comparison of our results with other studies. Further, scoring disability in a dichotomous manner (yes/no) did not allow to provide different degrees of disability (e.g., mild to severe) as used in other studies. However, we additionally asked the patients whether they received compensations of the accident or invalidity insurance, which usually allows reliable statements about disability. **Fourth**, in the present study **accident related** pain was only assessed at the three-year follow-up (T4) restricting conclusions regarding the onset/recurrence of pain at different time points. **Although common pain complaints were assessed with SCL-90-R-somatization items we cannot differentiate whether these self-reported pains were related to the accident or not**. Information about the presence of both pain and psychological problems at different time points, would allow to disentangle the causal/

temporal relation between the development of pain and psychopathological symptoms, such as PTSD and depression more precisely. **Further limitations of the current study are: males were over-represented within the sample, which is typically found in accident survivors but may have biased the results concerning PTSD, anxiety, and depression. Many of our data rest on self-report measures. However, PTSD symptoms, one of the main outcomes of the study, were assessed by interviews using the CAPS. Lastly, we have no information whether participants were involved in accident-related litigation (or workers compensation), which could have had a major impact on the development of persistent pain.**

Recently, several theoretical models regarding the relationship between PTSD and chronic pain have been proposed. According to Sharp and Harvey's mutual maintenance model [32], there are common cognitive, affective and behavioural factors that work to maintain or exacerbate both conditions. Asmundson et al. [16] proposed a shared vulnerability model in which anxiety sensitivity is a predisposing factor contributing to the development of both conditions. Our findings rather support the mutual maintenance than the shared vulnerability model because, if there would exist a predisposing factor for both conditions, differences between patients developing chronic pain conditions and those who do not should be detectable at an earlier stage of the course. Although our findings can not explain the relationship between PTSD symptoms and chronic pain in greater detail, they lend support to the hypothesis that a profound dysregulation of stress response systems resulting in typical PTSD symptoms like re-experience, hyperarousal and avoidance may also lead to substantial changes in pain processing due to behavioural and/or cerebral changes [33].

Although the Sense of Coherence, i.e. an individual's resilience to stress and his or her capacity to cope with it, is proposed as a personal trait [34], we found significantly lower SOC scores in patients with pain compared to those without chronic pain at T4 (but not in the assessments before). This is a noteworthy finding suggesting that injured subjects with chronic pain may experience fundamental personal changes, particularly, in their individual ability to cope with stress.

This study is unique in that it showed very clearly the strong relationship between the development of chronic pain and psychosocial variables and the course of persistent pain in accident survivors over a 3-year time span after the accident. A considerable proportion of severely injured accident survivors suffer from chronic pain. These patients are psychologically more impaired, significantly more classified as physically disabled, and use more frequently the health care system, as compared to accident survivors free of pain. The development of chronic pain seems to be associated with processes further down the road, particularly the maintenance of psychopathological symptoms rather than with sociodemographic and accident-related variables shortly after the accident. Chronic pain may subsequently lead to profound personality changes. Therefore, clinicians should re-

assess their injured patients after 6 and 12 months to detect the onset of chronic pain and initiate adequate treatment as early as possible.

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