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Review Article

Multivariate Prognostic Model of Whiplash Chronification

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Abstract

Objective: To study the pronostic factors involved in the chronification of whiplash.

Methods: The study includes 50 patients who had suffered a whiplash during the previous 24 hours. A clinical and posturographic assessment was performed and clinical questionnaires were completed. An analitical observational study was carried out in a 2-year follow-up to evaluate the role of clinical and posturographical variables in chronicity.

Results: A positive and significant relationship was observed between the HADS anxiety subscale and delayed resolution. The age, the presence of anxiety and the sweep areas (Romberg eyes open and eyes closed) were independently and significantly associated with the probability of chronification. From these results a multivariate model of chronification is generated which shows a high prognostic capacity with an area under the ROC curve of 0.89 (95%CI 0.76-1).

Conclusion: In this study, the prognostic factors of whiplash are: age, sweep area in Romberg eyes open and eyes closed and anxiety evaluated before 24 hours after the accident.

INTRODUCTION

Whiplash associated disorders (WAD) encompass, as described by the Quebec Task Force[1] group of experts, a series of symptoms affecting the cervical region that appear after an acceleration-deceleration mechanism. This group published in 1995 in the journal Spine the conclusions of a paper entitled "Whiplash associated disorders (WAD: Redefining whiplash and its management" [1], which protocolized the diagnosis, clinical, recommendations and treatment of whiplash. Its conclusions are still widely accepted despite the fact that there are authors who question the evolution of whiplash to chronicity. In general terms, acute whiplash is reserved for the first three weeks starting immediately after the accident, moment when the subacute phase begins, while chronic whiplash is considered if there is persistence of symptoms beyond 6 months.

To date, there is no consensus on the epidemiology and natural course [1,2] of whiplash, nor on the multifactorial mechanisms that cause the perpetuation of symptomatology after the accident. In their monograph on QTF, Spitzer [1] et al., reported that the natural course of this pathology was favorable, concluding that 87% and 97% of patients recovered at 6 and 12 months after the accident, respectively [1]. The authors defined cure as the cessation of compensation without considering clinical criteria and without specifying whether they continued to report complaints or pain. A review [2], contradicted these conclusions, noting that 14-42% of patients developed chronic discomfort. Long-term studies in patients with whiplash offer highly variable recovery rates of between 2-58% [3,4], but most studies suggest persistence of symptoms in 25-40% of patients after 1 year [5]. The enormous variability in recovery times after whiplash is a subject of much controversy to date.

The study of prognostic factors in patients at risk of developing chronic problems has gained great relevance. Thus, at least 8 systematic reviews have appeared in recent years [4-11]. Due to the heterogeneity of the methodology, they led to very disparate conclusions, finding only two consistent results with a high predictive capacity: high initial pain and self-perceived disability. As a result, Walton et al conducted a new systematic review and meta-analysis in 2013, finding 12 significant variables predictive

of poor prognosis:[6] high pain after whiplash understood as VAS > 5.5/10, presence of headache, education below high school, no use of seat belt during accident, low back pain after whiplash, high Neck Dissabilty index score > 14.5 / 50, pre-existing neck pain, initial neck pain after whiplash, high catastrophizing, female sex, WAD 2 OR 3 or isolated WAD 3. However, these factors appear to be different in patients undergoing litigation. In them it has been seen that the factors with the greatest predictive capacity for poor prognosis are pre-existing factors, including previous low back pain, high frequentation of primary care, evidence of depression or previous anxiety [12]. There are currently many articles that indicate that there must be variables not associated with the medical variables themselves in the genesis of pain and disability after whiplash. Numerous studies have shown that various psychological variables play an important role in determining the trajectory of recovery after whiplash [9]. A few years ago, attention began to be paid to a new model known as the FAM: Fear Avoidance Model, which attempts to explain why some patients with acute pain develop chronic pain while others do not. According to this model [13-15], the fear that movement or physical activity will cause more pain leads to avoidance behaviors, disuse, depression and increased pain. This theory, together with attitudes of catastrophizing, would favor a perpetuation of the limitation. Numerous authors point to a positive correlation between catastrophizing and kinesiophobia and the perpetuation of pain and disability after a whiplash [16,17]. Certain factors prior to the accident are beginning to gain importance, as evidenced by Carstensen [18], when he observed that the fact of having perceived benefits derived from the state of health was a predictor of delayed recovery after whiplash.

OBJECTIVES

The main objective was to develop a clinical-posturographic prognostic model of whiplash chronification applicable in clinical practice. For this purpose, the possible prognostic factors that could lead to an unfavorable evolution of whiplash were assessed.

METHODS

The following study was carried out in the Rehabilitation and Physical Medicine Department of the Hospital Arnau de Vilanova in Valencia. It is an analytical, observational, longitudinal cohort study. The patients, once clinically and posturographically assessed, were followed up to check the evolution and chronification of the condition at 2 years.

SAMPLE

A study of the postural response of patients in the first 24 hours after a traffic accident was made. The patients were selected according to the following criteria: patients whiplash type II QTF after traffic in the previous 24 hours with ages between 15 and 65 years. Patients with a medical history of pathologies or pharmacological treatments that limited the performance of posturography were excluded.

All subjects included in the study were informed of the characteristics and objectives of the study. Their participation in the study was voluntary and the patients gave their consent and agreement.

The data were quantified by means of a comparison with normal patterns belonging to a database of postural behavior in the healthy Spanish population that acted as a control group [19,20].

PROTOCOL

The first 50 consecutive patients who met the inclusion and exclusion criteria and who attended the trauma emergency department of the Arnau de Vilanova hospital in Valencia after suffering whiplash were selected. In the first evaluation in the emergency department, a clinical examination (cervical, neurological) and cervical X-rays were performed. Questionnaires (HAD, EVA, Tampa, ESV, DHI) were given to the patient to be completed at the 24-hour check-up. The patients were re-evaluated within 24 hours in the Rehabilitation and Physical Medicine department, where a detailed anamnesis, oculomotor assessment and postural response study by posturography were performed. Subsequently, a review of the health history of each patient was carried out to evaluate their evolution during the next two years after the accident. The history was analyzed by recording the performance of complementary tests, prescription of medication, health care attendance, need for work interruption and time off work.

As for the analysis of the data and in accordance with the proposed objectives, the prognostic factors of chronification were evaluated, establishing this as the need for follow-up or treatment for more than 6 months after the whiplash injury.

BIBLIOGRAPHIC REVIEW

An exhaustive search was carried out in the main international bibliographic databases (PubMed, EMBASE, Cochrane, Scopus and Web or Science) using as main descriptors: Postural Balance AND Whiplash Injuries. For them we used free terms in those databases without thesaurus (Scopus, Cochrane and Web of Science) or the descriptors of the corresponding document language in those that have it incorporated (Mesh in PubMed, EMTREE in EMBASE). The bibliography was managed with the Mendeley® reference manager.

STATISTICAL METHOD

In accordance with the objectives set, an inferential analysis was performed in two phases. On the one hand, a bivariate analysis where the different clinical and posturographic parameters were compared with the finding of chronification in the follow-up. The contrasts were performed with the following statistical tests: contrast of quantitative variables: Student's t test and, in case of non-compliance with the application conditions, the nonparametric Mann-Whitney U test. Contrast of qualitative variables: Chi-square test and, in the case of low expected values, Fisher's exact test. The association between quantitative variables was estimated with correlation tests (Pearson's r or Spearman's Rho in the case of non-normal distributions). The independent contribution of different prognostic variables for chronification was assessed using a nonconditional logistic regression model. An entry criterion based on the change in model likelihood was used. The measure of association was the odds ratio (OR), together with its 95% confidence interval (95%CI). In the final model and in an exploratory manner, its predictive capacity

was tested with the assessment of the area under the ROC curve (diagnostic performance curve) of the estimated predictions. The model is considered sufficiently discriminative if the area under the curve is greater than 0.70. All the contrasts were assessed with an alpha risk of 5% (p<0,05).

RESULTS

Among the sociodemographic and anthropometric variables, age was the only one associated with an increased risk of chronification (50% vs 16,/% p=0,02). Patients in an active work situation at the time of the accident had a somewhat higher risk of chronification than those who were not active, although the differences were not statistically significant (43.8% vs. 25.0%; p=0.19). Accident conditions such as patients position in the car or the place of impact of the vehicle were not related to the risk of chronification.

The presence of instability and low back pain were associated with a greater probability of chronification, although the differences were not statistically significant.

Regarding the rating scales; one third of the patients with VAS >5.5 chronified versus 20% of those with less pain (p=0.32). A similar relationship was observed in patients with high catastrophizing versus those with low catastrophizing (p= 0.32). A positive and significant relationship was observed between HADS anxiety score and chronification (p=0.03). Two thirds of the patients with an abnormal HADS anxiety score chronified, compared to a quarter of those with a doubtful score and only 14% of the patients without anxiety. In the depression subscale there was also a positive trend with no significant differences (p=0.783) (Table 1)

Regarding the posturographic assessment, it is observed that the alteration of sensory patterns is related to a higher frequency of chronification, except for the visual pattern (Table 2). There are no significant differences in the swept areas between patients who chronify and those who do not.

In the exploratory model, the age, the presence of anxiety at 24 hours and swept areas, with eyes open and closed, were independently and significantly associated with the probability of chronification (Table 3).

The multivariate model showed a high prognostic capacity, with an area under the ROC curve of 0.89 (95%CI 0.76 - 1): Figure 1.

The gradient of chronification risk shows a very wide range for different clinical profiles (Table 4).

DISCUSSION

Despite the many published studies, the factors associated with a poor clinical course of whiplash remain unknown. Several authors point out the importance of carrying out longitudinal studies from the most acute phases and long follow-ups for their analysis [18-21]. To date, numerous factors have been investigated to determine their influence on prognosis. These have included physical, psychosocial [22,23], compensation or litigation system [24,25], and demographic factors. Although it seems clear that physical trauma plays an important role in the onset of pain and disability, the importance of other factors is becoming increasingly important. These disorders generate a subjective sensation of loss of health or disability and have an impact on quality of life. Therefore, the determination of prognostic factors is useful not only for professionals who can provide specific interventions for patients at risk, but also serves to provide information to patients and their families. In the present study it was observed that, of the sociodemographic and anthropometric variables studied, age was the only one

Table 1: Frequency of chronification according to sociodemographic and clinical variablesand results on rating scales.

		No chronification		Chronification		
		N	%	N	%	p
Sex	Men	12	70,6%	5	29,4%	0,79
	Woman	18	66,7%	9	33,3%	
Age	≤ 35 years	20	83,3%	4	16,7%	0,02
	> 35 years	10	50,0%	10	50,0%	
Instability	No	13	72,2%	5	27,8%	0,40
	Yes	17	65,4%	9	34,6%	
Back pain	No	28	70%	12	30%	0,58
	Yes	2	50%	2	50%	
Headache	No	23	63,5%	10	36,4%	0,72
	Yes	7	69.7%	4	30,3%	
VAS	≤ 5,5	12	80,0%	3	20,0%	0,32
	>5,5	17	65,4%	9	34,6%	
HADS Ansiety	Normal (0 - 7)	18	85,7%	3	14,3%	0,03
	Unclear (8 - 10)	6	75,0%	2	25,0%	
	Abnormal (>10)	4	40,0%	6	60,0%	
HADS Depression	Normal (0 - 7)	19	73,1%	7	26,9%	0,78
	Unclear (8 - 10)	7	70,0%	3	30,0%	
	Abnormal (>10)	1	50,0%	1	50,0%	
Tampa Scale	Normal (<= 37)	12	80,0%	3	20,0%	0,32
	High level (>37)	17	65,4%	9	34,6%	

Table 2: Frequency of chronification according to sensory patterns

		No chronification		Chronification		p
		N	%	N	%	
Somatosensory	Normal (>=95)	18	75,0%	6	25,0%	0,40
	Altered (<95)	12	63,2%	7	36,8%	
Visual	Normal (>=95)	25	67,6%	12	32,4%	0,65
	Altered (<95)	5	83,3%	1	16,7%	
Vestibular	Normal (>=95)	13	68,4%	6	31,6%	0,86
	Altered<95)	17	70,8%	7	29,2%	
Dynamic	Normal (>=90)	25	75,8%	8	24,2%	0,17
	Altered(<90)	3	42,9%	4	57,1%	

Table 3: Factors associated with chronification.

	OR (IC95%)*	p
Age (incr 1 year)	1,093 (1,003 – 1,191)	,042
Anxiety (Yes vs. No)	14,48 (1,39 – 151)	,025
Sweep area Eyes Open (incr 1mm2)	0,971 (0,943 – 0,999)	,047
Sweep area eyes Closed (incr 1 mm2)	1,005 (1,000 – 1,010)	,051
OR (95%CI): Odds Ratio (95% confidence interval) with non-conditional logistic regression.		

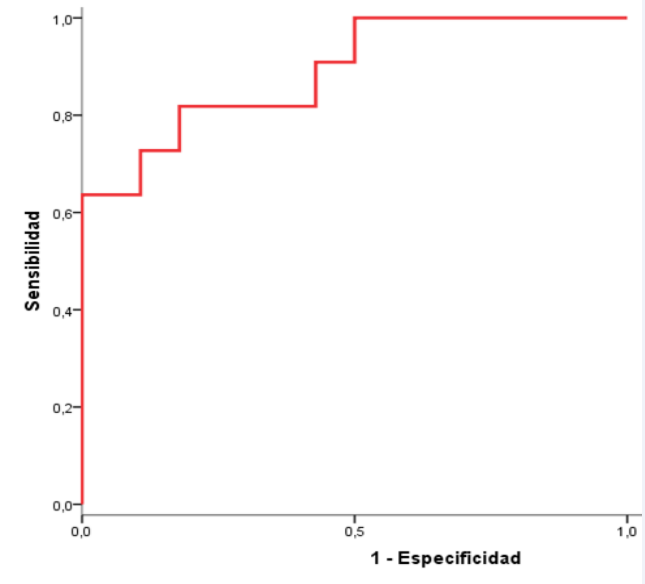

Figure 1 Area under the ROC curve of the probabilities predicted by the logistic regression model (ROC: 0.89; 95%CI 0.75 – 1).

Table 4: Profiles of increasing risk of chronification.

Anxiety	Age	Swept área Eyes Open (Mm^2)	Swept área eyes closed (Mm^2)	CHRONIFICACTION PROBABILITY
No	25	105	75	**0,8%**
No	25	105	425	**4,3%**
No	25	36	75	**5,7%**
No	25	36	425	**26,4%**
No	45	36	75	**26,5%**
No	45	36	425	**67,9%**
Yes	45	105	425	**79,7%**
Yes	45	36	75	**83,9%**
Yes	45	36	425	**96,8%**

associated with a higher risk of chronification with a significant value (p=0.02). This coincides with the majority of authors in pointing out its importance in a worse evolution [4,5,9,21,26,29]. Female sex has been considered a prognostic factor in patients with whiplash but recent studies agree with us in finding no such association [4,5,21,27]. Among other things, whiplash is of concern because it is a frequent cause of absenteeism. Although we have not studied this relationship, we did observe that patients in an active work situation had a somewhat higher risk of chronification than those who did not. Pleguezuelos [26], found a similar relationship, with self-employed patients chronifying to a greater extent than those who were not self-employed. Due to the significant health care costs derived from this pathology, it would be advisable to carry out more studies in this field. Factors related to the accident (type of impact, position in the car) have not shown the capacity to detect a worse outcome. These data coincide with those of other authors [19]. Another of the criteria established by Walton in his systematic review is the existence of previous neck pain. There are conflicting opinions on this issue. We did not analyze it since it is a frequent manifestation in the general population and was considered an exclusion criterion for our study. Both the presence and the intensity of the initial pain have been considered a prognostic factor on numerous occasions. Our results show a non-significant positive correlation between VAS>5.5 and the tendency to chronification. Several authors have found a significant relationship [3,4,7,27]. One possible explanation for the differences found could be the different choice of cut-off point; while we used the value of 5.5 because it was established by Walton in the systematic review, most authors choose higher cut-off points. Another explanation could be the sample size. In our results the presence of low back pain shows a non-significant positive correlation with chronification, coinciding with multiple authors [9,26,27]. Our results agree with those of Pleguezuelos [26], in that the presence of dizziness or instability also seems to offer prognostic information. However, we found no relationship between chronicity and headache. All this suggests that the most symptomatic patients since the accident will also have a worse outcome. However, causality remains unknown. Regarding the scales used, we found a significant positive relationship between high scores on the HADS anxiety subscale and kinesiophobia with chronification. Our results support recent theories pointing to the importance of psychological factors in the perpetuation of pain [9,13-17]. We found no relationship between ESV (anxiety subscale and depression subscale) and chronicity. To date, there are no studies that investigate the relationship between posturography and chronicity. From the results of the present study, it is noteworthy that the swept area was related in the ROA and ROC tests with a greater probability of chronicity. The somatosensory and especially the dynamic posturographic patterns show a higher probability of worse outcome. We cannot compare our results with literature, since there are no studies comparable to ours. The only one that found a positive correlation between the sweep area in RGA with days of disability was Pleguezuelos [26], but he did not point out any other as a possible prognostic factor. From our results we conclude that the main prognostic factors were age, the presence of anxiety and the eye-open and eye-closed sweep areas.

With these variables we developed a multivariate model of chronification that shows a high prognostic capacity with an area under the ROC curve of 0.89 (95%CI 0.76-1). The chronification risk gradient in our model shows a very wide range for different clinical profiles. Nevertheless, it should be pointed out that, as previous authors have mentioned, there is no cause-effect evidence and therefore no factor not included in the above should be considered negligible [12]. Furthermore, the systematic reviews performed point to inconsistencies in the studies in terms of time since injury, methodology, differences in the cohorts, analysis of various parameters [28-30]. It would therefore be advisable to continue with studies in this line of research.

LIMITATIONS AND STRENGTHS

The chronification was established on the basis of the data collected in the electronic medical record and not on the basis of direct follow-up by the researcher, which could lead to bias since the information collected there could have been lost.

It is important to point out the usefulness of predictive models in clinical practice. On the one hand, they are capable of identifying the patients at greatest risk, and on the other hand, they allow action to be taken on modifiable factors. The prognostic model developed stands ou due to its simplicity and predictive capacity. It could be of great use to the clinician in an attempt to reduce the perpetuation of symptomatology. We have obtained a very interesting prognostic model that would certainly merit further study. It may, if our impression is confirmed, serve as a simple and easy-to-apply guide to predict with a fair degree of certainty those patients who will have a poorer prognosis. Therefore, we consider that it would be necessary to expand studies that attempt to validate it in a clinical context.

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