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REVIEW

Mathias Haefeli
Achim Elfering

Pain assessment

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M. Haefeli (✉)
Centre for Spinal Surgery,
University of Zurich, University Hospital Balgrist, Forchstrasse 340, 8008 Zurich, Switzerland
E-mail: mhaefeli@research.balgrist.ch
Tel.: +41-44-3865769
Fax: +41-44-3861109

A. Elfering
Department of Psychology,
University of Berne, Berne, Switzerland

Abstract Pain usually is the major complaint of patients with problems of the back, thus making pain evaluation a fundamental requisite in the outcome assessment in spinal surgery. Pain intensity, pain-related disability, pain duration and pain affect are the aspects that define pain and its effects. For each of these aspects, different assessment instruments exist and are discussed in terms of advantages and disadvantages. Risk factors for the development of chronic pain have been a major topic in pain research in the past two decades. Now, it has been realised that psychological and psychosocial factors may substantially influence pain perception in patients with chronic pain and thus may influence the surgical outcome. With this background, pain acceptance, pain tolerance and pain-related anxiety as factors influencing coping strategies are discussed. Finally, a recommendation for a minimum as well as for a more comprehensive pain assessment is given.

Keywords Pain-assessment instruments · Spinal surgery · Coping strategies in pain patients · Pain perception · Pain experience

Introduction

General aspects

Back pain is one of the most frequent reasons for spinal surgery and therefore, pain relieving is one of the major aims to be achieved while operating on spine patients. Pre- and postoperative assessment of pain and pain relief often serves to evaluate the effectiveness of a specific therapy. However, when gathering and interpreting such data, one has to keep in mind some important findings of research in this area.

There are several aspects that define pain and its effects [45]:

1. *Pain severity*. This contains the pain-related interference with activities (disability) and the intensity of pain. It was found that these two aspects of pain severity may form a bidimensional [72] or a one-dimensional scale [3, 74, 44] depending on the specific instruments tested. High intercorrelations between pain-intensity measures and pain-related disability measures support the concept of using them as a unitary construct of pain severity [4, 41]. Moreover, disability is seen as a major indicator for the severity of a pain condition and several tools have been developed to assess the pain-related disability. Some of the most frequently used tools in the field of spinal surgery are the Oswestry Disability Index (ODI) and the Roland & Morris Disability Questionnaire. These tools assess the limitations in different activities of daily living such as dressing, walking, family life, etc.
2. *Chronicity*. Different definitions of chronic back pain are in use. In 1984, Nachemson and Bigos [60] defined it as a period of at least 3 months with persisting pain. In 1996, Von Korff and Saunders [43] defined it as the back pain that lasts at least for half of the days

during an year. Raspe et al. [68] investigated 40 epidemiologic/therapeutic studies between 1998 and 2000 with regard to the definitions of chronic back pain that were used. Between 4 weeks and more than 1 year of persisting pain, he showed that there is no consensus on the above definition of chronicity. Von Korff and Miglioretti [42] recently presented a prognostic approach to define chronic pain by defining it as a 'clinically significant pain likely to be present for one or more years in the future'. A 50–79% probability of future clinically significant pain was defined as 'possible chronic back pain' and an 80% or larger probability as 'probable chronic back pain'. Using a depression scale of pain intensity during the past 6 months, the number of days with back pain and the number of days with pain from other pain sites as prognostic factors they were able to predict which patients would surpass the aforementioned thresholds of 50 and 80%.

3. *Pain experience*. This contains pain intensity and pain affect. Pain intensity describes *how much* a patient is in pain whereas *pain affect* describes the 'degree of emotional arousal or changes in action readiness caused by the sensory experience of pain' [45]. It has been shown that pain intensity may quite easily be declared by most patients and that different methods of measuring pain intensity showed high intercorrelation [35, 36]. Contrary to these findings, alternative methods of pain affect-assessing did not intercorrelate as high as those of pain intensity, making the utilisation of this part of pain characterisation more complicated [58, 59]. A lot of factors such as social situation, work situation and setting and history of prior injury may influence pain perception and show large inter-individual differences. As perception of pain may differ within a time-period, recent studies have mentioned that it is more valuable to ask patients to rate their 'usual' pain on average over a past short period of time, e.g. 1 week, than to ask for 'current' pain at the specific time of fulfilling a questionnaire [7, 8, 43]. Posing such questions relies on the assumption that patients are able to accurately recall their pain levels of a past period of time. Whether or not this is reliable is discussed controversially. Whereas some studies find it to be unreliable to assess pain retrospectively [16, 47–49] others report acceptable levels of validity up to a 3-months recall period [7, 75, 45]. It has been found that pain is usually overestimated when actual intensity of pain is higher and underestimated when it is lower [10, 19, 47–49]. Moreover, Haas et al. [30] found that pain and disability recall become more and more influenced by the present pain and disability during a period of 1 year while the influence of actual relief and pain and disability reporting at the initial consultation decreased. On the other hand, Von Korff et al. [45] stated that recall of chronic pain in terms of its average intensity, interference with activities (disability due to pain), number of days with pain and number of days with activity limitation, lead to acceptable validity levels. As mentioned in the beginning, assessment of pain is broadly used in spinal surgery. In the setting of pre-/postoperative follow-up investigations, it is unavoidable to use some kind of pain recall when 'current pain' as a test-parameter (as recommended above), is not used. With regard to the current literature, it seems to be justifiable to use short time-periods of pain and disability recall for comparison of pain status of patients in the course of back disease. The interpretation whether or not a statistically significant change corresponds to a significant clinical change as well or defining a threshold remains challenging and needs further research [3]. It must also be kept in mind that the same method of assessing pain may have different thresholds of clinical significance, depending on the setting for example acute or chronic pain [5, 39, 79].

Instruments for pain-intensity assessment

Visual Analogue Scale/Graphic Rating Scale

The Visual Analogue Scale (VAS) consists of a straight line with the endpoints defining extreme limits such as 'no pain at all' and 'pain as bad as it could be' (Fig. 1) [1]. The patient is asked to mark his pain level on the line between the two endpoints. The distance between 'no pain at all' and the mark then defines the subject's pain. This tool was first used in psychology by Freyd in 1923 [24]. If descriptive terms like 'mild', 'moderate', 'severe' or a numerical scale is added to the VAS, one speaks of a Graphic Rating Scale (GRS) (Fig. 2) [1]. A line-length of 10 or 15 cm showed the smallest measurement error compared to 5- and 20-cm versions and seems to be most convenient for respondents [71].

Scott and Huskisson demonstrated that the configuration of a GRS may influence the distribution pattern of the answers [70]. Moreover, they showed that the experience of patients with this tool influenced the outcome. While patients who had no experience with a GRS with numbers of 1–20 underneath the line showed a

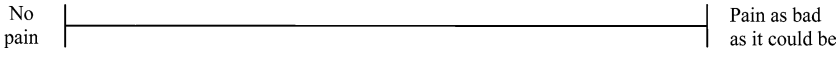

Fig. 1 Visual Analogue Scale (VAS)

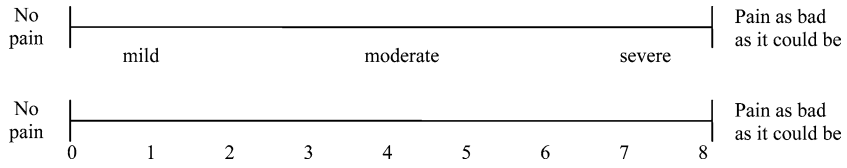

Fig. 2 Examples of Graphic Rating Scale (GRS)

preference for the numbers 10 and 15, subjects who were experienced in the use ignored the numbered scale and showed no preferences and therefore, a nearly uniform distribution of the answers. Analogue observations were made with descriptive terms. In several studies, VAS and GRS have been demonstrated to be sensitive to treatment effects [35, 38, 46, 71]. They were found to correlate positively with other self-reporting measures of pain intensity [35, 46]. In addition, difference in pain intensity measured at two different points of time by VAS represents the real difference in magnitude of pain which seems to be the major advantage of this tool compared to others [66, 65]. However, this ratio is more reliable at group level than at individual level.

Several attempts have been made to identify the amount of change necessary to be clinically significant [33, 40]. For chronic back pain, a change of about 20% and for acute pain a change of approximately 12%, is regarded to be clinically significant [5, 33].

As the distance between 'no pain' and the patient-made mark has to be measured, scoring is more time-consuming and susceptible to measurement errors than a rating scale . Hence, a mechanical VAS has been developed where subjects position a slider on a linear pain-scale instead of marking a cross on a drawn line. The investigator is then enabled to directly read the pain intensity on a millimetre-scale on the other side of the slider. Several studies have shown this system to be strongly associated with the original VAS [13, 28]. Moreover, it has been shown that the mechanical VAS does have a good test–retest reliability and appears to have ratio qualities as well [45].

Lately, computer-based assessment of pain has come up. Palm-top computers make it possible to use VAS on a touch screen allowing electronic data assessment. A report of Tiplady et al. [78] stated that pen-based electronic diaries were highly acceptable to asthma patients. Jamison et al. [34] compared the conventional paper VAS with the electronic VAS in an experimental study setting, using a pen-based palm-top computer. Pain levels marked on the touch screen were expressed as a number between 0 (no pain) and 100 (worst possible pain). The paper VAS consisted of a line of 10 cm length with the endpoints defined in the same manner as mentioned above. Electronic VAS scores showed a high correlation with the paper VAS and it was concluded that this is a valid and time-saving method for pain assessment.

Besides the disadvantages mentioned above, the VAS seems to be more difficult to understand than other measurement methods and hence, more susceptible to misinterpretations or 'zero-values'. This is particularly true in elderly patients [14, 35, 46]. In conclusion, VAS, mechanical VAS and GRS are valuable instruments to assess pain intensity and changes due to therapy when respondents are given good instructions and the limitations are borne in mind [14, 70].

Numerical Rating Scale

In a Numerical Rating Scale (NRS), patients are asked to circle the number between 0 and 10, 0 and 20 or 0 and 100 that fits best to their pain intensity [1]. Zero usually represents 'no pain at all' whereas the upper limit represents 'the worst pain ever possible'. In contrast to the VAS/GRS, only the numbers themselves are valuable answers, meaning that there are only 11 possible answers in a 0–10, 21 in a 0–20 and 101 in a 0–100 point NRS. It thus allows only a less-subtle distinction of pain levels compared to VAS/GRS, where there are theoretically unlimited number of possible answers.

Numerical Rating Scales have shown high correlations with other pain-assessment tools in several studies [35, 46]. The feasibility of its use and good compliance have also been proven [14, 22]. As it is easily possible to administer NRS verbally, it can be used in telephone interviews [45]. On the other hand, results cannot necessarily be treated as ratio data as in VAS/GRS [67].

As in VAS/GRS, a change on the NRS of 20% between two time-points of an assessment is regarded as being clinically significant [21, 22].

Verbal Rating Scale

In a Verbal Rating Scale (VRS) adjectives are used to describe different levels of pain [1]. The respondent is asked to mark the adjective which fits best to the pain intensity. As in the VAS, two endpoints such as 'no pain at all' and 'extremely intense pain' should be defined. Between these extremes, different adjectives which describe different pain-intensity levels are placed in the order of pain severity. Mostly, four- to six-point VRS are used in clinical trials. A different form of VRS is the behavioural rating scale where different pain

levels are described by sentences including behavioural parameters [11].

Like VAS, VRS has been shown to correlate strongly with other pain-assessment tools [35, 46, 62]. Compared to other instruments, the respondent's compliance is often as good or even better even though the subjects must read the entire list before answering, which is time-consuming [14, 35]. Due to the limited number of possible response categories, some patients may have problems in defining which answer fits best to their pain situation. Moreover, the intervals between different adjectives describing pain may not be equal which may reduce the assessment data level to ordinal data level. The different terms used to describe pain may further be interpreted differently by respondents. Thus, the interpretation of a VRS does not allways allow to draw conclusions on the magnitude of a change in pain intensity between two assessments as for example pre- and postoperative and inter-respondent comparison is problematic.

Pain drawing

In pain drawing, the patient is asked to mark the areas of pain on an outline of a human figure. According to some protocols, the subjects are just asked to shade those body areas where they feel pain. Others ask the patients to indicate different types of pain (e.g. burning, electrifying, etc.) with different symbols [54] and several grading-schemes have been developed [32]. Pain drawings have also been suggested for assessment of the psychological involvement in the pain experience. Individuals indicating diffuse, multiple areas of pain are often said to show a high psychological component of pain while those indicating pain as distinct line drawings limited to trunk and/or a single limb are suggested to mainly suffering from an organic problem [64]. Other authors however, did not find a reliable discrimination between patients with and without psychological involvement with their pain condition [2]. Furthermore, some authors postulated pain drawings to be predictive for surgical outcome of back pain [77]. Recently Hagg et al. [32] investigated the predictive value of pain drawings on surgical and non-surgical outcome in patients with chronic low-back pain. In a prospective randomised trial, pain drawings of 264 patients were analysed by four different methods and then correlated with the ODI [20], the General Function Score (GFS) [31] as well as with a VAS for pain intensity and the Zung Depression Scale (ZDS) [84]. There was no association found between any of the four methods analysing the pain drawing and the Oswestry or the GFS. However, pain drawing was significantly associated with the VAS and the ZDS. Therefore, the authors concluded that this method of pain assessment was not able to predict the outcome of surgical or non-surgical treatment of chronic low-back pain.

Instruments to measure pain affect

In general, the same techniques used for assessing the pain intensity may be used to assess the pain affect , e.g. VAS or VRS. In the VRS, the adjectives describe increasing unpleasantness caused by pain. The aforementioned drawbacks of these tools are also valid when using it for the assessment of pain affect. Furthermore, the evidence for the validity of VRS in assessing the pain affect is not as clear as it is for pain intensity. It has been recognised that it may fail to distinguish between pain affect and pain intensity [18]. However, some overlap of these two issues exist making the distinction between pain affect and pain intensity difficult.

Advantages and disadvantages of the pain-affect measurement by VAS are similar to pain intensity assessment. The terms defining the endpoints of the scale might for example be 'not bad at all' and 'the most unpleasant feeling possible'. In several investigations, VAS for assessing pain affect have shown to be valid and sensitive to treatment effects and to have ratio scales qualities [45].

Besides these methods, some more sophisticated tools are available to assess the pain affect. They are described in the following.

Pain-O-Meter

This tool consists of a mechanical VAS and two lists of terms describing the pain affect [25]. Each of these terms has an associated intensity value ranging from one to five. The respondents must decide, which of the 11 possible words best describe their pain. Then the associated intensity values are summed together to build the Pain-O-Meter-affective scale. This scale has been shown to be reliable and sensitive in different settings such as analgesic treatment or differentiation between chest pain caused by myocardial infarction and other chest pain [25, 26]. However, more research on validity and reliability in different settings should be performed to further understand this tool.

McGill Pain Questionnaire

The McGill Pain Questionnaire (MPQ) consists of three major measures—pain-rating index, the number of words chosen to describe pain and the present pain intensity based on a 1–5 intensity scale [55]. The pain-rating index is built by a numerical grading of words describing sensory, affective and evaluative aspects of

pain. The affective subscale consists of five sets of words describing the pain affect. The MPQ is the most extensive tool to measure pain affection. It has been used in many studies and has recently been reviewed extensively [56].

Other aspects of chronic pain perception: coping with pain, pain acceptance, pain tolerance and pain-related anxiety

Nowadays, it is accepted that pain perception is influenced by far more parameters than only pain intensity. Different coping strategies have found to influence significantly the development and perception of pain either directly [57] or indirectly [83]. Mercado et al. [57] showed that passive coping behaviour is a strong, independent predictor of disabling neck and/or back pain. That is, patients who gave responsibility for pain management to an outside source or allowed other areas of life to be adversely affected by pain were at a significantly higher risk of developing disabling pain compared to those exhibiting an active coping behaviour. On the other hand, Oron and Reichenberg [63] found young extroverted men at a higher risk for self-referring to a general practitioner and reporting pain than less-extroverted ones. This finding however is controversially discussed as other studies failed to demonstrate similar results [53, 81]. Other authors showed that patients with a pattern of catastrophic thinking had more difficulty in disengaging from pain compared to those with less or without catastrophic thinking [15]. Several tools were developed to assess different coping strategies [9, 23, 37, 69]. Truchon and Cote [80] showed that some of the subscales of the Chronic Pain Coping Inventory [37] and the Coping Strategies Questionnaire [69] were able to predict different outcome variables in conservatively treated patients with subacute low-back pain.

It is now realised that acceptance and/or tolerance of chronic pain and pain-related anxiety influences substantially the individuals' perception of pain. The acceptance of chronic pain has been found to be associated with reports of less pain, psychological distress and physical and psychological disability [50, 52, 76]. On the other extreme, high psychological and medical risk factors according to a pre-surgical psychological screening were highly correlated to a poor surgical outcome for chronic back pain [6]. Pain-related fear was found to be predictive of back-pain intensity in a recent study by van den Hout et al. [17]. Consequently, several instruments such as the Chronic Pain Acceptance Questionnaire [27], the Pain Anxiety Symptoms Scale [51] and the Fear Avoidance Beliefs Questionnaire [82] have been developed to assess these aspects.

Pain tolerance as the individual expectancy of how much pain would be bearable to work with has recently found to be predictive for work disability and future chronification of back pain [61]. Besides pain intensity, pain tolerance was found to be the most important predictor for the development of chronic low-back pain. Based on the preliminary results, the Heidelberger Questionnaire HKF-R 10 (ten items on pain intensity, pain tolerance, education, effect of massage, depression, catastrophic thinking, helplessness, duration of back pain and gender) was developed. This simple tool (currently available only in German) was able to correctly predict the course of pain development in 78.05% of all patients [61].

Importance of pain history

Besides the aforementioned parameters, a thorough assessment of pain history may be very helpful in evaluating better the back-pain patients. Smedley et al. [73] for example found in a longitudinal study on 1,400 nurses that back pain of gradual onset was associated with psychological symptoms measured at the baseline, but no such association was seen for those exhibiting a sudden pain. On the other hand, low-back pain of acute onset at work was strongly correlated with exposure to specific patient-handling tasks where no such association was found for gradual onset. Furthermore, previous back-pain symptoms were significantly associated with a higher incidence of low-back pain during follow-up and the risk of new back pain increased with increasing duration of previous pain and decreasing interval since the last episode. However, low-back pain of sudden onset was associated with greater short-term disability and more sickness-absence from work. Similarly, Burton et al. [12] investigated a cohort of police officers and found that exposure to occupational physical stress reduced the time from the baseline to the first-onset of low-back trouble. Recurrence of pain was associated with time since onset, whereas chronicity was related to distress and blaming police work. Not only pain onset but also duration of the first episode of the pain has some predictive potential. Patients remaining off work after 1–2 months, because of their back, exhibit a high risk of much longer-term disability [29].

These examples illustrate that besides the classical clinical symptoms such as neural claudication pain, radicular pain or pain aggravation during night pain history may add valuable information to a comprehensive picture of the individual's pain situation and its prognosis.

Summary

Usually, pain is the major complaint of back-pain patients and thus, the evaluation of pain is one of the

foundation pillars in the outcome assessment. Pain-intensity assessment seems to be most reliable when asking for an average pain level during a short past period of time from 1 week to 6 months. In well-informed patients, VAS and GRS are valuable instruments to assess pain intensity and changes due to therapy. Some restrictions have to be taken into account when using these tools in an elderly population. NRS and VRS are other methods in pain assessment. Although being well understandable and easy to handle (also in telephone interviews), they are not as appropriate to detect changes over time as are VAS and GRS. The value of pain drawing is controversially discussed. Whereas some authors find it to be useful to assess psychological involvement in pain, others do not. Moreover, this method failed to predict the outcome after surgical or non-surgical treatment as shown in a recently published randomised trial. Several instruments that address pain affect exist and have proven their validity. Besides all these methods, a thorough assessment of the previous pain history may contribute important information to the pathomorphologic correlate causing pain and may be of substantial prognostic importance. Finally, one should be aware of the influence of coping strategies, pain acceptance, pain tolerance, anxiety of pain and fear-avoidance behaviour when evaluating the pain situation of patients. These factors were found to be significantly associated with the outcome after treatment for chronic pain in several trials.

Recommendation

A standard minimum pain assessment for back-pain patients should integrate pain intensity (e.g. VAS/NRS), pain affect (e.g. five-point VRS) and pain-related disability. Depending on more detailed research questions, more sophisticated questionnaires on pain affect (e.g. MPQ), coping strategies and fear-avoidance behaviour should be used. This allows for a more comprehensive assessment of pain and factors influencing pain perception.

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