

Research Study

Pain Relief Scale Is More Highly Correlated with Numerical Rating Scale than with Visual Analogue Scale in Chronic Pain Patients

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The pain relief scale (PRS) is a method that measures the magnitude of change in pain intensity after treatment. The present study aimed to evaluate the correlation between PRS and changes in pain determined by the visual analogue scale (VAS) and numerical rating scale (NRS), to confirm the evidence supporting the use of PRS. Sixty patients with chronic spinal pain that had a VAS and NRS recorded during an initial examination were enrolled in the study. One week later, the patients received an epidural nerve block, then VAS, NRS, and PRS assessments were performed. Differences between VAS and NRS were compared to the PRS and scatter plots and correlation coefficient were generated. The differences and magnitude of decrease in the VAS and NRS raw data were converted to percentile values, and compared to the PRS. Both VAS and NRS values exhibited strong correlations (> 0.8) with PRS. Further, the differences between the VAS-PRS R (0.859) and NRS-PRS R (0.915) were statistically significant, ($P = 0.0259$). Compared to PRS, the VAS and NRS percentile scores exhibited higher correlation coefficients than scores based on the raw data differences. Furthermore, even when converted to a percentile, the NRS%-PRS R (0.968) was higher than the VAS%-PRS R (0.904), $P = 0.0001$. The results indicated that using the PRS together with NRS in pain assessment increased the objectivity of the assessment compared to using only VAS or NRS, and may have offset the limitations of VAS or NRS alone.

Key words: Pain relief scale, numerical rating scale, visual analogue scale, pain measurement, pain intensity measurement, pain intensity scale

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Pain is an important clinical symptom that pain specialists must consider as the fifth vital sign. Further, the assessment of pain can be considered a fundamental prerequisite to the overall treatment (1-3). The visual analogue scale (VAS) and numerical rating scale (NRS) are simple and quick pain assessment scales that measure pain intensity. The VAS and NRS are relatively easy for both the test administrator and the patient to understand, and provide satisfactory sensitivity, reliability, and accuracy (4-7). Furthermore, by assigning a numerical value to the pain intensity, these methods offer the advantage of quantification of the pain assessment process. However, the pain intensity is only measured at the time of assessment, and depending on the explanation provided and the

patient's understanding, discrepancies in the results may arise. Because the absolute numeric changes in the pain scores do not directly reflect the rates of change in pain, it can be cumbersome to calculate these rates separately. Specifically, when the test administrators differ, there may be variations when the standards for "no pain" (pain score of 0) to the "most severe pain imaginable" (pain score of 10), are established, depending on how the test administrator explains these standards (4,8).

The pain relief scale (PRS) is a method that employs the previous intensity of pain as the baseline, and subsequently measures the magnitude of change in pain intensity after treatment. The PRS standard designates the pain intensity score before treatment as either 10

or 100, which is easy to understand for both the test administrator and the patient. Similarly, the PRS standard simplifies the assessment process, and results in almost no differences associated with the test administrator's explanation, even when the administrators differ.

The advantages of PRS could offset the limitations of VAS or NRS in assessment of pain intensity. While there have been published reports investigating or comparing the utility, accuracy, and reliability of VAS or NRS, there have been virtually no reports to date that have investigated these parameters in PRS. The present study aimed to confirm the evidence to validate the PRS and its utility, by verifying the degree of correlation between changes in pain determined by PRS versus pain assessment using VAS or NRS.

METHODS

The study was conducted on 60 patients who visited the facility because of chronic spinal pain, and who had a VAS and NRS recorded during the initial examination. The patients were then readmitted one week later, and an epidural nerve block followed by the VAS, NRS, and PRS was performed. Four patients were excluded during follow-up and were not included in the analysis, resulting in a final total of 56 patients. The study included patients between the ages of 20 and 80 years, who had chronic pain persisting for greater than 3 months, and who were able to understand and express the concepts of VAS, NRS, and PRS. The exclusion criteria included patients younger than 20 years or older than 80 years; individuals with acute pain continuing less than 3 months; patients with decreased awareness, cognitive impairment, or psychiatric problems; and those suspected of having secondary gain motives.

The VAS was assessed on a 100 mm horizontal line. The patients were informed that the left end of the scale represented "no pain" and that the right end represented the "most severe pain imaginable." The patients were then instructed to mark the intensity of pain they were currently experiencing on the line. For the NRS, an 11-point scale was used, with "0" representing "no pain" and "10" representing the "most severe pain imaginable." For PRS assessment, the patient was instructed to consider the pain during the previous visit as 10, and to indicate the decrease in the current pain level. All pain assessments were performed by a single doctor who was blinded to the conduct of the study. When assessing the pain level during the second visit, the patients were not informed of the previous VAS or NRS results.

To determine the correlation between the VAS and NRS assessments, and the PRS, the difference in VAS from the first examination and one week later was calculated (pre-VAS–post-VAS). The difference in the NRS was calculated using the same method (pre-NRS–post-NRS). The differences were then compared to the PRS and a scatter plot and correlation coefficient were generated for each, using the R program (Language R, compOverlapConver 1.0) to validate the statistical significance of the correlation coefficients.

The differences in the VAS and NRS raw data, as well as the magnitude of decrease in the VAS or NRS, were converted to percentile values $([\text{pre-value} - \text{post-value}/\text{pre-value}] \times 100)$, and compared to the PRS score multiplied by 10. A scatter plot and correlation coefficient were then obtained for each. The 2 correlation coefficients were also confirmed as statistically significant using the R program (Language R, compOverlapConver 1.0). SPSS ver. 12.0 for Windows was used for the calculation of correlation coefficients, and a P -value < 0.05 was considered statistically significant. To determine the statistical significance between the correlation coefficients, the R program (Language R, compOverlapConver 1.0) was used, and a P -value of < 0.05 was considered statistically significant. The converted percentile values of the VAS and NRS were calculated using the PRS value multiplied by 10.

RESULTS

The patient characteristics, including age, gender, pain duration, and pain localization are shown in Table 1. Among the 56 patients enrolled in the study, 27 were men and 29 were women. The patients were aged 57.3 ± 13.3 years (mean \pm SD), and had a mean pain duration of 9.7 ± 5.7 months (mean \pm SD). Pain in the patients was localized to the lumbar region, and was accompanied by lower body pain in 16 patients and cervical pain 4 patients.

The correlation coefficients between the assessment methods and the correlation coefficients for each converted percentile value were calculated (Table 2). A scatter plot for each method is shown in Figs. 1–4. The correlation coefficient between VAS and PRS (VAS-PRS R) was 0.859, which was calculated by comparing the difference between the initial VAS and the VAS one week later to the PRS measured at the one-week examination. An identical method was used to calculate the correlation coefficient (NRS-PRS R) between NRS and PRS, which resulted in a value of 0.915. Both values indicated strong correlations (> 0.8). Further, the NRS-PRS R

Table 1. Patient demographics.

| | |
|---------------------------------------|-------------|
| Male:Female (No. of patients) | 27:29 |
| Age (years) (Mean ± SD) | 57.3 ± 13.3 |
| Duration of Pain (months) (Mean ± SD) | 9.7 ± 5.7 |
| Location of Pain (total 56 patients) | |
| Low back pain | 12 |
| Low extremity pain | 8 |
| Low back pain & Lower extremity pain | 16 |
| Neck pain | 9 |
| Upper extremity pain | 4 |
| Neck pain & Upper extremity pain | 7 |

value was higher than the VAS-PRS R value. The *P*-value resulting from analyses of the difference between the VAS-PRS R value (0.859) and NRS-PRS R value (0.915) was 0.0259, which indicated a statistically significant difference between the 2 correlation coefficients.

In addition, the magnitude of the decrease in the VAS and NRS were converted to percentiles, and compared to the PRS to obtain the respective correlation coefficients. When comparing the converted magnitude of decrease in the VAS to the PRS, the correlation coefficient (VAS%-PRS R) was 0.904, and the converted magnitude of decrease in the NRS to the PRS resulted in a correlation coefficient (NRS%-PRS R) of 0.968. The VAS and NRS percentile scores exhibited higher correlation coefficients than scores based on the raw data differences when compared to PRS. Furthermore, even when converted to a percentile, the NRS%-PRS R value (0.968) was higher than the VAS%-PRS R value (0.904). Further, the difference in correlation coefficients was found to be statistically significant (*P* = 0.0001). These results were also confirmed using scatter plots (Figs. 1–4).

DISCUSSION

Pain is an unpleasant sensory and emotional experience that is associated with actual or potential tissue damage, or is described associated with such damage. Pain is not a one-dimensional result of tissue damage, but a multi-dimensional experience caused by various factors including cognitive, behavioral, emotional, socio-cultural, educational, and religious factors (9). Therefore, a complete pain assessment of each patient must be accomplished through the analysis of the various factors in the individual. However, how and to what extent a particular factor may affect an individual's pain

Table 2. The correlation coefficients between each measurement.

| | Pain intensity measurements | Correlation coefficient (R) |
|-----------------|-----------------------------|-----------------------------|
| Raw data | NRS (raw) and VAS (raw) | 0.900 |
| | NRS (raw) and PRS | 0.915 |
| | VAS (raw) and PRS | 0.859 |
| Percentile data | NRS (%) and VAS (%) | 0.874 |
| | NRS (%) and PRS × 10 | 0.968 |
| | VAS (%) and PRS × 10 | 0.904 |

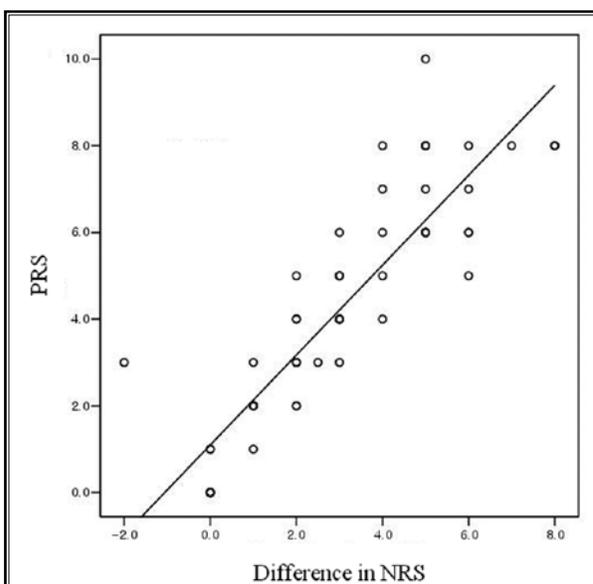


Fig. 1. Scatter plot between PRS and difference in NRS (*R*² = 0.78).

perception and magnitude of pain varies. However, developing universal multi-dimensional measurements that are applicable to everyone is nearly impossible. A few multi-dimensional measurements have been developed that consider the various factors affecting pain, but their clinical effectiveness falls short due to limitations in interpretation and the complexity of use and assessment (4,9). As a result, the current pain assessment methods most commonly employed in a clinical setting are one-dimensional measurements that only consider the subjective pain intensity. The most well-known of these methods are VAS and NRS (4,10).

Pain assessment using the VAS or NRS is limited by the inability to express the multi-dimensional aspects of pain. Furthermore, simple comparisons between

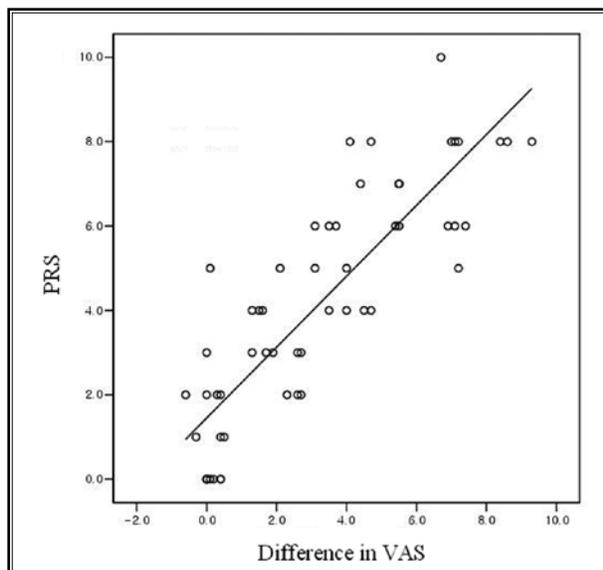


Fig. 2. Scatter plot between PRS and difference in VAS ($R^2 = 0.726$).

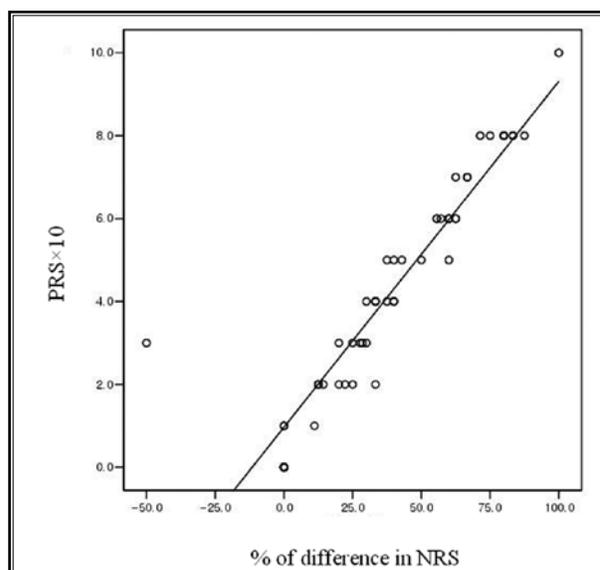


Fig. 3. Scatter plot between PRS $\times 10$ and percentile value of difference in NRS ($R^2 = 0.856$).

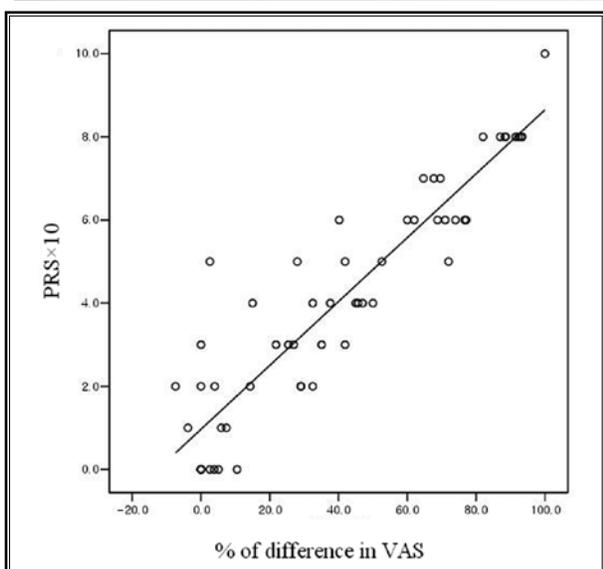


Fig. 4. Scatter plot between PRS $\times 10$ and percentile value of difference in VAS ($R^2 = 0.844$).

different times, the measured VAS numbers were not identical. Similarly, the explanation and understanding of the “most severe pain imaginable,” which is one of the primary criteria measured during the assessment, may differ between test administrators and affect the results (12).

Although PRS has the shortcoming of requiring the patient to remember the previous pain level, an advantage is that the scale describes pain on a 10- or 100-point standard, rather than by using the verbiage “most severe pain imaginable.” This technique should be much easier for the administrator to explain and for patients to understand, which may also minimize differences in the results between different test administrators. Notably, the VAS and NRS scores are absolute values that indicate the pain intensity at a specific moment. Consequently, the differences in the VAS and NRS pain intensity cannot reflect the change in pain magnitude. In contrast, PRS establishes the previous pain intensity as the comparative on a score of 10 or 100, and determines the percent change at the time of assessment, which has the inherent advantage of obtaining the rate of change without the need for calculations.

The present study findings indicated that the shortcomings and the cumbersome nature of the VAS and NRS were improved, and that their reliabilities increased when combined with the use of the PRS. However, because there are no previous studies that

patients may be difficult because the subjective level of pain felt and expressed by each individual may differ. Mader et al (11) reported that when measuring the magnitude of intolerable pain by VAS, individual results varied greatly, ranging from 8 mm to 73 mm. Additionally, when an individual was given the same stimulus at

confirm the reliability of PRS, this study aimed to maximize the accuracy and reproducibility of the VAS, NRS, and PRS by examining their correlations. Thus, to avoid a potential error caused by the tests being interpreted or administered differently, all pain assessments were conducted by a single individual who had no knowledge of the study objectives. Similarly, the change in pain level assessed by the PRS was performed one week after the initial examination, which was a relatively short duration that allowed the patients to easily recall previous pain levels.

In the current study, the differences measured one week apart for the VAS (pre-VAS–post-VAS), NRS (pre-NRS–post-NRS), and PRS all exhibited strong correlation coefficients ($R > 0.8$, $P < 0.001$) that were statistically significant, which indicated that the VAS, NRS, and PRS all obtained similar results in assessing the pain level in patients (Table 2). However, upon closer examination, the data revealed that the correlation between the PRS and NRS was higher than the correlation of PRS and VAS. Further, the results indicated that there was statistical significance between the 2 correlation coefficients, which indicates that the correlation between PRS and the NRS value was stronger.

When comparing the VAS and NRS, there were a few limitations. The VAS assessment is a method that requires the patient to directly mark the pain level on a straight line drawn on paper or on a computer monitor. However, differences in the length of the line have been shown to cause noticeable differences in the results (6,13). In addition, the distribution of the measured values can be influenced by the graphic orientation of the VAS, with the horizontally measured values differing from the vertically measured values (14).

Cultural differences have also been reported as significant factors; Chinese-speaking populations tend to have fewer errors using vertically measured values, while English-speaking populations show fewer errors with the horizontally measured values (15,16). Unlike VAS, which has numerous biases based on the assessment method, language, or culture, NRS has fewer shortcomings due to its standardization. In addition, NRS does not require any special equipment for the assessment, which makes the NRS easier to use than the VAS (17,18). Furthermore, while the VAS has a reported failure rate of 4–11%, the measured failure rate for the NRS was comparatively lower at 2% (19,20). As a result, the NRS is generally preferred over the VAS in clinical settings (21–23). In this study, PRS was more highly correlated to the NRS, which was already preferred due to

its standardization and lower failure rate.

Another factor to consider is that the measured VAS and NRS values are raw data. Comparing the differences in these raw data is inadequate for determining the change in pain intensity. To truly evaluate the change in pain intensity, it would be more appropriate to measure the magnitude of change in the VAS and NRS values (24,25). In the case of VAS and NRS, calculating the magnitude of change requires converting the data to the level of change. However, the PRS method sets the previous pain intensity to 10 and measures the magnitude of the decrease. Consequently, the concept of a level of change is incorporated into the measurement. Interestingly, in this study the correlation coefficients between the magnitude of change in the PRS to the VAS or to the NRS (VAS%-PRS R [0.904], NRS%-PRS R [0.968]) was higher than the correlation coefficients calculated using the raw data (VAS-PRS R [0.859], NRS-PRS R [0.915]).

Statistically, comparison of the correlations between the differences in the PRS and the VAS and NRS determined using the raw data, and to differences in the magnitude of change cannot be made. However, it can be surmised that the PRS has a greater potential to reflect the magnitude of change in the VAS and NRS. When comparing the correlation between the magnitude of change in PRS and VAS versus PRS and NRS, the correlation between the former was higher and was statistically significant ($P = 0.0001$). This trend was also apparent in the scatter plots (Figs. 1–4). In summarizing these results, the correlation between the PRS and NRS was greater than the correlation between the PRS and VAS. Similarly, when evaluating a patient's pain, the PRS and NRS are complementary, and can be used more effectively in pain assessment.

Nonetheless, the current study had some limitations. The study period was relatively short, and the conditions and number of patients evaluated were insufficient. Consequently, additional studies performed over a longer period and that evaluate a sufficient number of conditions and patients are required. For PRS in particular, the pain measurements were performed one week apart to minimize any bias from a loss of ability to recall pain intensity, but prolonging the follow-up time, may limit the PRS assessment.

CONCLUSION

The PRS proved to be an objective method for assessing pain that was less susceptible to influence from patient understanding or explanation by the test ad-

ministrator, and had the advantage of expressing the change in pain intensity through the PRS score itself. Furthermore, the PRS showed a statistically significant correlation to the VAS and NRS, with a stronger correlation between the PRS and NRS than between PRS and VAS. Therefore, using the PRS in combination with the NRS for pain assessment increases the objectivity of the assessment compared to the use of only VAS or NRS, and to a limited extent, overcomes the limitations of VAS or NRS alone.

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Author contributions

Jae Jin Lee; manuscript writing, search for references. Mi Kyoung Lee; adviser, clinical management of patients. Jung Eun Kim; data collection, clinical management of patients. Hee Zoo Kim; statistical analysis. Sang Hoon Park; search for references, statistical analysis. Jong Hyun Tae; patient interview, data collection. Sang Sik Choi*; provided the idea and the study design, managed all about the study, proofread the manuscript.

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