The Development and Validation of Hundred Paisa Pain Scale for Measuring Musculoskeletal Pain

A Prospective Observational Study

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Abstract: The reduction in the pain intensity is one of the most important outcome measures in musculoskeletal disorders. The assessment of pain required reliable and valid scale. The aims of this prospective observational study were to develop and evaluate concurrent validity and test–retest reliability of hundred paisa pain scale (HPPS) for measuring musculoskeletal pain.

A consecutive 74 patients with musculoskeletal pain with a wide variety of diagnoses were enrolled. Patients reported their intensity of pain on the following scale: HPPS, ''visual analog scale (VAS),'' and ''numerical rating scale (NRS).'' Patients were asked to complete another HPPS, VAS, and NRS after 2 days to determine the reproducibility of the scales. Spearman rank correlation coefficients between the HPPS and the NRS, and VAS were used to determine the validity of the scales. The correlation between the change score of HPPS, VAS, and NRS was used to determine the responsiveness of HPPS.

Results of test–retest indicate that the reproducibility of HPPS was good to excellent with the intraclass correlation coefficient (ICC) value of 0.85 (95% confidence interval [CI], 0.76–0.91). The standard error of measurement (SEM) was 5.24. The minimum detectable change based on the SEM for test–retest was 14.52. The reproducibility of VAS is moderate to good with the ICC value of 0.82 (95% CI, 0.72–0.88). The reproducibility of NRS is good to excellent with the ICC value of 0.88 (95% CI, 0.81–0.92). There was a strong correlation between the HPPS and the VAS, and NRS ($P < 0.01$), which confirm the validity. The HPPS was responsive as the correlation of the change score of HPPS with the change score of VAS, and NRS were good (0.80 and 0.86, respectively).

The HPPS is a valid and reliable scale to assess musculoskeletal pain, with psychometric properties in agreement with other comparable scale.

> **Abbreviations**: HPPS = hundred paisa pain scale, NRS = numerical rating scale, VAS = visual analog scale, VRS = verbal rating scale.

INTRODUCTION

The evaluation of treatment benefits for individuals with musculoskeletal pain requires outcome measures that are reliable, valid, and responsive.[1] The assessment of pain intensity is vital in clinical practice and treatment outcome research.[2,3] There are varieties of scale, including the ''visual analog scale (VAS),'' ''verbal rating scale (VRS),'' and ''numerical rating scale (NRS),'' are used to quantify intensity of pain.[4,5] The psychometric properties of these scales have been investigated, but no single scale has consistently been shown better to the others.[4,5] These 3 scales are different in a variety of aspects, for example, the number of response categories, patient preference, and administration requirements.[6]

Previous studies indicate that the application of the VAS in the elderly patients is difficult than the NRS, furthermore, that the elderly prefer NRS over the VAS.[7,8] For example, the application of VAS requires a person to imagine his pain in terms of a mathematical dimension, a task that may be difficult,[9,10] especially for the elderly. In addition, previous studies found 7% to 16% higher failure rates for VAS than those for NRS or VRS.[11–13] The correlation between the NRS and VAS are good and both are equally sensitive for the assessment of pain, but clinical studies indicate that the NRS is superior to others, especially with elderly, less educated, and chronic pain patients.[14–16]

Indian population, the majority of uneducated patients describes their pain on the amount of 100 paisa. For example, 20 paisa pain out of 100 paisa. It is easy for a person to imagine his pain intensity in terms of a given paisa as they know the magnitude of the money, for example, how much pain they feel on 100 paisa. Chakraborty and Mathur have published an anecdotal report on ''Rupee scale: For measurement of pain in India.''[17] They reported their personal experiences of assessment of postoperative pain using the ''Rupee scale.'' In addition, Kapadia-Kundu and Dyalchand has developed a numerical scale, the ''Pachod paisa scale'' to measure attitudes, intentions, emotions, patient's satisfaction, and pain.[18] However, both these studies did not report the psychometric properties such as the validity and reliability of these scales. In addition, the psychometric analysis of these scales to assess musculoskeletal pain intensity is not reported anywhere else. Therefore the present study intended to develop and validate a

hundred paisa pain scale (HPPS) for measuring intensity of musculoskeletal pain.

METHODS

Scale Development

The HPPS consists of 11 point horizontal scale on a sequence of paisa. The left and right of the scale is anchored by 2 end; 0 paisa means no pain at all, whereas 100 paisa describes worst pain ever. The intervening points are represented by proportionally the increasing amount of 10 paisa (Figure 1). The patients can indicate the amount of paisa that most close to the magnitude of their pain intensity.

Participants

The patients with musculoskeletal pain who were treated in the outpatient orthopedic department at the Pushpanjali Hi-tech Rehab Centre, Kolkata, India were selected in this prospective observational study by convenience sampling method. Both male and female subjects with symptomatic musculoskeletal pain, age older than 21 years were included. Subjects were excluded if they had known diabetes mellitus, neurological disease, inflammatory joint disease, and uncooperative. Initially a total of 90 subjects screened and 74 participants fulfill the inclusion criteria. The study had an approval of the Institutional Ethics Committee (IEC) of the Rehabilitation Research Chair of King Saud University and each participant had given a written informed consent.

Procedures

A brief instruction about the procedure before completing the scales was given to the participants. The demographic data, including age, gender, height, weight, and body mass index (BMI), was recorded. The baseline measurement of pain intensity of each patient was taken by the HPPS, VAS, and NRS. The correlation between the baseline score of the HPPS, VAS, and NRS were used to determine the concurrent validity of the scale. The order of administration of 3 scales for each patient was determined by computerized randomization performed before the commencement of the study. Patients were asked to complete another HPPS, VAS, and NRS after 2 days to determine the reproducibility of the scales. The correlation between the change score of HPPS, VAS, and NRS was used to determine the responsiveness of HPPS. Usually in the reliability study, the responsiveness was assessed using the prevalidated instruments as an external criterion of change.[19] In the present study, the VAS and NRS measurements were used as an external validation tool. Two independent investigators were involved in both sessions. During the 2nd and 3rd assessment, the participants were unaware about their first scores.

Statistical Analysis

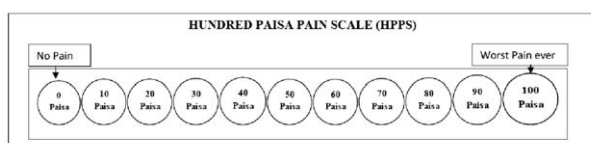SPSS for Windows version 19 (Statistical package for the Social Sciences, IBM, Inc. Chicago, IL, USA) was used to analyze the data. The normality of the data was tested using the Shapiro–Wilk test. The data were not normally distributed ($P < 0.05$). The test–retest reliability of an HPPS, VAS, and NRS were assessed using intraclass correlation coefficients (ICC 2, 1). The Bland–Altman plot method was used to assess the agreement between 2 readings. The average of 2 readings on the *x*-axis was plotted with the difference of each pair of readings on the *y*-axis (Figure 2). Data were visually interpreted to determine the consistency of 2 scores. The concurrent validity was tested using the Spearman correlation coefficients between the baseline scores of HPPS and the VAS and NRS. The responsiveness was tested using the Spearman correlation coefficients between the change score (end of intervention − baseline) of HPPS, VAS, and NRS. The calculation of the standard error of measurement (SEM) and the minimum detectable change (MDC) was done based on the results of the reliability analyses. The SEM was calculated as $SD\sqrt{(1-r)}$, where r is the reliability coefficient and SD is the standard deviation of the scores.[20,21] MDC was calculated as $1.96\sqrt{2}$ (SEM).[22] The level of significance in all tests was $P < 0.05$ with 95% confidence interval (CI).

RESULTS

Table 1 details the participants' characteristics. The mean age and standard deviation of the sample was 46.08 and 16.15 years, respectively. The sample consisted of 32 female and 42 male participants. Table 2 details the baseline score of HPPS, VAS, and NRS.

Test–Retest Reliability

Test–retest results are given in Table 3, showing that the reproducibility of HPPS is good to excellent with the ICC value of 0.85 (95% CI, 0.76–0.91). The reproducibility of VAS is moderate to good with the ICC value of 0.82 (95% CI, 0.72–0.88). The reproducibility of NRS is good to excellent with the ICC value of 0.88 (95% CI, 0.81–0.92). The Bland–Altman limit of agreement of HPPS is depicted in Figure 2 showing a reasonable agreement between the test–retest when differences between the 2 readings is plotted against the mean of 2 readings.

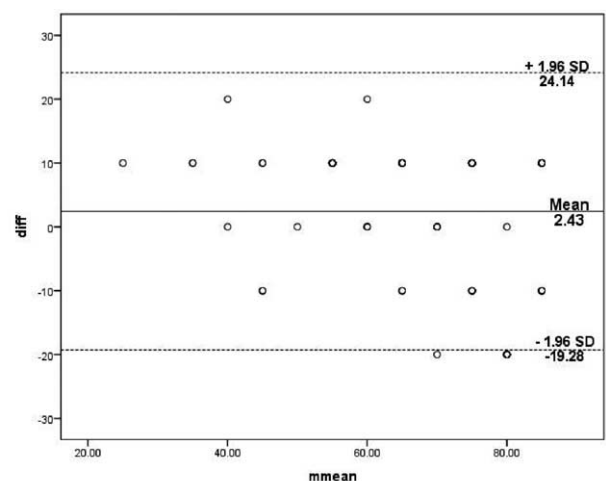**FIGURE 2.** Bland–Altman plot: intraindividual differences (n = 74) between the hundred paisa pain scale on test and retest, plotted against the average of the 2 scores. The central line represents the mean difference and the dashed lines display the 95% LOA.

FIGURE 1. Hundred paisa pain scale (HPPS).

TABLE 1. Participant's Characteristics

Gender, no. (%)	
Male	42 (56.8)
Female	32 (43.2)
Age, years	
Mean (SD)	46.08 (16.15)
Range	21−80
Height, m	
Mean (SD)	1.59 (0.08)
Range	1.50−1.80
Weight, kg	
Mean (SD)	63.81 (10.57)
Range	42−90
BMI, kg/m^2	
Mean (SD)	25.21 (4.23)
Range	18.80−36.52
Educational status, no. (%)	
Illiterate	24 (32.4)
Primary	5 (6.8)
Secondary	16 (21.6)
Graduation	29 (39.2)
Duration of pain, no. (%)	
0−3 weeks	20 (27.0)
4−12 weeks	15 (20.3)
>12 weeks	39 (52.7)
Diagnosis, no. (%)	
Low back pain	28 (37.8)
Knee osteoarthritis	14 (18.9)
Frozen shoulder	7 (9.5)
Neck pain	7 (9.5)
Fractures	17 (23)
Rotator cuff/impingement syndrome	1 (1.4)

BMI = body mass index, SD = standard deviation.

Concurrent Validity

A good positive correlation between HPPS and the VAS (r = 0.855), and excellent positive correlation between HPPS and the NRS (r = 0.918) were noted. This is shown in Table 4.

Responsiveness

The change scores (end of intervention − baseline) of HPPS, VAS, and NRS were used to determine the responsiveness of the scale. The correlation between change scores of HPPS and VAS were 0.80 (rho) ($P < 0.01$). The correlation between change scores of HPPS and NRS were 0.86 (rho) ($P < 0.01$).

TABLE 2. Descriptive Statistics of Baseline Scores

VAS (0−10 cm)	
Mean (SD)	7.07 (1.51)
Range	3−10
HPPS	
Mean (SD)	67.57 (13.54)
Range	30−90
NRS, no. (%)	
Mean (SD)	6.89 (1.42)
Range	3−9

HPPS = hundred paisa pain scale, NRS = numerical rating scale, SD = standard deviation, VAS = visual analog scale.

TABLE 3. Test−Retest Reliability of (HPPS), VAS, and NRS

	ICC (95% CI)		
	HPPS	**VAS**	**NRS**
Test−retest	0.85 (0.76−0.91)	0.82 (0.72−0.88)	0.88 (0.81−0.92)

95% CI = 95% confidence interval, HPPS = hundred paisa pain scale, ICC = intraclass correlation coefficient, NRS = numerical rating scale, VAS = visual analog scale.

Measurement Error and Minimum Detectable Change

The SEM was 5.24, based on repeated measurements for test−retest. The MDCs based on the SEM for test−retest was 14.52 (Table 5).

DISCUSSION

The aim of the present study was to examine the psychometric properties including reliability and validity of HPPS and compare them with 2 other commonly used scales, namely the VAS and NRS. The result of the present study indicates that the reproducibility of the HPPS, VAS, and NRS were good to excellent, moderate to good, and good to excellent, respectively. In the present study, the reliability of HPPS had an ICC value 0.85, which was lower than the NRS (ICC = 0.88) and higher to that of the VAS (ICC = 0.82). However, in the previous study of musculoskeletal pain the VAS and NRS had little higher ICC values (0.97 and 0.99, respectively).[14] In the latter, the sample consisted of group of orthopedics patients and limited to low education level. However, in the present study, there was no limitation of educational level. Ferraz et al[23] had reported a high ICC values for literate as compared to illiterate patients with rheumatoid arthritis.

A correlation coefficient of more than 0.75 is required to consider a valid instrument.[19] In the present study, the HPPS had high correlation coefficients (r = 0.85 − 0.91) with the NRS and VAS (Table 4), indicates strong consistency in pain scores between these scales. The results of present findings indicate that the HPPS is a valid measure of the musculoskeletal pain level. The HPPS appears to measure pain intensity similar to the VAS and NRS and may provide additional advantages for the Indian population as this scale is easy to understand by this population. In previous studies, the correlation between the NRS and VAS was high in patients with rheumatic and other chronic pain conditions.[23,24] In the present study, we found a strong correlation between the NRS and VAS (r = 0.91).

TABLE 4. Validity Analysis: Correlation Matrix of HPPS, VAS, and NRS

	HPPS	**VAS**	**NRS**
HPPS	−	0.855*	0.918*
VAS	0.855*	−	0.910*
NRS	0.918*	0.910*	−

HPPS = hundred paisa pain scale, NRS = numerical rating scale, VAS = visual analog scale.
* All correlations were significant at $P < 0.01$ (Spearman rank coefficients).

TABLE 5. SEM, MDC, and Bland and Altman Tests for HPPS

	SEM	MDC	Bland and Altman Test			
			đ	95% CI for đ	SD_{diff}	95% Limit of Agreement
HPPS	5.24	14.52	2.43	−0.13 to 4.9	11.08	−19.28 to 24.14

95% CI for đ = 95% confidence interval for the mean difference, đ = mean difference, HPPS = hundred paisa pain scale MDC = minimal detectable change, SD_{diff} = standard deviation of the differences, SEM = standard error of measurement.

Similarly, Bijur et al[25] have demonstrated strong correlation between the NRS and VAS (r = 0.94).

In the present study, the correlation between the change score of HPPS, VAS, and NRS was used to determine the responsiveness of HPPS. The results of the present study indicate that the correlation of change score of HPPS with the change score of VAS and NRS was good (0.80 and 0.86, respectively). A correlation score of 0.70 or more is acceptable for instruments that measure the same construct.[26] Therefore HPPS give similar responses as compared to VAS and NRS in assessing musculoskeletal pain.

Study Limitations

The present study involves some potential limitations. The generalizability of present results may be limited due to the heterogeneity in the samples (eg, participants had pain of different etiologies). In addition, the present study did not consider the chronicity of the pain (ie, acute vs. subacute vs. chronic). Therefore, we recommend that future studies be conducted to compare the chronicity of pain using HPPS and use a homogeneous patient population.

CONCLUSIONS

The HPPS is a valid, reliable, and responsive scale to assess the musculoskeletal pain, with psychometric properties in agreement with other widely used scale.

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