A Comparison of Visual Analog and Graphic Rating Scales for Assessing Pain Following Delayed Onset Muscle Soreness

By: Carl G. Mattacola, David H. Perrin, Bruce M. Gansneder, Jennifer D. Allen, and Cheryl A. Mickey*

Mattacola, C.G., Perrin, D.H., Gansneder, B.M., Allen, J.D., Mickey, C.A. (1997). A comparison of visual analog and graphic rating scales for assessing pain following delayed onset muscle soreness. Journal of Sport Rehabilitation, 6:38-46.

*****Note: Figures may be missing from this format of the document**

Abstract:

This study evaluated a visual analog scale (VAS) and a graphic rating scale (GRS) for the measurement of pain following delayed onset muscle soreness (DOMS) and following treatment for the symptoms of DOMS. Data from two studies were used to evaluate the scales. Pain intensity was assessed prior to and following induction of DOMS and immediately before and after each treatment session. In Study 1, subjects were randomly assigned to receive a 20- min ice pack followed by a 7-min sham ultrasound treatment or a 20-min ice pack followed by a 7-min nonthermal ultrasound treatment. In Study 2, subjects received a 20-min microcurrent neuromuscular stimulation (MENS) treatment or a 20-min sham MENS treatment. In both studies, significant differences were found between the VAS and GRS scales for pretest conditions on Days 1 and 2 for all subjects. There were no significant differences between any other days or tests. The differences on Day 1 and Day 2 were attributed to the novelty of filling out the scales. Therefore, a visual analog or graphic rating scale can be used to evaluate pain intensity following DOMS when repeated measurement is involved, although consideration should be given to potential differences the first one or two times the scales are completed.

Article:

The measurement of pain intensity is common in clinical and experimental settings. The study of descriptive rating scales originated in psychological and medical experimentation (11, 16), and variations of these scales are commonly used in the clinical setting. For example, athletic trainers frequently ask athletes to

* C.G. Mattacola was a doctoral student at the University of Virginia, Charlottesville, at the time of this study and is now with the Department of Physical Education, Temple University, Philadelphia, PA 19122. D.H. Perrin and B.M. Gansneder are with the Curry School of Education, University of Virginia. J.D. Allen was a student at the University of Virginia at the time of this study and is now a student at Shenandoah University, Winchester, VA. C.A. Mickey was a student at the University of Virginia at the time of this study and is now with Waynesburg College, Pittsburgh.

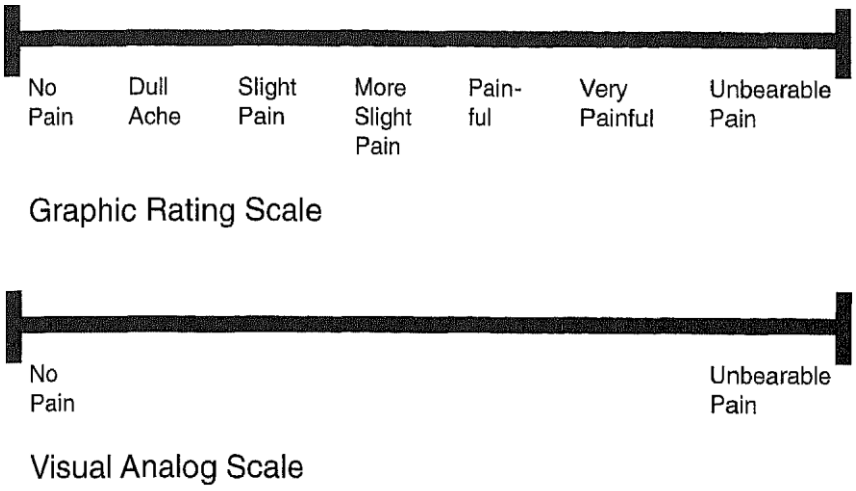

Figure 1— Visual Analog Scale and Graphic Rating Scale.

rate their pain arbitrarily from 1 to 10 to assess the effectiveness of a treatment intervention. The visual analog scale (VAS) and graphic rating scales (GRS) are two common measurement instruments used in this setting (Figure 1).

The VAS consists of a line of specified length (usually 10 cm) that has polar descriptors at its two extremes. The left end of the VAS is signified by the category of no pain and the right end by unbearable pain. The VAS offers a continuous spectrum with which to quantify subjectively the intensity of a pain stimulus (12, 15, 19). The GRS is similar to the VAS except that it contains descriptors placed at equal intervals along the base of the scale, The GRS contains, from left to right, categories of descriptors such as no pain, dull ache, slight pain, more slight pain, painful, very painful, and unbearable pain. It has been suggested that these descriptors may lack sufficient sensitivity to measure the pain experience (12).

It has been suggested that the placement of descriptors along the base of the scale creates an expression of the pain experience or intensity (10) and forces a patient to transform feelings into words (19), It has also been stated that the use of descriptor scales results in an artificial augmentation of the effect of treatment (19). Despite these criticisms, graphic rating scales are frequently used to measure the intensity of pain, especially when assessing pain following experimental inducement of delayed onset muscle soreness (5-7).

Our study was designed to determine if a difference existed between a visual analog scale and a graphic rating scale for measurement of pain intensity. Data from two studies that used an experimental model of delayed onset muscle soreness (DOMS) were used for this comparison. To our knowledge, this is the first comparison of a VAS and a GRS using a model of DOMS.

METHODS

All subjects volunteered and gave informed consent to participate in the investigation. The subjects had no history of upper extremity injury, surgery, or disease and had not participated in a weight-training program in the previous 6 months.

Pain Assessment

Our subjects completed both a VAS and a GRS prior to and following induction of DOMS and then before and after each treatment session as well as 24, 48, and 72 hr later. The subjects were asked to draw a vertical line at a point on each scale that best represented their pain at the time of measurement. The order of completion of the pain rating scales was counterbalanced. Subjects completed each scale on a clean, separate piece of paper to discourage comparison with the previous scale. The descriptors used for the GRS in this study were modeled after the scale presented by Talag in 1973 (22).

Subjects were positioned with the elbow of their nondominant arm resting on a plinth; the position was pain-free. We then applied a constant pressure to the belly of the biceps brachii muscle. A 1 in. diameter ball was constructed and glued to a flat piece of orthoplast, which was then placed over the biceps brachii. A cuff weight was hung (1.1 kg for Study 1, 2.26 kg for Study 2) from the orthoplast for 5 s, and subjects rated the intensity of their pain while the weight rested on their arm. This procedure provided a constant and consistent pressure during each application. Pain measurements were taken before and after DOMS induction and before and after treatment during subsequent sessions. The pain rating score was then determined. For both scales, the score was the distance in centimeters from the left border of the scale to the line marked during testing.

DOMS Induction

Delayed onset muscle soreness was induced by repeated eccentric isotonic contractions of the elbow flexors. All contractions were performed on the nondominant arm. At the start, the subjects stood upright with the elbow fully flexed, with a 13.6-kg dumbbell in the nondominant hand. They began by lowering the dumbbell for a 3-s count. The weight was raised back to the starting position by one of the investigators. This cycle continued until the subject could no longer control the weight for a 3-s lowering phase. Once fatigue or loss of control occurred, the dumbbell weight was decreased by 2.26-kg increments until the dumbbell equaled 126 kg. A maximum of 10 repetitions was then performed.

INSTRUMENTATION AND TREATMENT

For Study 1 (18), a nonthermal ultrasound treatment was delivered at a frequency of 1 MHz by a Sonicator 720 (Mettler Electronics Corporation, Anaheim, CA). Treatment consisted of a 20% duty cycle (2 ms on, 8 ms oft) with a 10 cm2 ultrasound head at 1.0 W/cm2 intensity for 7 min. The sound head was moved approximately 4 cm/s in circular overlapping movements. The treatment area and duration were calculated with an established equation by Dyson (9), which states that the treatment area should be two to three times the size of the ultrasound head for a 5-min treatment. Subjects were randomly assigned to one of two treatment groups. Group 1 received a 20-min ice pack and a 7-min nonthermal ultrasound treatment. Group 2 received a 20-min ice pack and a 7-min sham nonthermal ultrasound treatment. Treatment was applied to the belly of the biceps brachii, and the ice pack was held in place with a 15.24-cm elastic bandage at 24, 48, and 72 hr following DOMS induction.

For Study 2 (2), two Monad 2000 and four MENS units were used to administer the treatment and sham treatment conditions (Monad Corporation, Pomona, CA). One of the machines was altered by the manufacturer to elicit no current, and its status was blinded to subjects and investigators until the completion of the study. The treatment group received a 20-min MENS

application (2001.1A, 30 Hz, 10 min; 100 μA, 0.3 Hz, 10 min). A 5 cm x 10 cm pad was attached to the positive 10 min; 100 μA, 0.3 Hz, 10 min). A 5 cm x 10 cm pad was attached to the positive electrode and placed over the belly of the biceps brachii. A 5 cm x 5 cm pad was placed over the triceps brachii. This protocol is recommended by the manufacturer, and variations of these settings have been used in previous research (14, 17). The sham group was treated with a MENS machine that was disabled by the manufacturer. Although it elicited no current, it did maintain visual and auditory functions. Treatment was applied at 24, 48, and 72 hr following induction of DOMS. Subjects were instructed to refrain from commenting on any sensation they experienced during treatment to maintain the blind nature of this study.

STATISTICAL ANALYSIS

For both studies, separate paired t tests were performed between the VAS and GRS for each testing condition using the SPSS statistical package° (SPSS, Chicago). Using paired t tests has the potential of inflating Type I errors, that is, deciding that differences between the two scales are statistically significant when they are not. We decided that Type 1 errors would be preferable to Type II errors, since researchers should be cautious about concluding that visual analog and graphic rating scales are interchangeable.

RESULTS

The means, standard deviations, and associated t values for Study 1 are presented in Table 1 for all testing conditions. There was a statistically significant difference between the visual analog scale and graphic rating scale for the pretest condition on Day 1 ($t = —3.65$, $p < .001$) and the pretest condition on Day 2 ($t = —4.16$, $p < .001$).

The means, standard deviations, and associated t values for Study 2 are presented in Table 2 for all testing conditions. There was a statistically significant difference between the visual analog and graphic rating scale for the pretest condition on Day 1 ($t = —3.13$, $p < .006$) and the pretest condition on Day 2 ($t = —2.22$, $p < .041$).

Table 1 Means, Standard Deviations, and Associated *I* Values for All Testing Conditions From Study 1 *(0/* = 24)

	Mean (cm)	*SD* (cm)	*t* value	2-tail prob.
Day 1 pretest				
VAS	0.47	0.71	–3.65	.001*
GRS	0.58	0.80		
Day 1 posttest				
VAS	0.68	0.81	1.03	.312
GRS	0.65	0.76		
Day 2 pretest				
VAS	1.19	1.13	–4.16	.001*
GRS	1.34	1.40		
Day 2 posttest				
VAS	0.75	0.90	–0.54	.594
GRS	0.77	0.90		
Day 3 pretest				
VAS	1.70	1.80	–0.49	.631
GRS	1.73	1.75		
Day 3 posttest				
VAS	1.24	1.27	–0.59	.561
GRS	1.27	1.26		
Day 4 pretest				
VAS	1.15	1.41	–1.69	.105
GRS	1.24	1.44		
Day 4 posttest				
VAS	0.81	1.03	–0.27	.788
GRS	0.82	0.98		

*$p < .05$.

DISCUSSION

This study was conducted to determine if there were differences between a visual analog scale and a graphic rating scale when measuring pain intensity prior to and following induction of delayed onset muscle soreness and during treatment for related symptoms. Similar results were found with two different treatment paradigms from two different populations for the symptoms of DOMS. We found statistically significant differences ($p < .05$) between the visual analog scale and graphic rating scale on Day 1 and Day 2 for pretest measures for both studies. These identical findings suggest that differences may be due to performing a novel task. As the subjects became more familiar with the completion of the scales, there were no significant differences between the two scales. Prior to filling out the pain rating scales, subjects were familiarized with the two scales and read and signed a form stating that they understood the differences in the scales and the procedures for completing each scale. Even with this familiarization, differences were initially found. It has been previously reported that subjects have difficulty completing a VAS and GRS even with adequate explanation (13). When designing protocols using a single measurement occasion for recording pain intensity, researchers should consider the potential differences that may be present when the task is novel.

Table 2 Means, Standard Deviations, and Associated t Values for All Testing Conditions From Study 2 (n = 18)

	Mean (cm)	*SD* (cm)	*t* value	2-tail prob.
Day 1 pretest				
VAS	0.72	0.96	–3.13	.006*
GRS	1.18	1.40		
Day 1 posttest				
VAS	1.38	1.59	–0.51	.614
GRS	1.44	1.47		
Day 2 pretest				
VAS	2.71	2.34	–2.22	.041*
GRS	3.12	2.27		
Day 2 posttest				
VAS	2.92	2.21	–1.13	.272
GRS	3.1	2.09		
Day 3 pretest				
VAS	4.41	2.75	0.65	.524
GRS	4.35	2.65		
Day 3 posttest				
VAS	3.85	2.40	1.23	.236
GRS	3.47	2.40		
Day 4 pretest				
VAS	1.82	1.56	–0.72	.479
GRS	1.89	1.54		
Day 4 posttest				
VAS	1.58	1.58	–1.85	.081
GRS	1.84	1.45		

*$p < .05$.

Pain intensity values were statistically higher on the graphic rating scale when compared to the visual analog scale for the pretest occasions on Day 1 and Day 2 for both studies. However, the values for the graphic rating scale were not significantly different for six out of eight occasions for Study 1 and six out of the eight testing occasions for Study 2 when compared to the visual analog scale (Tables 1 and 2). The reason for this difference is not clear. Even though the graphic rating scores were higher than the visual analog scores on Day 2, the general pattern revealed no significant difference between the scores produced by the two scales. In all probability, protocols using repeated test occasions can use either scale.

It has been suggested that a scale with descriptors may artificially augment the effect of a treatment (19). The treatment was introduced in both of our studies on Days 2, 3, and 4. We found little evidence of an augmentation of the treatment effect. Only in Study 1 on Day 2 was the change from pre- to posttest statistically greater for the graphic rating scale scores. This was not true in Study 2 on Day 2 or in either study on Days 3 and 4. In addition, if we consider the absolute differences between the means and the associated standard deviations that accompany the means, these differences appear to have little clinical relevance.

The mean values for pain intensity were generally higher in Study 2 compared to Study 1. This was expected because we suspended a 1.1-kg weight from the orthoplast ball in Study 1 versus a 2.26-kg weight in Study 2. This similarity in findings while using two different weights to assess

pain intensity indicates that the different weights used to induce pain did not influence the subjects' ability to report their pain using the two different scales.

Delayed onset muscle soreness protocols are frequently used to assess the effectiveness of various treatments on musculoskeletal trauma (6, 7, 14, 17). It would be questionable to intentionally injure a subject for the purpose of science; therefore, it is possible to create symptoms with a DOMS protocol that are similar to more traumatic injuries. Delayed onset muscle soreness is characterized by pain, loss of range of motion and strength, and edema (1, 3, 4, 21). The symptoms occur 24-48 hr after unaccustomed exercise and mimic the pain—injury cycle that athletic trainers are accustomed to treating.

The use of visual analog or graphic rating scales for measuring pain intensity following delayed onset muscle soreness is an attempt to measure a subjective phenomenon. Although we should be concerned with using scales that are sensitive for many situations, we should also begin to look further in our attempt to understand the variables affecting pain. The VAS and GRS are described as more sensitive than traditional descriptive pain scales (20). However, a recent report suggests that a scale which measures both the sensory and affective components of pain may be more sensitive to small differences in pain than the VAS (8). The Descriptor Differential Scale (DDS) has been shown to be more sensitive in measuring small changes in electrocutaneous stimulation than the VAS while satisfying the following criteria: separately assessing the sensory intensity and affective dimensions of pain, providing immediate information about the accuracy and reliability of the subject's performance on the scaling responses, relatively free of biases inherent in different physical methods, simple to use for pain patients and nonpain patients in both clinical and research settings, reliable and generalizable, sensitive to changes in pain intensity, demonstrating ratio—scale properties, useful for both experimental and clinical pain, and allowing for reliable comparison between both types of pain (8). One disadvantage of the DDS is that it takes more time to complete than a VAS or GRS. While the VAS and GRS are easily and quickly administered, these scales are unidimensional. Therefore, it may be more appropriate to use multidimensional assessment procedures such as the DDS when time is not a consideration and when trying to establish sensitive measures for research purposes.

CONCLUSION

Graphic rating scales are commonly employed when measuring pain intensity for experimental models involving delayed onset muscle soreness. Our results indicate that protocols using a single measurement occasion need to consider the potential differences that exist when these scales are initially completed. This may not be an issue with research protocols using numerous testing occasions, because over time these differences apparently diminish to a clinically and statistically insignificant level. In the future, researchers should examine the role of familiarization between unidimensional scales such as the VAS and GRS with multidimensional scales such as the DDS when investigating delayed onset muscle soreness.

REFERENCES

1. Abraham, W.M. Factors in delayed muscle soreness. Med. Sci. Sports 9:11-20, 1977.
2. Allen, J.D., C.G. Mattacola, and D,H. Perrin. Effect of microcurrent stimulation on delayed onset muscle soreness [Abstract]. J. Athletic Training 31:S-37, 1996,

3. Armstrong, R.B. Mechanisms of exercise-induced muscular injury. Med. Sci, Sports Exerc. 16:529-538, 1984.
4. Armstrong, R.B. Initial events in exercise-induced muscular injury. Med. Sci. Sports Exert:. 22:429-435, 1990.
5. 5, De Conno, F., A. Caraceni, A. Gamba, L. Mariani, A. Abbattista, C. Brunelli, A. La Mura, and V. Ventafridda. Pain measurement in cancer patients: A comparison of six methods. Pain 57:161-166, 1994.
6. Denegar, C.R., and C.B. Huff. High and low frequency TENS in the treatment of induced musculoskeletal pain: A comparison study. J. Athletic Training 23:235-237, 1988,
7. Denegar, C.R., D.H. Perrin, A.D. Rogol, and R. Rutt. Influence of transcutaneous electrical nerve stimulation on pain, range of motion, and serum cortisol concentration in females experiencing delayed onset muscle soreness. J. Orthop. Sports Phys, Then. 11:100-103, 1989.
8. Doctor, J.N,, M.S. Slater, and J.H. Atkinson. The descriptor differential scale of pain intensity: An evaluation of item and scale properties. Pain 61:251-260,1995.
9. Dyson, M. The use of ultrasound in sports physiotherapy. In Sports Injuries. New York: Churchill Livingstone, 1989, p. 213.
10. Flandry, F., J.P. Hunt, G.C. Terry, and J.C. Hughston. Analysis of subjective knee complaints using visual analog scales. Am, J. Sports Med. 19:112-118, 1991.
11. Freyd, M. The graphic rating scale. J. Educ. Psychol. 14:83-102, 1923.
12. Heft, M.W., and S.R. Parker. An experimental basis for revising the graphic rating scale for pain. Pain 19:153-161, 1984.
13. Huskisson, E.C, Measurement of pain. The Lancet 2(7889):1127-1131, 1974.
14. Jeter, J.S., and D.P. Valenta. The effects of microcurrent electrical nerve stimulation on delayed onset muscle soreness and peak torque deficits in trained weight lifters following eccentric exercise [Abstract]. Phys. The,: 73:S24, 1993.
15. 15, Joyce, C.R., D.W. Zutish, V. Hrubes, and R.M. Mason. Comparison of fixed interval and visual analogue scales for rating chronic pain. Eur. J. Clin. Pharmacol. 8:415-420, 1975.
16. Kneele, K.D. The pain chart. The Lancet 2:6-8, 1948,
17. Kulig, K.L., L. DeYoung, C. Maurer, and S. Stone. Comparison of the effects of high-velocity exercises and microcurrent neuromuscular stimulation on delayed onset muscle soreness [Abstract]. Phys. Then 71:S115, 1991.
18. Mickey, C.A., J.N. Bernier, and D.H. Perrin. Ice and ice with nonthermal ultrasound: Effects on delayed onset muscle soreness [Abstract]. J. Athletic Training 31:S-19, 1996.
19. Ohnhaus, RE., and R. Adler. Methodological problems in the measurement of pain: A comparison between the verbal rating scale and the visual analogue scale. Pain 1:379384, 1975.
20. Scott, J., and E.C. Huskisson. Graphic representation of pain, Pain 2:175-184, 1976.
21. Smith, L,L. Acute inflammation: The underlying mechanism in delayed onset muscle soreness? Med. Sci. Sports Exerc. 23:542-551, 1991,
22. Talag, T.S. Residual muscular soreness as influenced by concentric, eccentric and static contractions. Res. Q. 12:458-469, 1973.

Acknowledgments

We wish to thank Julie Bernier, EdD, ATC, and Thomas Kaminiski, PhD, ATC, for their consultation during the early stages of this project. We also wish to thank the Monad Corporation, Pomona, CA, for their support of this project.