INTRODUCTION:
There are several rating scales used to assess recovery of locomotion following spinal cord injury, however, no single scale is used by all laboratories in this area of research. Therefore, comparisons of these studies can be difficult. The purpose of this study was to assess the sensitivity of two commonly used behavioral scales, the 21-pt Basso, Beattie, and Bresnahan (BBB) Locomotor Rating Scale and the 5-pt Tarlov Scale, to determine locomotor recovery in a new rat model of lumbar spinal cord injury.

METHODS:
Surgical Procedure: Ten female Sprague-Dawley rats weighing 240-260gm underwent a concentric crush at the L2 vertebral level, resulting in a severe crush injury to the L2-L3 roots. 2-0 silk suture was passed ventrally underneath the spinal cord to create a loop. Tension was applied to both ends by adding weights for a determined amount of time. The injury groups were 100gm for 10 minutes (n=2), 100gm for 15 minutes (n=2), 125gm for 10 minutes (n=1) and 200gm for 20 minutes (n=5). The 100-125gm groups were considered low injury and the 200 gm group was considered high injury.

Locomotor Rating Scales:
The Basso, Beattie, and Bresnahan(BBB) scale was developed at Ohio State University to measure recovery of locomotor function following spinal cord injury in rats. It is an ordinal 21-point scale, 0 being no observable hind limb movement and 21 being normal rat locomotion. The scale takes into consideration limb movement, trunk and abdomen position, paw placement and position, walking, and trunk instability.

The Tarlov scale is used to measure and record locomotor recovery following injury. If often modified by different laboratories to better fit their injury models. Our Modified Tarlov scale ranged from a score of 0 to 5: 0, movement in the hip only; 1, movement in the hip and one other joint; 2, movement at all joints and non-weight bearing; 3, movement at all joints with partial weight bearing; 4, movement at all with full weight bearing yet abnormal; 5, normal locomotion.

Behavioral Assessment: Prior to injury, the rats were acclimated to the open field where behavioral observations were conducted. The protocol was similar to the BBB Open Field Testing Procedures. Behavioral data was collected during four minute testing periods beginning post-operative day 3, and continuing once a week thereafter for 8 weeks. An investigator scored each hind limb individually according to the BBB and the Modified Tarlov scales.

Statistical Analysis:
- The agreement between the BBB and Modified Tarlov scales was computed using the correlation coefficient at two different time points, post-operative day 3 and post-operative week 8, and between high and low injury groups.
- A ratio of behavior score given to total possible score was to adjust for the variable number of parameters between the two scales.
- A difference between the two ratios was considered lack of agreement between the two scales.
- Regression was applied to difference scores to assess the relationship with degree of injury.
- ANOVAs were calculated for each scale separately with one trial factor (repeated measure) and severity of injury as a grouping factor.
- Sufficient sample size was calculated for each scale using power analysis with the highest standard deviations and equivalent differences in scores: 4 points for the BBB and 1 point for the Modified Tarlov scales.

RESULTS:
- The correlation coefficient for the low injury group was 0.95 at post-operative day 3 and 0.76 at post-operative week 8.
- The correlation coefficient for the high injury group was 0.88 at post-operative day 3 and 0.89 at post-operative week 8.
- Regression analyses on the difference scores did not show an association with the degree of injury.
- Comparing the two scales separately by ANOVA showed mean BBB scores were significantly different between post-operative day 3 and post-operative week 8 [F(1,6)=154, p<.001] In contrast, the mean Modified Tarlov scores did not differ at the two time points.
- There were no significant interactions between degree of injury and time. Using a power analysis and equalizing ratios, the determined sample size for a difference of four points on the BBB scale was n=6; while for a difference of one point on the Modified Tarlov scale, the sample size was n=13.

CONCLUSIONS:
The BBB and Modified Tarlov scores were highly correlated at early and late time points in both injury groups, yielding equivalent locomotor recovery ratios in all cases as determined by correlation coefficients. The difference in ratios, which reflect the lack of agreement between the two scales, were not significantly related to the degree of injury or the duration of recovery by regression analyses.

Although the two scales were highly correlated, the Modified Tarlov was not able to distinguish between behavioral scores at post-operative day 3 and post-operative week 8. However, the BBB scale, because of its greater detail, was able to discriminate significant differences between the two time points by ANOVA. This greater sensitivity of the BBB scale is reflected by a fifty percent decrease in the sample size necessary to demonstrate differences in behavioral scores. The results of this study suggest that the BBB scale can serve as an excellent alternative to the more established Tarlov Scale, because of the high correlation of locomotor recovery data and the BBB’s greater sensitivity for differences of lower magnitude in groups of smaller sample size. The BBB scale is easy to learn and we have chosen to use only the BBB scale at UCLA to assess locomotor recovery in our rat model of lumbar spinal cord injury.

REFERENCES:

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