examined the reliability of active ROM measurements. The studies they cite that examined the reliability of elbow, knee, and shoulder measurements all assessed passive ROM. The small differences in reliability between those studies and that of Youdas and colleagues may have simply been due to the fact that Youdas et al examined active ROM measurements, whereas the other authors examined passive ROM measurements. Research is needed to further examine the reliability of visual estimates and active ROM measurements of other joints.

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We thank Riddle for his critical review and commentary on our recent work. In response to his question of generalizability, we believe it was scientifically justifiable to standardize the measurement techniques and subject position in our study, because most physical therapists are inexperienced with making clinical measurements of cervical spine range of motion (ROM) using goniometric devices. We would agree that it was not necessary for Watkins et al (see article in this issue) to standardize goniometric measurements of knee ROM in the sagittal plane, because physical therapists select three common bony landmarks (ie, greater trochanter, lateral femoral epicondyle, and lateral malleolus) when positioning a universal goniometer (UG). No single protocol, however, has been popularized for measurement of neck ROM. To reduce avoidable variability when taking measurements of the cervical spine, we carefully described placement of both goniometric devices (UG and cervical-range-of-motion [CROM]) for all three neck movements. Furthermore, the CROM device was new and unfamiliar to most physical therapists when this project was conducted, so we requested the testers use it only after a supervised training session using the standardized measurement protocol. In the absence of the training session, we predicted considerable measurement error, simply attributable to unfamiliarity with a new device. Such avoidable error could have unfairly labeled the CROM device as inadequate for taking reliable ROM measurements of the cervical spine in the clinic. We also chose to measure a patient's cervical active ROM while the patient was sitting, because sitting is a posture habitually assumed during normal activities of daily living.

We referenced an absolute scale of reliability, because we believe most clinicians desire an adjective to express the amount of agreement or disagreement they can expect when making repeated clinical measurements such as ROM. Beattie et al1 likewise used adjectives in conjunction with intraclass correlation coefficients (ICCs) to express the degree of reliability they found when measuring lumbar spine backward bending using the attraction method. Perhaps absolute scales of reliability should be avoided when expressing the degree of reliability of a measurement. We would suggest that the degree of reliability of a particular clinical measurement is most relative to findings that have been published previously by others interested in the same phenomenon.

Riddle seems to argue that an ICC of .80 represents a 20% measurement error. Our understanding, however, is that the ICC is merely a ratio that results from comparing the adjusted between-subjects variance ("true" variance) with between-subjects variance combined with appropriate error terms (total variance).2 We believe the ICC does not translate directly to a percentage of measurement error as suggested by Riddle. Riddle also stated that "the reliability coefficient provides the clinician with an estimate of the magnitude of change required to infer that a real change in ROM has occurred." Because the ICC is a ratio of variances, it is unitless and is not intended to be used as a number with the same units of measurement as the variable of interest. We contend that the statistic Riddle described is not the ICC but the standard error of measurement (SEM). The SEM and its clinical relevance to physical therapists have been previously described.3

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References