medicalmetricsINC.

Accuracy and Reproducibility of QMA®

QMA® has been independently validated in numerous scientific studies. These studies have consistently shown an average error of 0.5 deg with an upper limit of ≤ 1.4 deg.

Zhao KD, Yang C, Zhao C, Stans AA, An K-N. **Assessment of noninvasive intervertebral motion measurements in the lumbar spine.** *Journal of Biomechanics* 2005; 38:1943-1946.

- **Lumbar validation study:** Reported an average accuracy of 0.47 deg ± 0.24 deg and a 95% confidence interval 0 to 1.4 deg.

Reitman CA, Hipp JA, Nguyen L, Esses SI. **Changes in segmental intervertebral motion adjacent to cervical arthrodesis. A prospective study.** *Spine* 2004; 29: E211-E26

- **Cervical validation study:** Reported a mean absolute accuracy of < 0.5 deg and < 0.3 mm with maximum errors of 1.4 deg and 0.8 mm.

Pearson AM, Spratt KF, Genuario J, McGough W, Kosman K, Lurie J, Sengupta DK. **Precision of lumbar intervertebral measurements: Does a computer-assisted technique improve reliability?** *Spine* 2011; 36(7):572-580

- **Lumbar reproducibility study:** Reported a 95% confidence interval of ± 1 deg and ± 0.6 mm with an ICC > 0.85 for agreement amongst observers.

Sears WR, Duggal N, Sekhon LH, Williamson OD. **Segmental malalignment with the Bryan cervical disc prosthesis-contributing factors.** *J Spinal Disord Tech* 2007; 20:111-7

- **Cervical reproducibility study:** Reported an ICC of 0.82 for measurements of intervertebral motion using QMA compared to 0.68 for manual measurements.

Ghiselli G, Wharton N, Hipp J, Wong D, Jatana S. **Prospective Analysis of Imaging Prediction of Pseudarthrosis after Anterior Cervical Discectomy and Fusion: Computed Tomography vs. Flexion-Extension Motion Analysis with Intraoperative Correlation.** *Spine* 2011; 36(6):463-468

- **Cervical reproducibility study:** Reported an average difference amongst observers of 0.18 deg with a max difference of 1.2 deg and a correlation coefficient always above 0.96

Auerbach J, Namdari S, Milby A, White A, Reddy S, Lonner B, Balderston R. **The parallax effect in the evaluation of range of motion in lumbar total disc replacement.** *SAS Journal 2008*; 2:184-8.

- **Parallax sensitivity study:** Reported that range of motion measurements made with QMA were not significantly affected by X-ray beam parallax effects (P=0.22)

Taylor M, Hipp JA, Gertzbein SD, Reitman CA, Gopinath S. **Observer agreement in assessing flexion-extension X-rays of the cervical spine, with and without the use of quantitative measurements of intervertebral motion.** *Spine J* 2007; 7: 654-8

- **Reproducibility of visual assessments aided with QMA:** Reported significantly improved observer agreement amongst physicians for various clinical diagnoses; kappa increased from 0.17 before application of QMA to 0.77 after use of QMA