THE EFFECTS OF ALTERING INTERVERTEBRAL STIFFNESS ON PASSIVE MOVEMENT TESTING OF THE CERVICAL SPINE: A COMPUTER-BASED SIMULATION. Tuttle N, Laakso L, Barrett R; School of Physiotherapy and Exercise Science, Griffith University, Gold Coast, Australia

PURPOSE: To determine how increasing segmental intervertebral stiffness affects simulated passive posteroanterior movements (PAs) to the cervical spine. RELEVANCE: PAs are common techniques intended to assess stiffness of individual intervertebral motion segments. PAs were originally considered to produce isolated accessory glides between vertebrae and were described as though the PA movement occurred entirely at the target location. It is now known that PAs affect both local and regional structures, but it is not known how altered mobility at specific locations affect PAs. PARTICIPANTS: Computer based simulation. METHODS: A simplified two-dimensional computer-based model of the cervical spine was constructed consisting of eight bodies corresponding to the head and cervical vertebrae linked by seven uniaxial joints. One set of simulations of PA movements at C4/5 (target level) was performed with the joints modelled as linear springs with constant stiffness. Simulations were performed using: 1) normal stiffness values, 2) increased intervertebral stiffness at the target level and 3) increased stiffness at C3/4 (adjacent level). Two additional sets of simulations were then performed with the joints modelled as non-linear springs with minimal stiffness in the neutral zone and linear interpolations of stiffness between known data points. Sets of simulations were performed with the intervertebral stiffness increased in two ways; the size of the neutral zone decreased and the stiffness within the neutral zone increased. ANALYSIS: SD curves of PAs were plotted for each simulation. RESULTS: For the linear model where the stiffness of each joint was a constant, the stiffness of all PA movements were also constants. Stiffening the target level resulted in greater effect on the PA stiffness than increasing the adjacent level. The SD curves of PAs from the non-linear model consisted of a series of ‘steps’ of increasing stiffness. Decreasing the size of the neutral zone resulted in SD curves of similar shape, but shifted horizontally such that increases in stiffness occurred earlier in the PAs. Increasing the stiffness within the neutral zone also resulted in a similar shaped SD curve, but the curve was distorted vertically. The effects on PA stiffness from increasing stiffness of the target level occurred earlier in the movement and were greater in magnitude than effects from increasing stiffness of the adjacent level. CONCLUSIONS: When intervertebral stiffness was modelled as non-linear, the location and type of altered intervertebral mobility were reflected in characteristic changes in the pattern of PA stiffness suggesting ways clinicians using PAs may be able to localize the location and type of increased intervertebral stiffness in the cervical spine. IMPLICATIONS: The results of this study are consistent with pilot data we have collected where differences in stiffness curves of PAs of the cervical spine in painful and less painful locations were suggestive of both of the patterns described from the non-linear simulations. Further studies are underway to clarify the relationship between symptoms and PA mobility. Recognising the non-linear behaviour of intervertebral stiffness and the complex relationship between intervertebral mobility and PA stiffness may result in greater accuracy in the assessment and interpretation of both manual and instrumented assessment of passive movements. KEYWORDS: simulations passive movements. FUNDING ACKNOWLEDGEMENTS: NT is supported by an Australian Postgraduate Award. CONTACT: n.tuttle@griffith.edu.au