INTRODUCTION

Full active range of motion (AROM) is frequently used as a benchmark to which subsequent trials are normalized as a percentage of full range. This assumes that full range is obtained, even if the activity is unfamiliar or constrained. The purpose of this study was to analyze AROM obtained for 3 active movements: hip extension, lumbar extension and rotation, comparing unconstrained movements with those when the participants were asked to restrict motion to the joint/plane of interest.

METHODS

27 healthy males were recruited from a university population. Body segment and joint motion data were captured (Vicon MX Motion System, Oxford, UK) using 15 reflective markers over anatomical landmarks on the thigh, pelvis and trunk. An initial calibration pose was collected (standard “t”-pose), providing the baseline position of zero degrees.

In a randomized order, participants were asked to perform the following: a) lumbar rotation, right and left, while attempting to actively minimize associated hip and pelvis rotation; b) lumbar rotation, right and left, with unconstrained hips/pelvis; c) right hip extension, while attempting to maintain an upright torso and right knee extension; d) lumbar extension with no constraints on hip or pelvis motion, but minimizing knee flexion. All trials took place in upright standing, and were repeated twice.

Joint angles were extracted using the “Plug-in-Gait” software (Vicon, Oxford, UK). Peak joint angles were calculated; those for lumbar rotation represent the summation of both right and left rotation. Paired t-tests compared constrained vs. unconstrained AROM, with Bonferroni adjustments applied.

RESULTS

No differences were found in average peak hip extension angles when active hip extension was compared to active back extension (unconstrained) (Figure 1a)(p = 0.138). Correlation between the two was low (R^2 = 0.28), indicating one method is poorly predictive of the other. Peak lumbar extension was greater when participants were asked to perform unconstrained lumbar extension, compared to active hip extension (p < 0.001), with R^2 values of 0.48. Active lumbar rotation was greater when the pelvis was not constrained (Figure 1b) (p < 0.001), with R^2 values of 0.49. Concurrent frontal and sagittal motion was also greater, as would be expected with unconstrained motion (p < 0.001 and p = 0.002, respectively).

DISCUSSION AND CONCLUSIONS

It is not possible to predict which method of hip extension (actively extending the hip vs the spine) will result in maximum hip range. The two methods are the result of different mechanisms: the former being mostly a concentric activity of the posterior hip/back extensors, whereas the latter would involve more co-contraction of the anterior muscles. Thus, although researchers may choose between the methods based on preferred outcome, it may be advisable to compare both to ensure maximum range.

Actively extending the hip resulted in more than 10° of concurrent lumbar extension in all but 4 participants. Even so, a greater amount of extension was produced when they were specifically asked to perform lumbar extension in the majority of participants (23 out of 27), making it the protocol of choice.

Lumbar rotation angles were greater when unconstrained. This may be due to the associated co-contraction that would ensue if asked to minimize pelvis motion, or the unfamiliarity of performing such a motion. Concurrent axial and sagittal motion would also affect facet joint positioning, potentially allowing more rotation to occur. Thus, we see that constrained lumbar motion, although sound from a mechanical perspective, may not result in maximum AROM.