THE NEUTRAL CURVE OF THE SPINE DURING RUNNING

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INTRODUCTION

During the running the spine's contour oscillates periodically, accomplishing a complete cycle at each stride in the frontal plane [1]. Like in the walking, even in healthy people and athletes, the movement in the frontal plane should not happen around a rectified posture [2] but around a curve with individual characteristics. Few studies exist on the kinematics of the spine during running [1] and we didn't found in the literature a description of the behavior of these asymmetries in function of the running speed. Our hypothesis is that the countour of the spine oscillates around an average curve of the dynamic postures presented during the stride. We denominate this average curve as Neutral Curve and we suppose that it is a reflex of personal postural characteristics. If that supposition is correct, the Neutral Curve should be stable, for example, in relation to variations in the intensity of the running. The aim of this work was to propose a methodology to quantify the spine Neutral Curve and to present preliminaries results, about Neutral Curve, in different running speeds.

METHODS

Two athletes participated in the experiment, a long-distance runner (63.5kg, 1.79m, 19 years old) and a velocity runner (69.20kg, 1.78m, 20 years old). Videogrametric registers were made of the static posture and of treadmill runs at speeds of 1.8, 2.0, 2.2, 2.4, 2.8, 3.2, 3.6 and 4.0 m/s, 40 seconds in each.

To quantify the spine's 2D geometric curvature in the frontal plane we used the method proposed in Brenzikofer et al [2,3]. Retroreflexives adhesive disks (5 mmØ) are fixed to the skin along the curve defined by the vertebral processes and represent the shape of the analyzed spine. Bilateral markers preserved the location of L4, T12, T6 and T1. All markers were registered by two calibrated digital video-cameras (60Hz). The location of the adhesive markers in the 3D space was obtained by videogrametrics techniques with the Dvideow system [4]. For each speed, we compute one standard gait cycle by the average of 15 strides. At every analyzed moment of the standard gait cycle the origin of the coordinates system was translated to the marker positioned in T12 and the coordinates of the markers was projected in the frontal plane. In each instant, the form of the vertebral column was represented by a polynomial function of eight degree, parameterized by the vertical coordinate. With the polynomial function we calculated the 2D geometric curvature along the spine, in the frontal plane. Then we calculated the Neutral Curve at each speed (black lines - in Figure 1A, B), defined as the average of the dynamic postures presented in the stride pattern. With the same method [2], we quantified the spine geometric curvature in the static posture in the frontal plane (red lines - in Figure 1).

RESULTS AND DISCUSSION

Figure 1 shows the frontal plane geometric curvatures of the Neutral Curves and the static curve of the long-distance runner (A) and of the velocity runner (B). The graphs show few variation of the Neutral Curves at the different running speeds. The largest differences among the Neutral Curves were of the order of 0.5 (long-distance runner) and 0.3 m^{-1} (velocity runner).
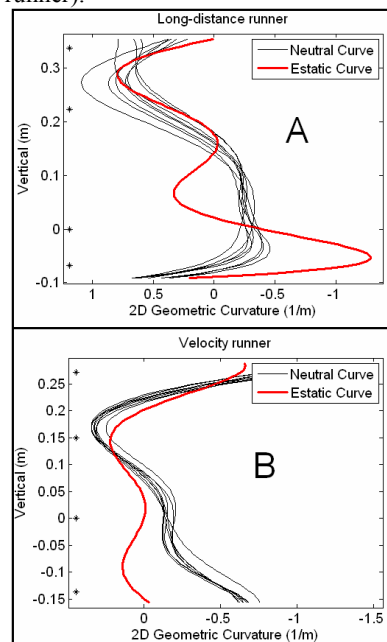

Figure 1: Neutral Curves (black lines) and Static Curve (red line) of the volunteers (A – long-distance runner, B – velocity runner). *Anatomical references T1, T6, T12 and L4, top to down.

Figure 1 shows that the curvature presented by the spine in the static posture (red line) is out of the region defined by the Neutral Curves (black lines) in the lowers thoracic area (vertical coordinate between 0 and 0.1m) and in the lumbar area (vertical coordinate <0). That shows that the Neutral Curves were different from the static curves. This comparison also evidences the stability of the Neutral Curve.

CONCLUSIONS

In this work, we presented a methodology for quantification of the Spine's Neutral Curve and we presented preliminary data about its behavior in different running intensities. The results suggest that the Neutral Curve doesn't depend on the running speed, being reflex of personal postural characteristics.

ACKNOWLEDGEMENTS

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