ASSIMILATING FULL BODY GAIT GRAPHS INTO SINGLE AREA PLOTS

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INTRODUCTION

Gait analysis offers detailed kinematic and kinetic assessments of multiple segments and joints. A single condition gait analysis report often includes over 60 graphs of individual segments and joints in multiple planes. The method presented assimilates all kinematic or kinetic gait data from one plane into a single area graph. Deviations from normal are assigned unique colors, creating multi-joint patterns. This visual integration of color patterns uniquely highlights pathologic data in a reproducible manner and facilitates accurate and relevant interpretations of gait analyses.

METHODS

A retrospective review of subjects with a primary diagnosis of Cerebral Palsy resulted in 7 patients for whom bilateral hamstring lengthening only was recommended, and 4 patients for whom bilateral gastrocsoleus lengthening only was recommended. The deviations from normal of these two groups were calculated for each frame of data and each joint/segment in a fashion similar to Manal, et al [1]. The deviation (d) was calculated from the pathological average (x_p), the normal average (x_n), and the normal standard deviation (sd_n), using the equation $d = (x_p - x_n)/ sd_n$.

The trunk and ankle data were plotted horizontally at the top and bottom of the area graphs. The pelvis, hip, and knee data were plotted horizontally with 20 vertical data points between them and adjacent joint data. A continuous gradient of deviations was calculated for the areas between joints. The deviation gradient (d_g) was calculated for each frame using the inferior joint deviation (d_i) and the superior joint deviation (d_s) with the equation $d_g = d_i + g*(d_s - d_i)/20$, where g is the gradient position above the inferior joint (1 to 20).

Each deviation was assigned a color based on a gradient of 56 colors from red (+3 deviations) to violet (-3 deviations). Green was normal (0 deviations). Red was indicative of excessive anterior trunk/pelvic tilt, hip/knee flexion, and ankle dorsiflexion. Violet was indicative of excessive posterior trunk/pelvic tilt, hip/knee extension, and ankle plantar flexion. A total of 8500 data points were assigned colors (85 points high by 100 points wide).

RESULTS AND DISCUSSION

In the hamstring-lengthening-only group (Figure 1a) the predominant patterns were excessive knee flexion at initial contact, excessive ankle dorsiflexion at weight acceptance, and excessive knee flexion during mid-stance. There was mild ankle plantar flexion during mid-stance and hyperextension of the knee during mid-swing.

In the gastrocsoleus-lengthening-only group (Figure 1b) the predominant patterns were excessive knee flexion at initial contact, excessive ankle plantar flexion during mid-stance, excessive knee extension during mid-swing, and excessive hip flexion during late swing. There was a mild increase in ankle dorsiflexion during weight acceptance, and an increase in pelvic anterior tilt during mid-stance and early swing.

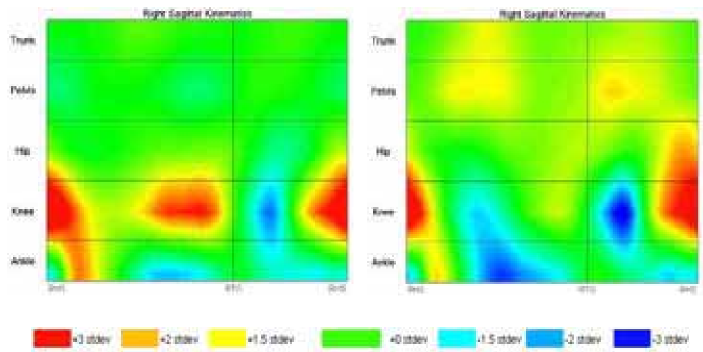

Figure 1: a) Hamstring Lengthening, b) Gastroc Lengthening

CONCLUSIONS

This method of displaying gait analysis data has the advantage of displaying area patterns, which result from multi-joint as well as single joint deviations. The resulting shapes, as well as colors, are indicative of particular pathologies and corresponding interventions. The excessive knee flexion pattern during mid-stance in the hamstring lengthening group (Figure 1a) as well as the knee flexion at initial contact "pouring" into the ankle are characteristic patterns of this population. Likewise, the "chair-like" shape of the ankle plantar flexion/knee extension pattern during mid-stance in the gastrocsoleus lengthening population (Figure 1b) is both indicative and unique.

This method treats gait data as though they are "connected" from one joint to another, rather than disconnected line graphs. Interpretation and integration of the data is still required. However, the patterns assessed are not isolated to single joints and are typical of multi-joint pathologies.

Each clinician has his/her own preferred method of integrating and interpreting gait data. For those who find it difficult to integrate 5 graphs, let alone 60, this method offers an alternative presentation style of data for analysis. Having both color and shape in "zones" from the ankle to the trunk is a potentially useful alternative. The process of applying this method to individual subjects with combinations of pathologies has been enlightening. In doing so we have discovered combinations of the patterns discussed herein as well as new patterns that were not appreciated through more traditional presentation styles of gait data.

REFERENCES

1. Manal, K, et al: A novel method for displaying gait and clinical movement analysis data. Gait & Posture, Volume 20, Issue 2, 222-226, 2004