Ankle Plantar Flexor Moments Scale to Planning Time during Unexpected Side Step Cut Tasks

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INTRODUCTION

During sports play quick movements such as cut tasks are believed to place athletes at risk. The ankle joint plantar flexors, responsible for controlling tibial progression during midstance,[1] may play a key role in successfully completing a quick cut task.[2] As planning time is reduced, rapid development of large plantar flexor moments and restraint of tibial progression (dorsiflexion range of motion) during second rocker are expected. Further, we theorized that as planning time decreased the plantar flexor response would show a non-linear increase to control tibial progression. The purpose of this study was to examine the relationship between indicators of ankle plantar flexor function (Table 1) and planning time during second rocker (10-60% of stance) of an unexpected side step cut task.

METHODS

Nineteen healthy subjects (22.6 ± 5.5 years old, 172.8 ± 9.0 cm, and 71.9 ± 14.3 kg) participated in this study. Data were collected using an Optotrak Motion Analysis System (Northern Digital, Inc.) and force plate (Kistler) integrated with Motion Monitor Software (Innsport Training, Inc.) to generate ankle joint angles, moments and power. Position data were sampled at 100 Hz and force and analogue data at 1000 Hz. Each testing session included expected tasks, straight walking (ST) and 45° side step cut (SS), followed by a set of unexpected straight walking (STU) and unexpected side step cut (SSU) tasks in a random order. For all tasks speed was maintained at 2 m/s using infrared timing gates (Bower Timing Systems, Draper UT). Only the SSU tasks are included in this analysis. Planning time is defined as the interval between the visual cue and initial contact (Figure 1). The relationship between the dependent variables (Table 1) and planning time were examined using SPSS 10.0.

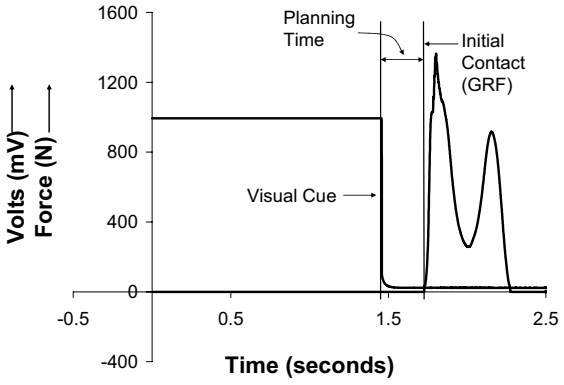

Figure 1. Subjects went straight or cut when given a visual cue to turn. Planning time was the interval between an analogue signal synchronized with the light cue and initial contact determined from the ground reaction force data.

RESULTS AND DISCUSSION

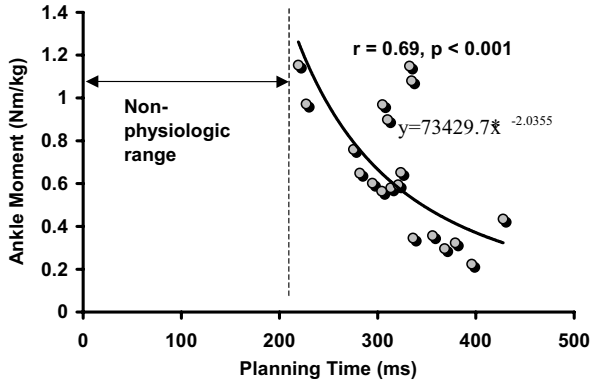

Figure 2. The non-linear relationship between peak ankle plantar flexor moments and planning time showed increased moments with decreasing planning time.

Table 1. Pearson Product Moment Correlations between Planning Time and Ankle Variables During Second Rocker.

Variable	Mean (SD)	r - value
Planning Time (ms)	321±52	
Dorsiflexion Range of Motion (°)	11.7±4.8	-0.31
Plantar Flexion Moment (Nm/kg)	0.66±0.3	**-0.66**
Power Absorption Integral (W/kg * %Stance)	6.6±7.8	-0.09

Bold values indicate significance at $p < 0.05$

The findings of this analysis suggest that the peak ankle plantar flexor moments scale to planning time during an unanticipated cut task (Figure 2). The range of planning times executed during this task varied from ≈200 – 450 ms (Table 1). The shorter planning times (< 350 ms) are associated with large plantar flexor moments (> 0.6 Nm/kg). These large responses, in some cases equal to the plantar flexor moment at push off, may challenge athletes. The longer planning times (>350 ms) are associated with smaller plantar flexor moments (< 0.4 Nm/kg), suggesting longer planning times have less effect on limb loading. This data supports the view that ankle plantar flexor weakness or poorly timed control of plantar flexor function may impact performance during unexpected cut tasks.

REFERENCES

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