Are the horizontal deceleration phases of immediate stopping and change of direction tasks comparable?

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Summary

Deceleration literature has often considered the deceleration phase of change of direction (COD) and immediate stopping (IS) movements as equivalent. However, it remains uncertain whether they are biomechanically comparable. To investigate, sixteen netballers were asked to complete a 505 COD and an IS tasks with their non-dominant foot as the final contact. Kinematic and kinetic variables were captured using synchronised 3D motion capture and force plates. Two significant differences at PFC and ten significant differences at FFC (all with large effect sizes) were observed between the COD and IS tasks. Whilst the initial period of the deceleration phase (PFC) was similar, the differences at FFC highlights the need for COD tasks to concurrently optimise movement patterns for both deceleration and body reorientation. Therefore, caution is required when assuming the deceleration phases of COD and IS tasks are equivalent.

Introduction

Literature investigating the biomechanical determinants of deceleration often considers the deceleration phases of COD and IS tasks as equivalent [1]. This knowledge has been utilised to develop a braking performance framework [2], aimed at enhancing horizontal deceleration ability. However, as most deceleration studies have focused on COD movements, its applicability to IS tasks remains uncertain. Furthermore, the deceleration phase in COD movements is a dual-task process, requiring both braking and body reorientation for subsequent acceleration, whereas IS movements are single-task actions focused solely on braking. Given these differences, it remains uncertain whether the deceleration phases across both tasks are biomechanically comparable. This study aims to compare the deceleration phases of COD and IS tasks to determine whether biomechanical differences exist.

Methods

One IS task (5m acceleration before stopping within 2 steps) and one 505 COD movements (5m acceleration before a 180° COD and second 5m acceleration) were completed by 16 female high performance netball players (age: 19.8 ± 1.6 yrs; height: 1.73 ± 0.08 m; mass: 71.2 ± 7.1 kg). Data was captured using a 12 camera (Oqus) Qualisys 3D motion capture system at 200Hz with two force plates at 1000Hz capturing penultimate (dominant) foot contact (PFC) and final (non-dominant) foot contact (FFC). Joint angle, segment orientation, and ground reaction force parameters were determined using Visual3D for the stance leg at PFC and FFC for each trial. The outputs for each deceleration movement were compared using paired samples t-tests (0.05 alpha threshold) and effect sizes (ES). An adjustment to the alpha threshold for multiple comparisons was not performed due to the exploratory nature of the study.

Results and Discussion

At PFC, only two significant differences (both with large effect sizes) were observed between the COD and IS tasks. On average, the IS tasks had greater centre of mass velocities (3.6 vs. 3.4 m/s; $p < 0.02$) and less trunk extension (-4.8 vs. -7.8°; $p = 0.07$) compared to the COD tasks. At FFC, ten significant differences (all with large effect sizes) were observed between the COD and IS tasks (Table 1). All other joint angles and ground reaction force variables showed no statistically significant differences between tasks.

Table 1: Means and differential statistics for selected parameters

FFC Parameter	COD	IS	*p*	ES
COM velocity (m/s)	2.0	2.4	<0.01	1.47
Horizontal Loading Time (ms)	83	48	<0.01	1.66
Vertical Loading Time (ms)	82	41	<0.01	1.86
Horizontal Peak Force (N)	1086	861	<0.01	1.03
Ankle Flexion Angle (°)	45	26	<0.01	1.89
Knee Abduction Angle (°)	2.6	0.7	0.03	0.59
Hip Flexion Angle (°)	40	55	<0.01	0.62
Hip Abduction Angle (°)	12	2.5	0.02	1.93
Pelvic Tilt (°)	20	1.4	<0.01	0.96
Pelvic Rotation (°)	0.0	83	<0.01	0.77

These findings suggest that the initial period of deceleration (PFC) may be similar between COD and IS tasks, which may have led to the conclusion that they can be considered equivalent [1]. The differences at FFC highlight how the dual-task requirement in COD tasks influences movement during the later stages of deceleration. The differences during the later stages of the deceleration phase (FFC) are reflective of the single- vs. dual-task process of each movement pattern. While IS tasks can solely focus on optimising deceleration, COD tasks require concurrent optimisation of both deceleration and body reorientation.

Conclusions

The initial period of deceleration may be similar between COD and IS tasks, however, the later stages differ due to the single- vs dual-task nature of the movements. Therefore, caution is required when assuming the deceleration phases of COD and IS tasks are equivalent.

References

[1] Harper DJ et al. (2022). *Sports Med*., **52(10)**: 2321-2354.
[2] Harper DJ et al. (2024). *IJSC*., **4(1)**.