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Corrigendum to “The effects of rehabilitation on the biomechanics of patients with athletic groin pain” [J. Biomech. 99 (2020) 109474]

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The authors regret that the function used to normalise joint moments to body mass in the analysis for this paper contained an error which resulted in incorrect calculation of these variables. Full reanalysis of the corrected data identified small differences from those originally reported in some effect sizes, but did not affect the interpretation of the study. Corrections to the text, tables and figures are detailed below with changes to the corrected text highlighted in **bold**.

Abstract

In total 18 different biomechanical variables were significantly different between the AGP group and the uninjured group pre-rehabilitation. Of these, **eight** variables were no longer significantly different between the AGP group post-rehabilitation and the uninjured group. These **eight** variables may represent the factors most related to return to play in this cohort and are potential targets for rehabilitation.

Results

In contrast, ankle plantar flexor moments, power absorption and power generation remained significantly less in the AGP group in comparison to the uninjured group post-rehabilitation from **11** to 92%, 8 to **41%** and 47 to 88% of the ground contact, respectively. In the transverse plane there was a trend towards uninjured values with the AGP group displaying a decrease in ankle external rotator power generation from 31 to **40%** of ground contact. At the knee joint pre-rehabilitation, the AGP group had significantly greater extensor moments from 13 to 24% of ground contact in comparison to the uninjured group and was no longer significantly different post-rehabilitation. In the frontal plane, knee abductor/valgus moments were significantly greater in the AGP group in comparison to the uninjured group pre-rehabilitation from **9** to 23% and remained so from 7 to **30%** of the ground contact post-rehabilitation. Hip abduc-

tor moments from **17** to **21%** and hip extensor moments from **43** to **52%** of the ground contact were significantly less in the AGP group in comparison to the uninjured group pre-rehabilitation, however post-rehabilitation these phases were no longer significantly different. Pre-rehabilitation hip flexor power absorption from **39** to 43% was significantly less in the AGP group in comparison to the uninjured group **and was no longer significantly different post-rehabilitation**. In the transverse plane, hip power generation was significantly greater pre-rehabilitation in the AGP group in comparison to the uninjured group from **74** to **81%** of the ground contact phase, but post-rehabilitation this was no longer significantly different to the uninjured group. Full kinematic and kinetic waveforms are presented below as means \pm standard errors (Figs. 2–5), while the full results are presented in Table 3.

Discussion

This study presents the effects of an exercise intervention on the biomechanics of an AGP cohort during a hurdle hop task using a continuous waveform approach. All AGP patients within this cohort were returned to play in a median time of 9.14 weeks with no return of symptoms. A total of 18 kinematic and kinetic variables were identified which were significantly different between the subjects with AGP pre-rehabilitation and the uninjured group. These identified variables were then subsequently examined to assess for change post-rehabilitation. As a result of the intervention, **eight** of these variables were no longer significantly different between the AGP group and the uninjured group post-rehabilitation. These findings suggest that these **eight** variables are the most related to return to play in this cohort.

Before rehabilitation hip abductor moments were significantly less in the AGP group when compared to the uninjured group. As previously noted (Gore et al., 2018), this may represent a compensatory mechanism striving to reduce ipsilateral hip joint reaction forces (Neumann, 2010; Wesseling et al., 2015) thereby reducing force transfer across the pubic symphysis region. While this may also represent an increased hip adductor moment, previous research has also demonstrated reduced gluteus medius activity in AGP patients (Morrissett et al., 2012). In the AGP group hip

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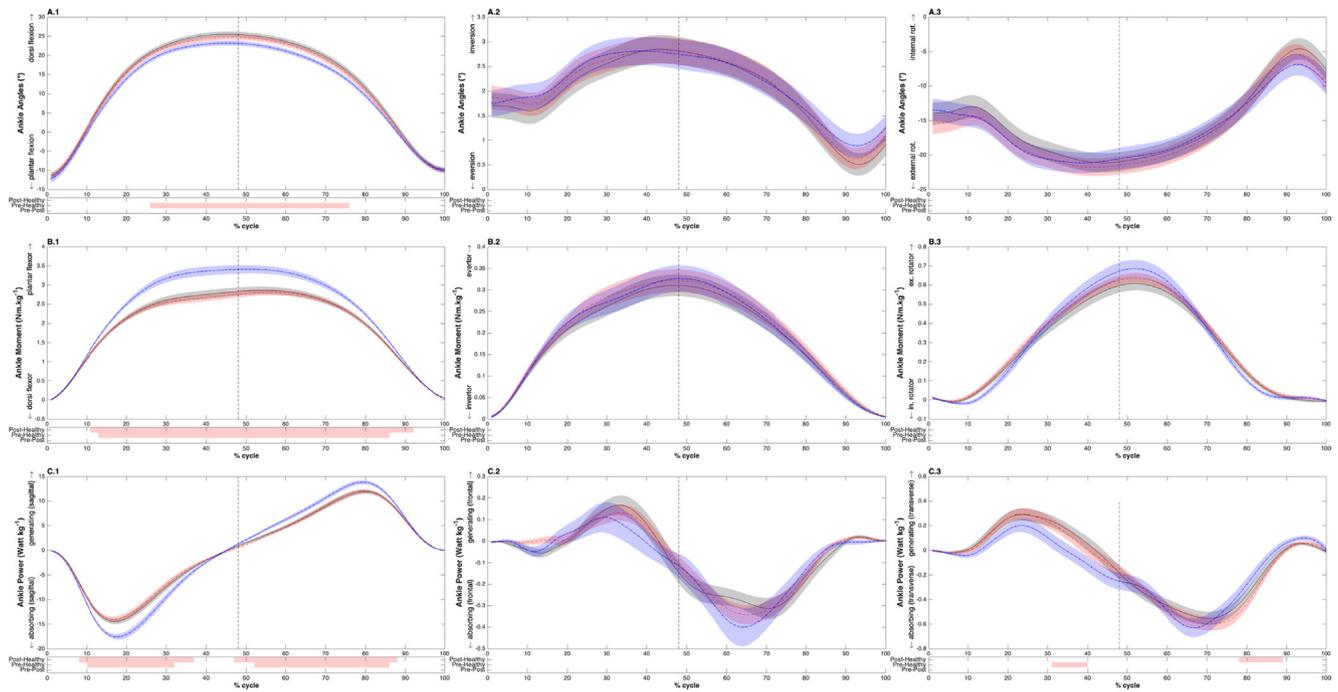


Fig. 2.

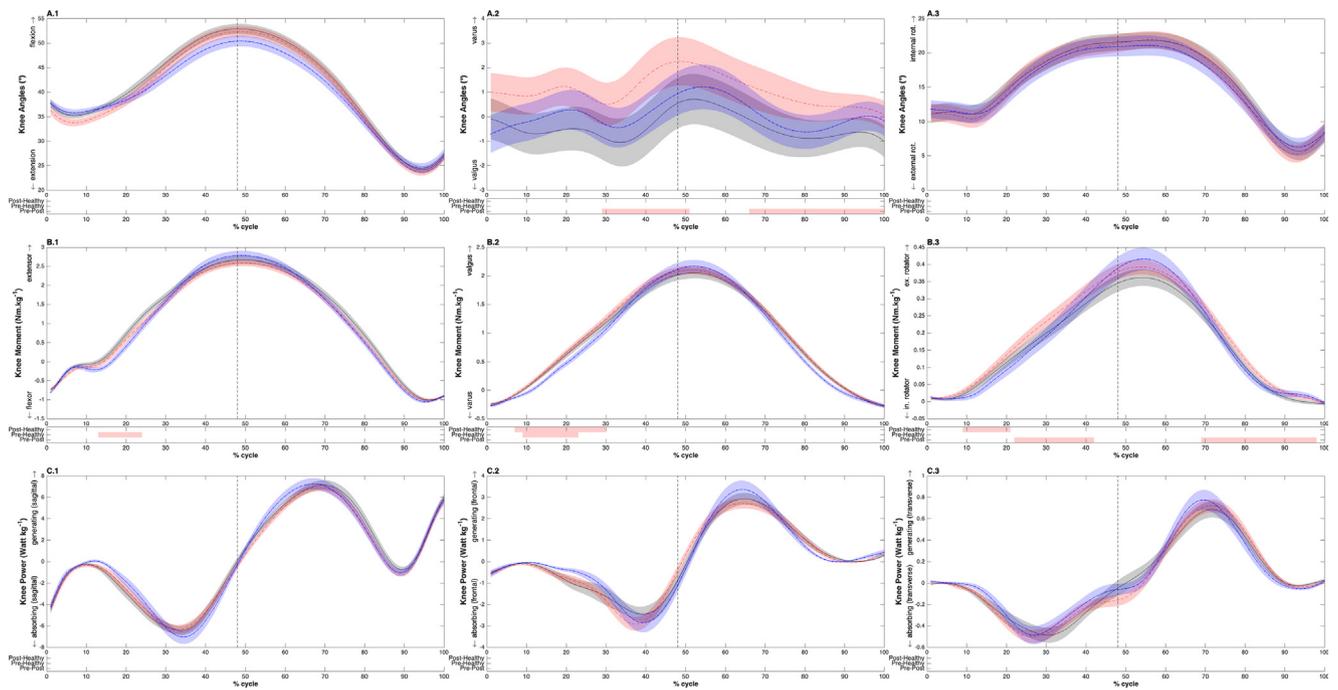


Fig. 3.

abductor moments improved post-rehabilitation and were no longer significantly different to uninjured group. This is in line with work by King et al. (King et al., 2018) who reported reduced adductor moments in AGP patients post-rehabilitation during a running cut task. Furthermore, at the hip, **pre-rehabilitation, hip extensor power dissipation, hip external rotation power production and hip extensor moments, were all significantly less in those with AGP in comparison to uninjured controls. Given the close proximity of the hip to the region of pain in AGP, this may represent**

a protective mechanism utilized to reduce loading at the hip/pelvic region.

Following rehabilitation, there was an increase in hip external rotation power production and hip extensor moments, with the AGP group no longer significantly different from the uninjured controls. Contrary to previous research (Kopper et al., 2012), this increase in hip extensor moments was observed even with a significant decrease in thorax flexion angle **from pre to post rehabilitation** suggesting that the hip extensor muscles are working more

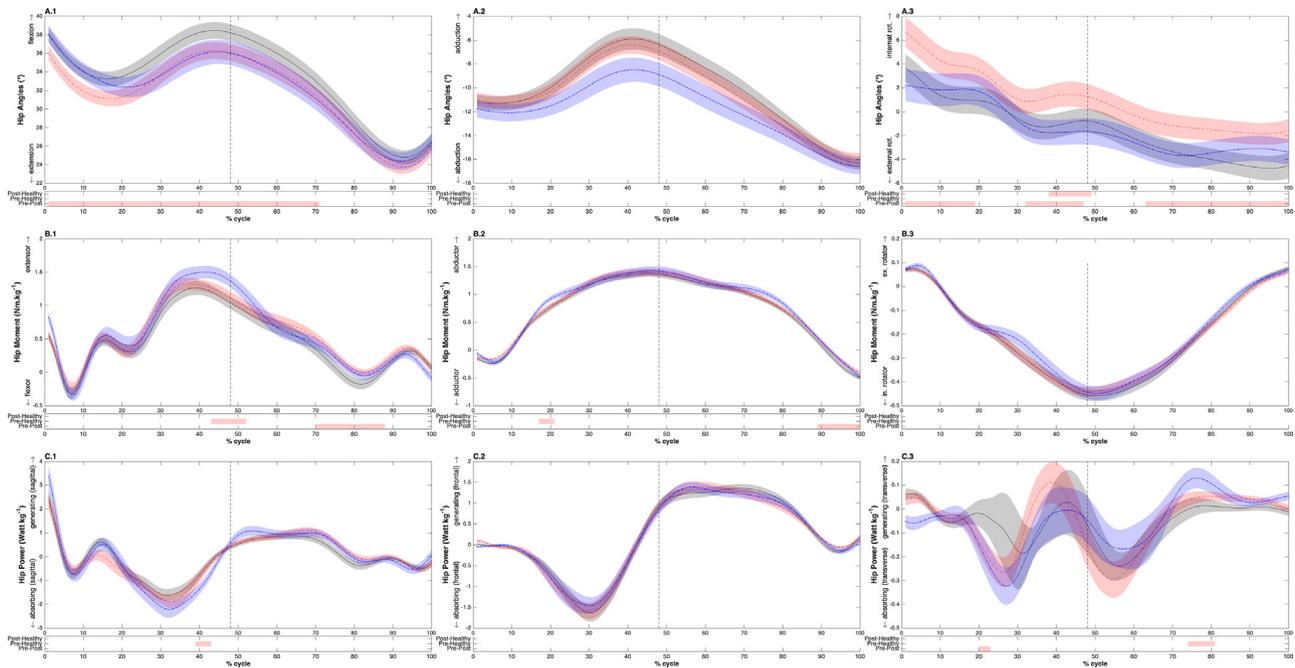


Fig. 4.

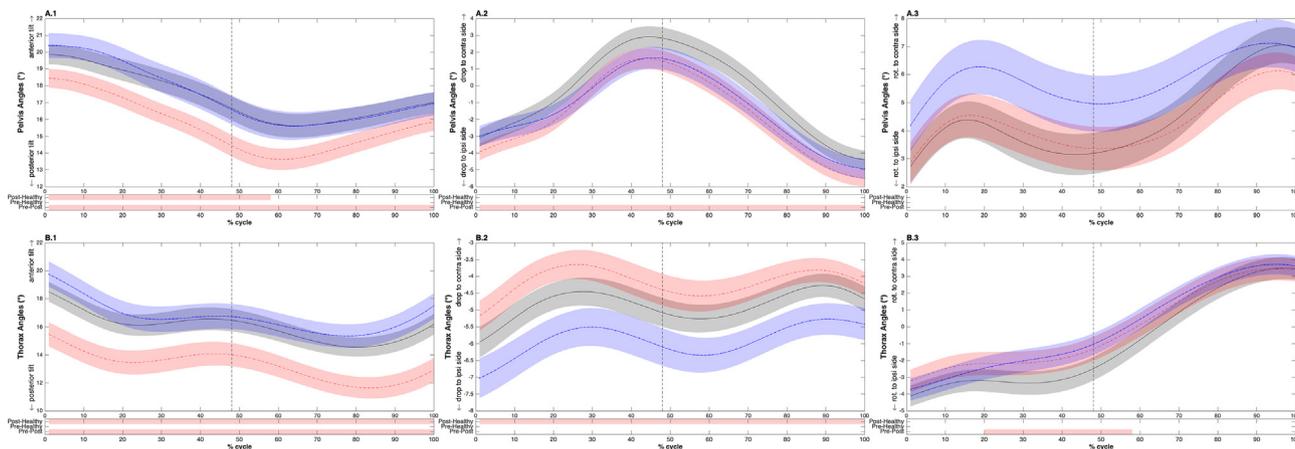


Fig. 5.

post-rehabilitation. At the knee, there were significantly greater eccentric moments in the AGP group pre-rehabilitation in comparison to the uninjured group. Post-rehabilitation however, knee moments were no longer significantly different suggesting a shift to a hip dominant strategy.

Conclusion

The AGP patients in this study were returned to play in a median time of 9.14 weeks with no return of symptoms. This successful return to play was associated with significant improvements in five out of six HAGOS subsections and a significant improvement in adductor squeeze scores. A total of 18 kinematic and kinetic variables were identified which were significantly different between the subjects with AGP pre-

rehabilitation and the uninjured group. Following rehabilitation **eight** of these variables [centre of mass height (31–69%), centre of mass frontal plane power (3–16%), ankle flexion angle (26–76%), ankle rotation power (31–40%), hip abduction moment (17–21%), hip extensor moment (43–52%), **hip extensor power (39–43%)** and hip rotation power (74–81%)] were no longer significantly different between the two groups. These variables may represent the factors most related to return to play in this cohort and are potential targets for rehabilitation. Clearly however, this needs to be re-examined using appropriate prospective research to determine conclusively what biomechanical factors are related to the development of this condition.

The authors would like to apologise for any inconvenience caused.

Table 3
Kinematic and Kinetic Findings.

Variable	AGPpre vs. CON			AGPpre vs. AGPpost			AGPpost vs. CON		
	Percent	Sig	Cohen's d	Percent	Sig	Cohen's d	Percent	Sig	Cohen's d
Ground contact time	–	<0.01	0.66				–	<0.01	0.66
Ground Reaction Force x	26–71%	0.02	0.43	48–85%	0.01	–0.34	20–87%	<0.01	0.68
Ground Reaction Force y	10–15%	<0.01	–0.66	1–8%	<0.01	–0.40	4–5%	0.03	0.41
							10–15%	<0.01	–0.56
							32–37%	0.04	–0.40
Ground Reaction Force z	23–77%	<0.01	–0.73				24–84%	<0.01	–0.67
Centre of mass height	31–69%	0.04	–0.40	6–100%	<0.01	–0.21			
Centre of mass Power x	3–16%	0.02	–0.45	1–21%	0.01	–0.32	56–81%	<0.01	–0.64
				43–92%	<0.01	0.56			
Centre of Mass Power y	10– 14%	<0.01	0.52	88–100%	0.01	0.43	1–6%	0.01	–0.56
							10–15%	0.01	0.51
							88–100%	0.01	–0.50
							22–47%	<0.01	0.67
Centre of Mass Power z	22–47%	<0.01	0.62				50–75%	0.02	–0.46
Ankle Angles (Dorsi/Plant)	26–76%	0.02	0.46						
Ankle Moment (Dorsi/Plant)	13–86%	<0.01	–0.71				11–92%	<0.01	–0.85
Ankle Power (Dorsi/Plant)	10–32%	<0.01	0.70				8–37%	<0.01	0.75
	52–86%	0.01	–0.51				47–88%	<0.01	–0.62
Ankle Power (Int/Ext Rot)	31– 40%	0.02	0.45				78–89%	0.02	–0.46
Knee Moment (Abd/Add)	9–23%	0.03	0.43				7– 30%	0.01	0.49
Knee Moment (Fle/Ext)	13–24%	0.01	0.48						
Hip Moment (Abd/Add)	17–21%	0.02	–0.43	89–100%	<0.01	–0.28			
Hip Moment (Fle/Ext)	43–52%	0.02	–0.45	70–89%	0.01	–0.35			
Hip Power (Fle/Ext)	39–43%	0.03	0.42						
Hip Power (Int/Ext Rot)	74–81%	0.03	–0.41	20–23%	0.02	0.32			

Moments measured as Moments ($Nmm\cdot kg^{-1}$) Sig = significance (p), D = Cohen's D effect size.