Enhancing Performance of Baseball Pitchers Through IMU-Based Biofeedback Training for Lumbopelvic Control

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Summary

This study examined the impact of a real-time biofeedback lumbopelvic control training system on the performance of baseball pitchers. Seventeen pitchers (17.59 ± 2.03 years) completed a six-week program (twice-weekly) featuring single-leg bridges, cat-dog movements, lateral slides, and single-leg squats, using an IMU on the S2 vertebra for real-time pelvic control feedback. Pre- and post-training assessments revealed significant pelvic control and pitching velocity improvements. These findings highlight the role of lumbopelvic control in enhancing pitching velocity, demonstrating the potential of IMU-based biofeedback systems for optimizing athletic performance.

Introduction

Effective pelvic control is crucial for optimizing pitching performance, facilitating efficient energy transfer from the lower limbs to the upper body, and enhancing mechanical efficiency[1]. Inertial measurement units (IMUs), wearable and wireless tools, have become indispensable in sports biomechanics for precisely analyzing motions[2]. This study developed a real-time biofeedback system displaying pelvic angles during lumbopelvic control training. Therefore, the purpose of this study is to investigate the effects of the training system on the pitching performance of baseball pitchers.

Methods

Baseball pitchers (18–25 years, no surgical history) underwent a six-week, twice-weekly training using a real-time biofeedback lumbopelvic control system. Exercises included single-leg bridges, cat-dog movements, lateral slides, and single-leg squats, with real-time pelvic control feedback from an S2 IMU sensor. Before and after training assessments measured single-leg balance, single-leg bridge, and pitching velocity. Pelvic angle deviations (medial-lateral, ML; anterior-posterior, AP) of the stride and drive legs during single-leg balance and bridge tests, as well as pitching velocity during pitching, were analyzed. The Wilcoxon signed-rank test was utilized, with a *p*-value of less than 0.05 indicating statistical significance.

Results and Discussion

Seventeen baseball pitchers (17.59 ± 2.03 years; 181.41 ± 4.36 cm; 80.18 ± 9.28 kg) showed significant improvements in pelvic control during single-leg balance and bridge tests (**Table 1**) and increased pitching velocity (pre: 128.11 ± 3.99, post: 129.96 ± 4.04, $p < 0.01$) after training. These results highlight the important role of lumbopelvic control in pitching performance, which is consistent with previous studies[3].

Table 1: The results of pelvic control before and after training in baseball pitchers.

Assessments (Parameters, unit)	Sides (direction)	Pre	Post	*p*-value
Single-leg balance (Pelvic angle deviation, degree)	Stride leg (ML)	1.80±1.56	0.99±0.89	< 0.01*
	Drive leg (ML)	2.88±1.45	1.83±1.12	< 0.01*
	Stride leg (AP)	1.46±1.34	0.90±0.56	0.21
	Drive leg (AP)	1.03±0.37	0.91±0.35	0.14
Single-leg bridge (Pelvic angle deviation, degree)	Stride leg (ML)	3.14±1.68	2.63±0.85	0.38
	Drive leg (ML)	3.05±0.79	2.72±0.46	0.26
	Stride leg (AP)	3.30±1.22	2.12±0.68	< 0.01*
	Drive leg (AP)	3.33±1.17	2.51±1.06	0.03*

ML, medial-lateral; AP, anterior-posterior

Conclusions

Real-time biofeedback lumbopelvic control training improves pelvic control and pitching velocity in baseball pitchers, proving its value as an essential training method.

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