Can regional bioimpedance vector analysis highlights functional asymmetry in the legs of professional cyclists?

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Introduction

Cycling involves the transmission of forces from human body segments to bicycle components. Although riding is considered a constrained motion, there is an asymmetry in pedalling, even in healthy riders (Bini et al., 2015). Professional road cyclists ride for several hours daily, power output, terrain and fatigue influence muscle recruitment strategies (Bini et al, 2015). These conditions may alter the correct body position on the bike, leading to a muscle imbalance that could potentially trigger leg injuries. However, there is a lack of data ascertaining muscle imbalance in cycling using body composition analysis. Regional body compartment analysis may be an important indicator of health status and may identify potential body asymmetries (Stahn, 2016). Bioimpedance vector analysis is a rapid and inexpensive method to identify regional change in muscle mass or fluids; it uses raw bioelectrical values without quantitative prediction of masses with multiple regression body composition models.

Purpose

The aim of this investigation was to determine the prevalence of leg muscle asymmetries by electrical analysis that may result in injury, and estimate segmental body compartments in professional road riders.

Material and methods

Thirty-two male professional road cyclists (Mean ± SD; age: 27 ± 5 years; stature: 1.77 ± 0.06 m; body mass: 66.20 ± 6.82 kg) took part in the study during their peak performance period.
All data were collected using a standardized protocol by the same operator in accordance with the procedures described by Sardinha et al. 1998. All measurements were collected at rest before a training session (7:00 a.m.). The impedance measurements were performed with phase sensitive bioimpedance using 8-electrodes and a specialized cable analyser (BIA 101 Anniversary, Akern, Florence, Italy), which applies an alternating current of 400 µA at a single frequency of 50 kHz.
Hotelling's T2-test was performed to determine if the changes in the mean group vectors determined in left and right legs and hemisoma were significantly different.

Results

We observed no significant differences in the changes in bioimpedance measurements between the right and left legs (Table 1). No significant differences in vector position were found between left and right legs ($p = 0.60$) (Figure 1) and between left and right hemisomas ($p = 0.92$) (Figure 2).

Discussion

The main finding of this investigation is that the two hemisomas and the limbs, analysed by regional bioelectrical impedance parameters, showed no significant differences between the right and left leg, indicating an absence of muscles asymmetries. In pedalling, the use of legs muscles is a result of neuromuscular adaptations (Chapman et al. 2008). Existing evidence confirmed that dominant leg contributes more to the average power than the other leg, leading to a muscle asymmetry recruitment between legs (Smak et al. 1999).

Despite bilateral asymmetries may be affected by a contribution of muscle force production (Bini et al. 2015), our results have shown that the phase angle, a derived bioelectrical parameter of cellular health indicating the amount and quality of soft tissue, did not differ between the right and left legs.

These results support the evidence that, in uninjured cyclists without muscles abnormalities, the muscle recruitment asymmetry between the two legs mainly depends on the neuromuscular activation and cyclists' ability to produce forces perpendicular to the crank and not from the size of muscles mass (Bini et al, 2015). Future research could further investigate pedalling symmetry data collected by bilateral power meters and bioelectrical impedance parameters.

Conclusions and practical applications

Regional bioimpedance vector analysis is a novel, affordable and helpful tool to support the activities of medical staff and biomechanics assessments, identifying body compartments imbalances leading to potential muscles injuries.

References

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Bioimpedance variable	Right leg	Left leg	P
Phase angle hemisoma (°)	7.88±0.60	7.93±0.66	.722
Phase angle arm (°)	8.08±1.52	7.78±0.79	.353
Phase angle leg (°)	8.05±0.69	8.22±0.85	.480
Resistance/height arm (ohm/m)	125.8±16.33	126.9±15.75	.773
Resistance/height hemisoma (ohm/m)	268.00±33.07	270.2±31.88	.754
Resistance/height leg(ohm/m)	130.20±17.50	131.1±16.88	.742
Reactance/height arm(ohm/m)	17.83±4.50	17.22±2.02	.957
Reactance/height hemisoma (ohm/m)	37.03±4.60	37.49±4.49	.493
Reactance/height leg(ohm/m)	18.87±2.76	18.84±2.57	.379
Impedance Vector length arm (ohm)	127.1±16.56	128.1±15.78	.808
Impedance Vector length hemisoma (ohm)	270.5±33.27	272.8±32.03	.770
Impedance Vector length leg (ohm)	131.5±17.65	132.4±16.96	.720

Table 1: Bioelectrical parameters of the body compartments.

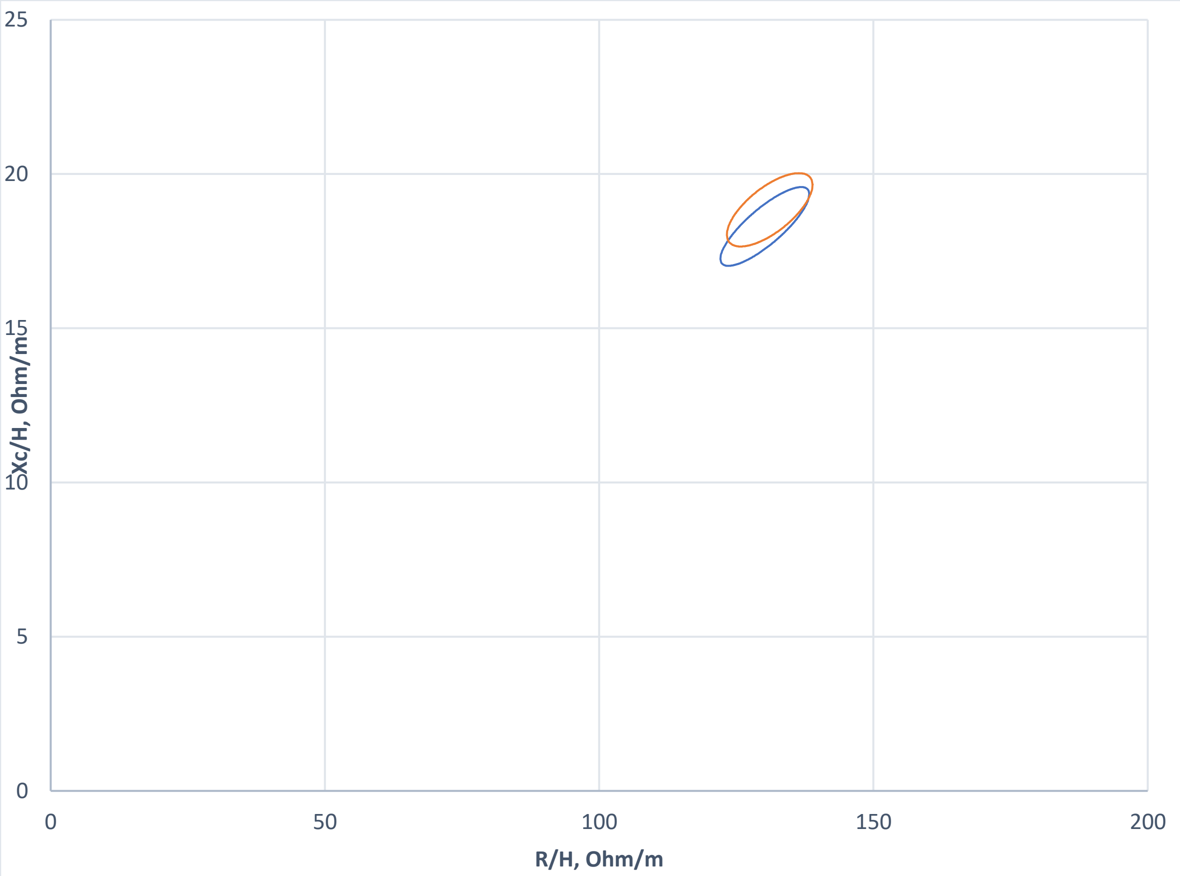

Figure 1: Mean impedance vectors with the 95% confidence ellipses for both athlete legs.

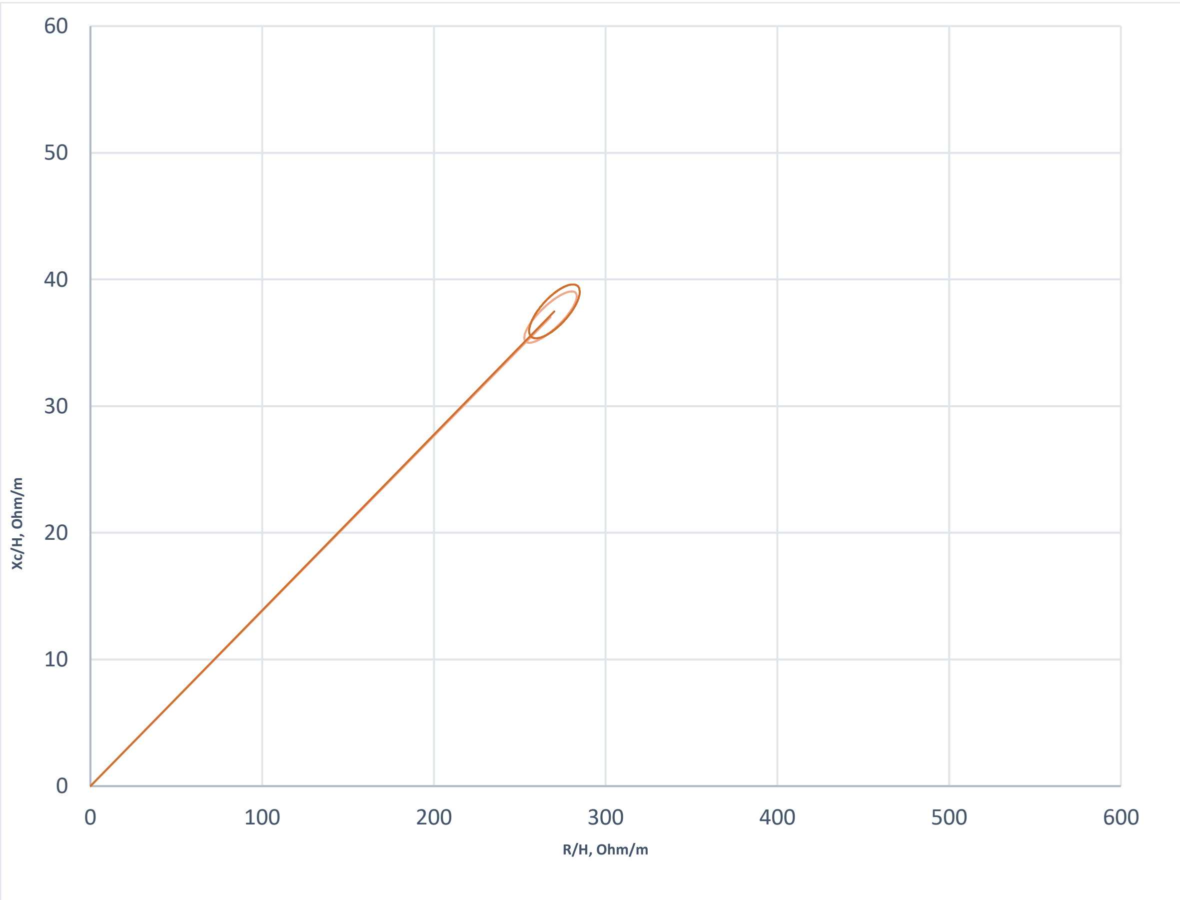

Figure 2: Mean impedance vectors with the 95% confidence ellipses for both athletes hemisomas.