Recent advances in electrical bioimpedance

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Over the past decade, electrical bioimpedance has been undergoing a rebirth as enhanced methodologies and new theories are greatly extending its use in the field of neuromuscular disease (NMD). Simply put, NMDs change the structure and internal composition of skeletal muscle which, in turn, alter the electrical properties muscle. Thus, the capability of measuring the electrical properties of muscle with accuracy has great potential to provide valuable new insights to inform medical assessment and diagnosis of NMDs.

One technique well-suited for measuring the electrical properties of muscle is electrical bioimpedance, where an electrical current is applied to the muscle using two electrodes and the resultant voltage is measured using two additional electrodes. However, the accuracy to detect onset of disease, track disease progression and response to therapy using surface electrodes placed on the skin is limited: data are largely influenced by skin and subcutaneous fat (SF) overlying the muscle. Here, we will present a new source separation (SS) technique that, unlike existing blinded SS techniques principal component analysis (PCA) and independent component analysis (ICA), can distinguish muscle from SF with the accuracy being 99.2%.

However, the standard procedure of patient care for diagnosing NMDs consists of inserting needles electrodes into the muscle to measure the electrical activity at rest and during muscle contraction. To take advantage of this, we have designed an enhanced needle device also integrating impedance recording capabilities. Our new needle improves the accuracy measuring the electrical properties by recording these properties and their direction dependence directly in the muscle, the latter also known as anisotropy. Ongoing work in this area promises exciting and valuable new applications in the years to come.

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