

ANALYSIS OF FIBER TYPE PROPORTION OF ADDUCTOR POLLICIS AND TRICEPS BRACHII MUSCLE USING STOCKWELL TRANSFORM AND SINGULAR VALUE FEATURES

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ABSTRACT

The proportion of muscle fiber types determines the ability to perform various tasks. In this study, variation of surface electromyography (sEMG) features with varying muscle fiber proportions is analyzed. The signals are acquired from adductor pollicis (AP) and triceps brachii (TB) muscles during isometric contraction using approved protocols. Time-frequency representation of the signals are computed using Stockwell transform for initial and final segments of 2 s duration. Singular value decomposition method is used to extract the features such as singular value energy (SVEg), singular value entropy (SVEp) and maximum singular value (SVm) of the signal. The percentage variation of these features from initial segment to final segment for both muscles are computed. The reduction in SVEg (-70.75%) and SVEp (-1.35%) for AP may indicate the greater composition of type I fibers. The increase of SVEg (123.23%) and decrease of SVEp (-14.44%) for TB muscle may imply a higher ratio of type II fibers. This study can be found useful in analyzing muscle fiber proportion in the field of sports science.

Keywords: Surface electromyography (sEMG), Fiber type, Adductor pollicis, Triceps brachii, Stockwell transform, Singular value decomposition

INTRODUCTION

Human skeletal muscle characteristics vary with muscles and individuals. The force production of the muscle depends on motor unit recruitment, rate coding, motor unit (MUs) number, and proportion of muscle fibers. The ratio of muscle fibers depends on the role of the muscle. Type I (slow-twitch) muscle fibers are dominant in muscles that generate force for a long duration. Whereas, muscles with a larger composition of type IIa or IIb (fast-twitch) fibers produce high force and fatigue early [1].

Several invasive and non-invasive methods have been reported for identifying muscle fiber type proportions. Methods such as histochemistry, tensiomyography, and proton magnetic resonance spectrography have been used for fiber type estimation [2], [3]. Several works have been reported on fiber type analysis using surface electromyography (sEMG) signals [4], [5]. sEMG is a non-invasive method to record bioelectric potentials during muscle activity. sEMG signals provide information about the motor unit activity [6]. These signals are found useful in the field of clinical diagnosis, ergonomics, exercise physiology, rehabilitation process and sports science [6], [7].

Time and frequency domain features have been reported useful for analysis of fiber type proportion. Time domain parameters such as root mean square and signal amplitude ratio are used for fiber type analysis [4]. The frequency domain biomarkers such mean frequency and median frequency of the power spectrum are found related with proportion of muscle fiber types [4], [5].