PGC-1 ALPHA-MEDIATED CHANGES IN PHOSPHOLIPID PROFILES OF 
EXERCISE-TRAINED SKELETAL MUSCLE

Senoo, N.¹, Miyoshi, N.¹, Morita, A.¹, Kamei, Y.² and Miura, S.¹

¹University of Shizuoka, Shizuoka, Japan
²Kyoto Prefectural University, Kyoto, Japan

Introduction

Exercise training influences phospholipid fatty acid composition in skeletal muscle and these changes are associated with physiological phenotypes (Anderson et al., 2000; Goto-Inoue et al., 2013); however, the molecular mechanism of this influence on compositional changes is poorly understood. Peroxisome proliferator-activated receptor γ coactivator 1α (PGC-1α), a nuclear receptor coactivator, promotes mitochondrial biogenesis, the fiber-type switch to oxidative fibers, and angiogenesis in skeletal muscle. Because exercise training induces these adaptations, together with increased PGC-1α, PGC-1α may contribute to the exercise-mediated change in phospholipid fatty acid composition. To determine the role of PGC-1α, we performed lipidomics analyses of skeletal muscle from genetically modified mice that overexpress PGC-1α in skeletal muscle (PGC-1α-Tg mice) (Tadaishi et al., 2011) or that carry knockout alleles of PGC-1α (PGC-1α-KO mice) (Handschin et al., 2007).

Methods

Lipidomics analyses of the extensor digitorum longus (EDL) and the soleus-derived lipid extract from PGC-1α-Tg mice were performed using LC/MS. To capture the characters of different muscle samples and the PGC-1α-driven alterations in lipid profile, we performed a hierarchical clustering analysis (HCA) and a principal component analysis (PCA). Next, to determine whether exercise training-induced changes in the lipid profiles were similar to those observed in PGC-1α-Tg mice, and whether PGC-1α was involved in these changes, the amounts of phospholipid species in sedentary and trained muscle were measured in skeletal muscle from PGC-1α-KO and control PGC-1αflox/flox mice.

Results

As a result of HCA and PCA, we found that overexpression of PGC-1α in the skeletal muscle caused a significant change in the overall lipid profile of the muscle, and increased several phospholipid species in EDL, namely phosphatidylcholine (PC) (18:0/22:6) and phosphatidylethanolamine (PE) (18:0/22:6). PC(18:0/22:6) and PE(18:0/22:6) increased in trained EDL from PGC-1αflox/flox mice; however, these lipid species did not increase in trained EDL from muscle PGC-1α-KO mice, suggesting that exercise training increased these molecules depending on PGC-1α.

Discussion

In conclusion, overexpression of PGC-1α and exercise training altered phospholipid profiles in skeletal muscle, especially in glycolytic fiber, and some exercise-induced changes were required for PGC-1α expression. Since phospholipid fatty acid composition influences cell permeability and receptor stability at the cell membrane, these phospholipids may contribute to exercise training-mediated functional changes in the skeletal muscle.

References