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High expressions of the cytoglobin and PGC-1α genes during the tissue regeneration of house gecko (*Hemidactylus platyurus*) tails

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Abstract

Background: The tissue regeneration process requires high oxygen and energy levels. Cytoglobin (Cygb) is a member of the globin family, which has the ability to bind oxygen, plays a role in dealing with oxidative stress, and carries oxygen into the mitochondria. Energy production for tissue regeneration is associated with mitochondria—especially mitochondrial biogenesis. The peroxisome proliferator-activated receptor-gamma coactivator (PGC)-1alpha protein helps to regulate mitochondrial biogenesis. House geckos (*Hemidactylus platyurus*) are reptiles that have the ability to regenerate the tissue in their tails. House geckos were selected as the animal models for this study in order to analyze the association of Cygb with oxygen supply and the association of PGC-1α with energy production for tissue regeneration.

Results: The growth of house gecko tails showed a slow growth at the wound healing phase, then followed by a fast growth after wound healing phase of the regeneration process. While Cygb mRNA expression reached its peak at the wound healing phase and slowly decreased until the end of the observation. PGC-1α mRNA was expressed and reached its peak earlier than Cygb.

Conclusions: The expressions of both the Cygb and PGC-1α genes were relatively high compared to the control group. We therefore suggest that Cygb and PGC-1α play an important role during the tissue regeneration process.

Keywords: Cytoglobin, PGC-1α, Mitochondrial biogenesis, House gecko, Tissue regeneration

Background

Tissue regeneration is a complex process that attempts to restore organ morphology to functional levels after an injury. This process involves cell proliferation, migration, and differentiation, and synthesis of the extracellular matrix [1–5]. Since the tissue regeneration process aims to restore tissue morphology and physiology, it requires high levels of energy, which in turn require the aerobic metabolism to produce high numbers of ATPs. The ATPs fulfill their function in this process only when the O_2 supply is sufficient [5–7]. If the aerobic metabolism does not keep pace with the increase of oxygen demand, the tissue enters a relative hypoxia state [8, 9]. In this state, the organisms strive to meet the oxygen demand in order to maintain the metabolism for cellular activities; hence, oxygen might be transferred to the mitochondria by the Cygb protein [10–12].

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The high affinity of Cygb to oxygen led to our assumption that Cygb might play a significant role as an oxygen diffusion factor, transferring oxygen to the mitochondria. Cygb protein also has a function in oxygen storage and as an oxygen sensor [13, 14]. This functionality is similar to that of the myoglobin in muscle cells, which contributes to the maintenance of the oxidative phosphorylation process [15, 16]; therefore, we suspected that Cygb was involved as an adaptive response to hypoxia-mediated injuries.

Mitochondria, as energy-producing organelles, play an important role in certain cellular events, such as cell proliferation and differentiation, which require high energy levels. When these cells demand high levels of We also hypothesize that Cygb and PGC-1α play a role in the tissue regeneration process.

Results

Tail growth

The growth of the house gecko tails, as a result of the tissue regeneration process, was measured in centimeters from the proximal to the distal parts of the tails. The tails grew slowly from day 1 to day 13 (the wound healing and blastema phase), then the growth curve increased markedly from day 13 to day 21 (the regeneration phase), and increased slowly again from day 21 to day 30 (the maturation phase). The growth of house gecko tails differed significantly between day 13