Photoengineering of tissue repair in skeletal and cardiac muscles.

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This review discusses the application of He-Ne laser irradiation to injured muscles at optimal power densities and optimal timing, which was found to significantly enhance (twofold) muscle regeneration in rats and, even more, in the cold-blooded toads. Multiple and frequent (daily) application of the laser in the toad model was found to be less effective than irradiation on alternate days. It was found that in the ischemia/reperfusion type of injury in the skeletal leg muscles (3 h of ischemia), infrared Ga-Al-As laser irradiation reduced muscle degeneration, increased the cytoprotective heat shock proteins (HSP-70i) content, and produced a twofold increase in total antioxidants. In vitro studies on myogenic satellite cells (SC) revealed that phototherapy restored their proliferation. Phototherapy induced mitogen-activated protein kinase/extracellular signal-regulated protein kinase (MAPK/ERK) phosphorylation in these cells, probably by specific receptor phosphorylation. Cell cycle entry and the accumulation of satellite cells around isolated single myofibers cultured in vitro was also stimulated by phototherapy. Phototherapy also had beneficial effects on mouse, rat, dog and pig ischemic heart models. In these models, it was found that phototherapy markedly and significantly reduced (50-70%) the scar tissue formed after induction of myocardial infarction (MI). The phototherapeutic effect was associated with reduction of ventricular dilatation, preservation of mitochondria and elevation of HSP- 70i and ATP in the infarcted zone. It is concluded that phototherapy using the correct parameters and timing has a markedly beneficial effect on repair processes after injury or ischemia in skeletal and heart muscles. This phenomenon may have clinical applications.

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