

Endothelial Effects and Angiogenesis

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Low-energy laser irradiation increases endothelial cell proliferation, migration, and eNOS gene expression possibly via PI3K signal pathway.

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BACKGROUND AND OBJECTIVES: The purpose of this study, therefore, was to determine the mechanisms by which low-energy laser irradiation (LELI) may exert some of its angiogenic effects via the PI3 kinase/eNOS signaling pathway and induce endothelial cell migration and neovascularization, an important and necessary part of wound healing. **STUDY DESIGN/MATERIALS AND METHODS:** The possible molecular mechanism of helium-neon (He-Ne) laser irradiation on endothelial cells was proposed. He-Ne laser at 632.5 nm was used to stimulate human umbilical vein endothelial cell (HUVEC), and its effect on cell proliferation, nitric oxide secretion, and cell migration was determined. **RESULTS:** Irradiation enhanced endothelial nitric oxidase synthase (eNOS) protein expression, and irradiation of less than 0.26 J/cm² enhanced eNOS gene expression in HUVEC. The cell migration ability was promoted for HUVEC irradiated with 0.26 J/cm². This agreed with the vinculin protein expression induced by irradiation. In addition, the angiogenesis was promoted. The induced eNOS expression was inhibited by LY294002, indicating that the effect of laser on EC could be attributed to the up-regulation of eNOS expression through PI3K pathway at the cellular and molecular levels as a result of the He-Ne laser. **CONCLUSIONS:** The study has shown that LELI increased endothelial cell proliferation, migration, NO secretion, and identified that activation of PI3K/Akt pathway was a critical step for the elevated for eNOS expression upon LELI.

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Low-power helium: neon laser irradiation enhances production of vascular endothelial growth factor and promotes growth of endothelial cells in vitro.

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BACKGROUND AND OBJECTIVE: Numerous reports suggest that low-power laser irradiation (LPLI) is capable of affecting cellular processes in the absence of significant thermal effect. The objective of the present study was to determine the effect of LPLI on secretion of vascular endothelial growth factor (VEGF) and proliferation of human endothelial cells (EC) in vitro. **STUDY DESIGN/MATERIALS AND METHODS:** Cell cultures were irradiated with single different doses of LPLI (Laser irradiance from 0.10 to 6.3 J/cm²) by using a He:Ne continuous wave laser (632 nm). VEGF secretion by smooth muscle cells (SMC) and fibroblasts was quantified by sandwich enzyme immunoassay technique. The endothelial cell proliferation was measured by Alamar Blue assay. VEGF and transforming growth factor beta (TGF-beta) expression by cardiomyocytes was studied by reverse transcription-polymerase chain reaction (RT-PCR). **RESULTS:** We observed that (1) LPLI of vascular and cardiac cells results in a statistically significant increase of VEGF secretion in culture (1.6-fold for SMC and fibroblasts and 7-fold for cardiomyocytes) and is dose dependent (maximal effect was observed with LPLI irradiance of 0.5 J/cm² for SMC, 2.1 J/cm² for fibroblasts and 1.05 J/cm² for cardiomyocytes). (2) Significant stimulation of endothelial cell growth was obtained with LPLI-treated conditioned medium of SMC (maximal increase was observed with LPLI conditioned medium with irradiance of 1.05 J/cm² for SMC and 2.1 J/cm² for fibroblasts). **CONCLUSIONS:** Our studies demonstrate that low-power laser irradiation increases production of VEGF by SMC, fibroblasts, and cardiac myocytes and stimulates EC growth in culture. These data may have significant importance leading to the establishment of new methods for endoluminal postangioplasty vascular repair and myocardial photoangiogenesis.

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Augmentation of the expression of proangiogenic genes in cardiomyocytes with low dose laser irradiation in vitro.

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BACKGROUND AND OBJECTIVE: Several reports suggest that low power red laser light (LPRL) is capable of affecting cellular processes in the absence of significant thermal effect. The objective of the present study was to determine the effect of LPRL on proliferation of fetal cardiomyocytes in vitro and on the expression of proangiogenic genes, transforming growth factor-beta (TGF-beta), and vascular endothelial growth

factor (VEGF). **STUDY DESIGN/MATERIALS AND METHODS:** All cell cultures were irradiated with single-dose LPRL using a He-Ne continuous wave laser (632 nm) with different doses. The effect of LPRL on new DNA synthesis was studied by ³H thymidine-incorporation assay. VEGF and TGF-beta expression by cardiomyocytes was studied by reverse transcription-polymerase chain reaction (RT-PCR). **RESULTS:** We observed that a dose-dependent increase in cardiomyocytes proliferation can be obtained with LPRL and that there is a significant increase in VEGF and TGF-beta mRNA expression by cardiomyocytes. **CONCLUSIONS:** These data may have significant importance leading to the establishment of new methods for myocardial photoangiogenesis and photoregeneration as well as in vitro proliferation of cardiac myocytes