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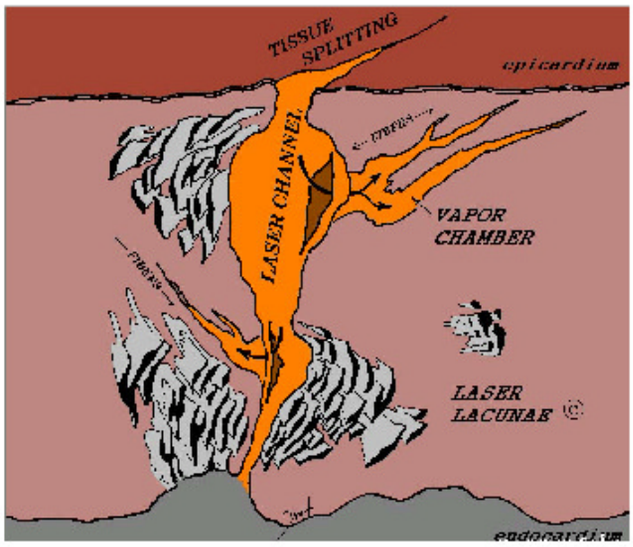
Transmyocardial Laser Revascularization: Mechanism of Action

PHOTOACOUSTIC TISSUE DISRUPTION CREATES LASER LACUNAE© THAT PERFUSE ISCHEMIC MYOCARDIUM.
Lasers Surg Med 1999; 11 (Suppl):9



Purpose: Identify the mechanism of efficacy of transmyocardial laser revascularization (TMR).

Methods: Histology of porcine left ventricular mycardium immediately post-TMR. Laser channels were made with a 1.3msec duration, 6-10 Joules, 1 mm diameter pulse from a CO_2 laser (Circulase, LLT, San Leandro, CA).

Results: One pulse drills a transmural channel. Acute tissue effects: (1) Laser channel, (2) Tissue splitting, (3) Radial vapor chambers and, (4) Artificial laser lacunae. The epicardial surface was either spit up to 3 mm along the muscle fiber plane or the channel opening was approx. 1 mm in diameter. Within the myocardium the channel lumen varied significantly from a narrow slit to large chambers several mm's in diameter. Intramural vapor pressures opened vapor chambers radial to the axis of the laser channel along natural planes of dissection. Partially interconnected blood-filled spaces were seen both adjacent to the chambers and at radial distances up to 9 mm. These lacunae were irregular flattened discs aligned along the plane of the myocyte fibers, oriented in concentric arcs centered on a vapor chamber, and communicated with capillary networks but not directly with the channel lumen.

Conclusion: Explosive vaporization expands channel walls and generates an acoustic pressure wave that propagates into the surrounding tissue. High amplitude compression and rarefaction disrupts and separates the myocardium to form artificial spaces. Ruptured capillaries fill these spaces with blood (laser lacunae). Photo-acoustic tissue disruption provides immediate perfusion to a large volume of myocardium surrounding both the laser channel and the radial vapor chambers.

High-speed cinematography of the impact of a 1.3msec, 10 Joule CO_2 laser pulse in agar gel.