STUDIES ON EXPERIMENTAL BRAIN EDEMA CAUSED BY Nd-YAG LASER IRRADIATION: MEASUREMENT OF WATER CONTENT BY GAS-LIQUID CHROMATOGRAPHY

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Introduction
As the tissue absorption of the Nd-YAG laser is much lower than that of the CO2 laser, tissues can be coagulated very effectively for hemostasis. Since the Nd-YAG laser has strong optical scattering and promotes diffuse distribution of radiation within the tissue, edema might be produced in the surrounding cerebral tissue in case of brain irradiation. The time-course changes of water content of the experimental rat brain edema and histological finding of brain tissue caused by Nd-YAG laser irradiation were investigated.

Materials and Methods
136 Wistar rats weighing 250-280gm were used in the experiment. A trephine opening of 4mm in diameter was made in the parietal region, and Nd-YAG (Medilas type) laser irradiation was carried out. The laser beam irradiation was performed over the exposed cortex with single pulse at 30W, 50W, and 100W respectively. The duration of exposure was 0.5 second. The animals were divided into the focused beam group and defocused beam group. The animals were sacrificed on the 1st, 3rd, 5th, and 7th day respectively. The gas-liquid chromatography was employed to obtain the percentage of water content in the brain tissue. Histological examination was associated with Klüver-Barrera staining for myelin sheath and Nissl substance.

Results
In the irradiated area with focused beams, water content was maximal on the 1st day in all groups and proportional to the intensity of laser beams. The water content regressed gradually thereafter. By the 3rd day in the 30W group and the 5th day in the 50W, 100W groups, the water content decreased to the control level (Fig. 1).

In the focused beam irradiation, water content of the corresponding area on the opposite side increased...
in the 50W and 100W groups and persisted for the first three days (Fig. 2).
In the defocused 50W and 100W irradiation, the increase of water content was also maximal on the first day. However, it was less than in the focused 30W group. There was no increase of water content on the opposite side at any time (Fig. 3).
Histologically, tissue destruction was more severe in focused beam irradiation. Reparative process such as invasion of fibroblasts from the pia-arachnoid membrane and gliosis was already found on the 3rd day.

Discussion
The poor absorption of Nd-YAG laser energy by non-pigmented tissue results in extensive damage to neural structures and thus is not usually applicable to cerebral parenchymal surgery. However, the absorption of Nd-YAG is color dependent, and it can be transmitted efficiently through fiberoptic systems. Thus, Nd-YAG lasers are potentially useful for highly vascular or deep seated tumors. The Nd-YAG laser has strong optical scattering and promotes even distribution of the radiation within the tissue. As a result of this effect, heat could be conducted into deep portion. Thermal damage with surrounding brain edema might be occurred significantly in case of irradiation to the brain tissue. Beck reported that the laser induced brain edema was seen in the first 24 to 36 hours after injury within the pale zone through the over necrosis. This result corresponded to our study that maximal increase of water content was first 24 hours after irradiation. In another our experiment, we attempted to quantitatively measure water content of the brain tissue.
after CO₂ laser irradiation. In this series, brain edema was maximal at 3 days following lesion making. In histological examination after Nd-YAG laser irradiation, the defocused beam led to decoloration of brain surface or formation of depression, while the focused beam gave a more wedge shaped lesion. Consequently the damaged area was energy dependent. Yamagami, et al investigated the histological findings of rat brain tissue by irradiation of Nd-YAG laser. They found that recovery began from 3 days after lesion with appearance of macrophage and fibroblasts.

Conclusion
Brain edema produced by Nd-YAG laser irradiation was studied by gas-liquid chromatography and histology.
1. Brain edema was more remarkable in the focused beams irradiation than in the defocused beams irradiation.
2. Brain edema was maximal on the 1st day after the lesion was made.
3. Increase in the water content in the brain tissue was proportional to the intensity of laser beams on the 1st day after irradiation was performed, and such relationship was not noted thereafter.
4. The focused beams led to edema on contralateral hemisphere at 50W and 100W output power.
5. The defocused beams produced no edema on contralateral hemisphere at any intensity of the beams.
6. Histologically, the focused beam irradiation showed more severe tissue destruction.

References