

Combination of plasmonic photothermal therapy with surgery applied to naturally occurring mammary tumors in canines and felines: clinical outcomes and molecular studies

Moustafa R. Ali · Haithem A. Farghali · Hala R. Ali · Ahmed H. Osman · Mostafa A. El-Sayed

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Abstract

Plasmonic Photothermal Therapy (PPTT) is a cancer therapy where gold nanorods (AuNRs) are injected at the tumor site and near-infrared light (safe to bio-system) is applied to generate localized heat causing cancer cell death. PPTT is a potentially good alternative to replace traditional surgery for localized tumors. However, for large tumors (volume ≥ 10 cm³), PPTT could be ineffective due to an uneven distribution of injected AuNRs causing possible inhomogeneity of heat. Surgery is frequently recommended in those cases. However, it carries a high risk of cancer recurrence. For effective treatment of large tumors, we combined both PPTT and surgical resection and applied it to naturally occurring tumors in mammary glands of dogs and cats, which could realistically represent their human equivalents at the molecular level. For the experimental design, we divided the animals into three different groups. 20 cases (7 cats and 13 dogs) were all diagnosed with adenocarcinoma; the animals were monitored for 1-2 years after treatments. Group (I): three cases were solely treated by mastectomy (control group); all of them died within a few weeks. Group (II): five cases were treated with mastectomy first. Then, each tumor wound was divided into two halves, and only one half was exposed to PPTT. After treatment, two cases in this group rendered complete remission. In the other three cases, the half wound that was not exposed to PPTT had tumor recurrence causing animal death within one year. Group (III): 12 cases were treated with surgery followed by PPTT treatment. This regime showed complete remission without any recurrence for eight cases. However, four cases died 4-12 months after therapy for reasons such as pneumonia (no tumor found, based on X ray). Histopathology results showed a decrease of cancer grades before (variant grades from 1-4) and after two weeks of treatment via PPTT and surgery (grade 0). Blood tests (conducted 1 year after therapy) showed no obvious change in liver and kidney functions in groups II and III. In addition, X-ray diffraction showed no metastasis 1- 2 years after treatment. We have performed quantitative, real time-PCR analysis two weeks before and after treatment to study the expression levels of several important genes. The genes that are responsible for repairing cancer cells such as BRCA1, BRCA2, and CD163-IL-10 were significantly diminished two weeks after treatment (group III). Furthermore, tumor microenvironment cells such as tumor-associated macrophages (TAMs) were greatly altered after treatment. TAM 1, which retards tumor growth, augmented, and TAM 2, which promotes tumorigenesis, was diminished, which explains the animals' increased survival rate. In conclusion, our study demonstrates the feasibility of applying PPTT after surgery for large tumors in dogs and cats. Citation Format: Moustafa R. Ali, Haithem A. Farghali, Hala R. Ali, Ahmed H. Osman, Yousef A. Soliman, Yue Wu, Ibrahim M. Ibrahim, Salah A. Selim, Dong M. Shin, Mostafa A. El-Sayed. Combination of plasmonic photothermal therapy with surgery applied to naturally occurring mammary tumors in canines and felines: clinical outcomes and molecular studies [abstract]. In: Proceedings of the American Association for Cancer Research Annual Meeting 2017; 2017 Apr 1-5; Washington, DC. Philadelphia (PA): AACR; Cancer Res 2017;77(13 Suppl):Abstract nr 175. doi:10.1158/1538-7445.AM2017-175