Targeting Ovarian Cancer: Advancing Precision Therapy with Porphysome Nanotechnology

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Purpose

Ovarian cancer is one of the leading causes of gynecologic cancer mortality due to delayed diagnosis, metastatic involvement, and immune-suppressive tumor microenvironment. Limitations on current therapies are from challenges in intraoperative tumor visualization and ineffective treatment delivery. Porphysome-based nanotherapy is a promising novel treatment, offering targeted delivery, real-time imaging, and minimal toxicity. This review evaluates preclinical studies of murine models exploring the safety and efficacy of porphysomes in imaging and treating ovarian cancer.

Materials and Methods

A Pubmed search (2020-2025) identified studies on porphysome-based nanotherapy in ovarian cancer using keywords “porphysomes,” “photodynamic therapy,” “nanotherapy or nanoparticles,” and “ovarian cancer.” Three studies met inclusion criteria.

Results

Lui et al. developed folate-conjugated porphysomes (FPs) for fluorescence-guided imaging and photodynamic therapy (PDT).

- FPs showed significant uptake in ovarian cancer cells vs. non-targeted porphysomes (NPs).
- FP fluorescence = stronger tumor signal for imaging.
- FP + laser showed significant tumor growth inhibition by day 7 compared to controls.

Xu et al. incorporated verteporfin into FPs (VP-FPs), boosting cytotoxic efficacy.

- VP-FPs showed higher uptake and stronger fluorescence in tumor cells compared to control.
- In vivo imaging confirmed tumor selectivity and signal intensity.
- VP-FP + laser showed smaller tumor volumes vs. NP + laser, free VP, or saline by day 14.
- No overt organ toxicity.

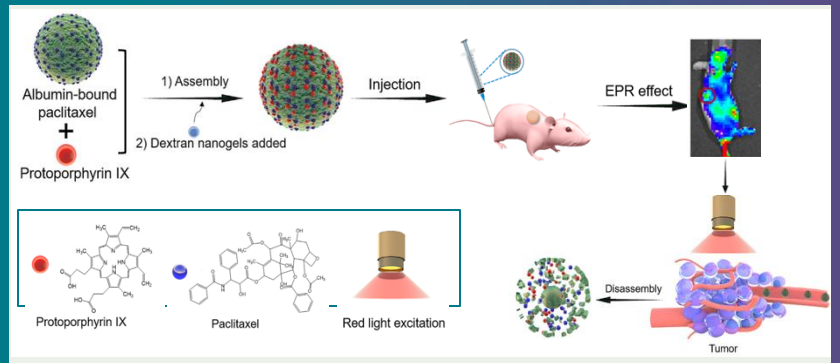

Figure 1. Design of VP-FP nanoparticles: Albumin-bound paclitaxel and protoporphyrin IX assembled into nanoparticles, which accumulate at tumor sites. Upon red light activation, ROS and paclitaxel released to overcome chemoresistance (adapted from Xu et al.,2023)

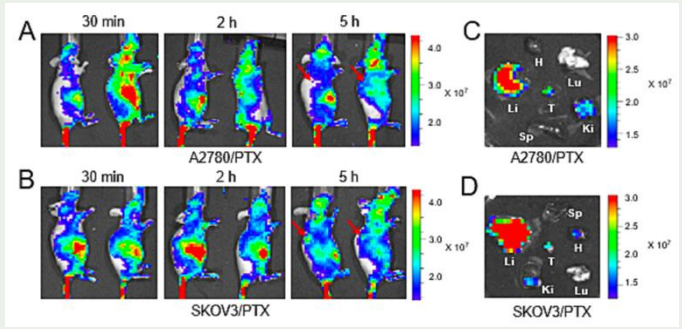

Figure 2. (A,B) *In vivo* tumor-selective fluorescence in A2780/PTX and SKOV3/PTX xenograft models. Red arrows are tumor sites. (C,D) *Ex vivo* imaging of uptake to tumor, heart, liver, spleen, lung, and kidney (adapted from Xu et al., 2023)

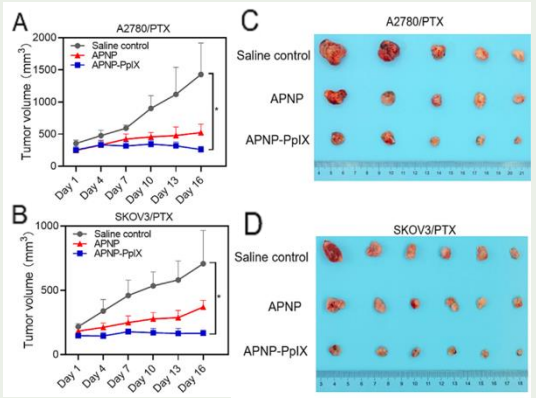

Figure 3. (A) Tumor volume and (B) tumor weight of saline (control), APNP, and APNP-PpIX groups during treatment in A2780/PTX and SKOV3/PTX cells. (C,D) Harvested tumors from saline (control), APNP, and APNP-PpIX groups, demonstrating reduced tumor burden compared to saline and APNP groups (adapted from Xu et al., 2023)

Kaur et al. highlighted immunomodulation by porphysomes.

- PDT with porphysomes released damage-associated molecular patterns (DAMPs).
- Promoted activation of antigen-presenting cells and T-cell priming.
- Links local cytotoxicity with systemic immune activation.

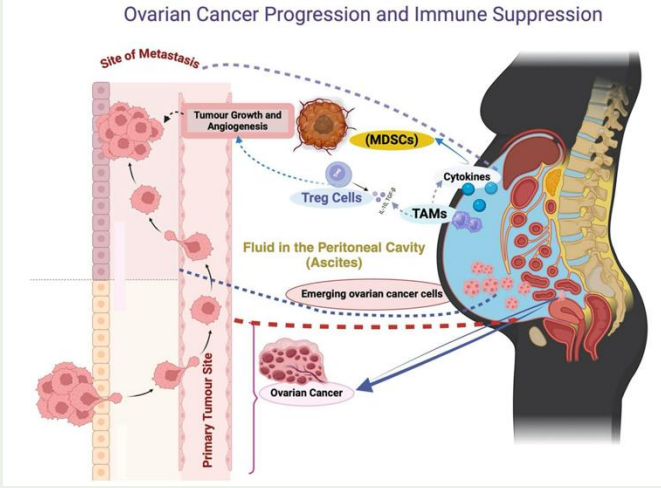

Figure 4. Immunosuppressive tumor microenvironment in ovarian cancer, supporting tumor progression and metastasis in the peritoneal cavity (adapted from Kaur et al., 2024)

Conclusion

Porphysome-based nanotherapy offers a multifaceted approach to ovarian cancer by enhancing tumor selectivity, real-time imaging, and photodynamic cytotoxicity while reducing tumor burden. This dual-function platform is promising for clinical translation in fluorescence-guided photodynamic therapy to improve treatment delivery and precision-guided treatment in ovarian cancer.

References

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