Orbital Angular Momentum in Biomedical Applications: Navigating Complex Environments with Preserved Phase Integrity

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We explore the potential of structured vortex laser beams, known also as shaped light with orbital angular momentum (OAM), for diagnosis of cells and cells cultures, as well as for quantitative characterization of biological tissues. The structured vortex beams contains a spin contribution, conditioned by the polarization of the electromagnetic fields and an orbital contribution, related to their spatial structure. When the shaped light propagates in a homogeneous transparent medium, both spin and orbital angular momenta are conserved. In order to study a conservation of spin and orbital angular momenta of the shaped light propagation in a homogeneous transparent medium we have built a Mach-Zehnder-like interferometer featuring spatial light modulator (SLM) for generating Laguerre-Gaussian (LG) light beams with different momenta. The LG beam passes through a tissue sample and the interference with reference plane wave is detected on the camera. We show that when the LG beam propagates through normal and cancerous tissue samples the OAM is preserved with the noticeably different phase shift -– twist of light. We also demonstrate that the twist of light is up to ~ 1000 times more sensitive to the refractive indices changes within the tissue samples and, therefore, has a high potential to revolutionize the current practices of tissue diagnosis, *e.g.* histology examination. The results of our experimental studies are well agreed with the results obtained with newly developed by Monte Carlo code developed in-house. Finally, we conclude that the application of OAM for biomedical diagnosis offers fascinating opportunities for both new fundamental biological studies and practical clinical applications.