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In vitro evaluation of a novel oxygen-generating biomaterial for chronic rhinosinusitis therapy

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Abstract:

Background: Hypoxia due to closure at the ostiomeatal complex is widely considered one of the major pathogenic mechanisms leading to chronic inflammation in chronic rhinosinusitis (CRS). The objective of this study was to develop and characterize an oxygen-generating biomaterial (OGB) as an innovative treatment strategy for CRS.
Methods: An OGB was fabricated by coating hydrophobic beeswax (BW, 15mg or 30mg) on the surface of calcium peroxide - catalase complex (CPO-CA, 30mg) and characterized using scanning electron microscopy (SEM). In vitro releases of both oxygen and hydrogen peroxide (H2O2) were spectrophotometrically quantified, and cytotoxicity in human sinonasal epithelial cells (HSNECs) was evaluated. The influence of OGB on transepithelial Cl− secretion was also determined by pharmacologically manipulating HSNECs, cultured under hypoxic conditions, in Ussing chambers.
Results: Three groups of OGBs: (1) CPO only; (2) CPO coated with CA and BW (1:1 ratio, CPO-CA(1)-BW(1)); and (3) CPO coated with CA and BW (1:0.5 ratio, CPO-CA(1)-BW(0.5) were analyzed for accumulated oxygen release over 7 days: highest release (mmol/mg) was observed in CPO-CA(1)-BW(1) = 0.11 ± 0.003, followed by CPO-CA(1)-BW(0.5) = 0.08 ± 0.010, and CPO = 0.05 ± 0.004 (p<0.0001).H2O2 production (mM)was significantly higher inCPO(1.87±0.50) compared to CPO-CA (1)-BW(1) (0.00 ± 0.00) (p < 0.001) after 24 h. CPO-CA(1)-BW(1) showed significantly reduced cytotoxicity and increased Cl− transport compared to the CPO group.
Conclusion: A novel OGB (CPO-CA-BW complex) exhibited sustained oxygen release over 7 days without significant cytotoxicity after 24 h in vitro. Preclinical studies evaluating the efficacy of OGB in CRS are warranted, especially for potential therapy in an obstruction-based CRS model.

Keywords: chronic rhinosinusitis, hypoxia, oxygen generating biomaterial, sinusitis