552 CHARACTERISTICS OF THE TUMOR MICROENVIRONMENT IN IDH1-MUTATED CHOLANGIOCARCINOMA PATIENTS FROM CLARIDHY TRIAL

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Background Somatic isocitrate dehydrogenase 1 mutations (*IDH1*m) convert α-ketoglutarate to the oncogenic metabolite R-2-hydroxyglutarate (2-HG). *IDH1*m are detected in approximately 13% of intrahepatic cholangiocarcinomas (CCAs).[1] Ivosidenib, an oral inhibitor of the IDH1m protein inhibits 2-HG and restores immune response in CCA.[2] We analyzed pre-treatment samples, using machine learning models to quantify histologic features of the CCA tumor microenvironment, enabling identification of correlates of *IDH1*m status, early disease progression (patients experienced progression or death within 1.54 months), and plasma 2-HG levels (median, 630 ng/ml).

Methods A set of H&E images, including from ClarIDHy[3], a phase 3 placebo controlled clinical trial of ivosidenib in *IDH1*m CCA, were split into training/validation (n=200) and test sets for model development. Whole slide images were annotated by GI pathologists to identify and quantify more than 500 different human interpretable features (HIFs), including cell (cancer cell, lymphocyte, macrophage, plasma cell, fibroblast) and tissue (cancer epithelium, stroma, necrosis) features. Utilizing *IDH1*m and wild type (WT) screening samples, multivariate logistic regression models were trained to predict *IDH1*m status. P-values were calculated by univariate logistic regression and corrected for multiple comparisons via adjustment for FDR.

Results A HIF-based multivariate model discriminated between *IDH1m* and WT CCA (AUC, 0.83; 95% CI, 0.74-0.92). *IDH1*m was associated with a lower proportion of lymphocytes throughout the tumor (OR, 0.64; $P<0.01$; FDR $P=0.022$), and higher proportion of fibroblasts (OR, 1.8; $P<0.01$; FDR $P=0.023$) and lower proportion of plasma cells in the stroma (OR, 0.68; $P<0.01$; FDR $P=0.032$) (figure 1A). In a subset of samples, CD3 and CD8 staining showed reduced T-lymphocyte infiltration patterns in *IDH1*m (n=5) samples relative to *IDH1* WT (n=19) (figure 1B). Early disease progression of enrolled ClarIDHy patients (ivosidenib n=61, placebo n=38) was associated with a higher proportion of macrophages (OR, 1.70; $P<0.01$; FDR $P=0.08$) and a lower proportion of tumor infiltrating lymphocytes (OR, 0.63; $P<0.01$; FDR $P=0.08$), (figure 2A). When correcting for treatment effect, the proportion of lymphocytes in the tumor were still associated with improved PFS ($P=0.011$). Consistent with previously published data[2], high 2-HG levels were associated with lower numbers of tumor infiltrating lymphocytes (OR, 0.63; $P=0.011$; FDR $P=0.08$) (figure 2B).

Conclusions Quantitative histologic evaluation suggests that pre-treatment *IDH1*m CCA samples have a colder tumor microenvironment relative to *IDH1* WT CCA, with an immunosuppressive tumor microenvironment being associated with early progression. Results from this analysis support exploration of combination with immune checkpoint inhibitors.

Trial Registration NCT02989857

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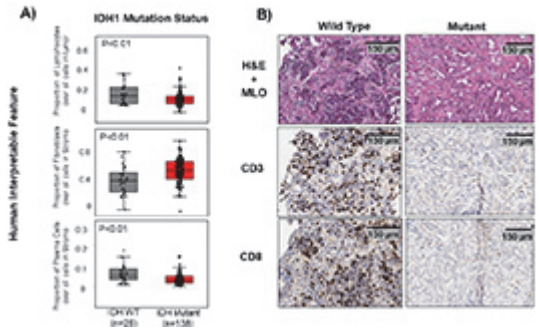
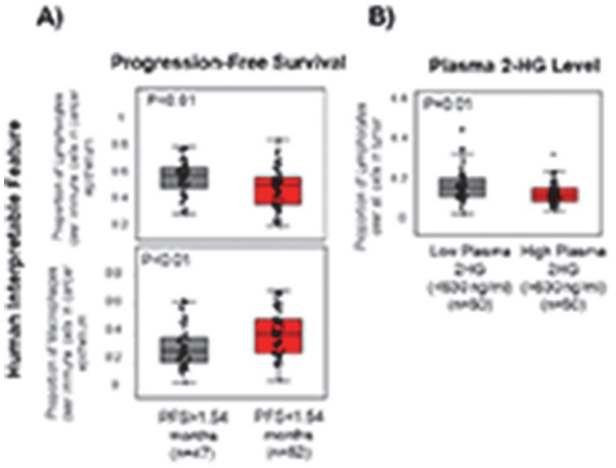
Ethics Approval This study was done according to the International Conference on Harmonisation of Good Clinical Practice guidelines and the principles of the Declaration of Helsinki. Approval from the institutional review board and international ethics committee was obtained at each study site. Patients provided written, informed consent before participating in the study.



Abstract 552 Figure 1 Tumor microenvironment of IDH1m vs IDH1 WT

Tumor microenvironment of IDH1m CCA compared to IDH1 WT at screening. (A) 163 screening samples, including IDH1m (n=138) and IDH1 WT (n=25) subjects were analyzed by machine learning of histological features. Samples deemed by a panel of GI pathologist to be extrahepatic as a best response were excluded from the analysis. IDH1m status in CCA was associated with lower proportions of lymphocytes in the tumor (Upper Row), higher proportions of fibroblasts in the stroma (Middle Row), and lower proportions of plasma cells in the stroma (Bottom Row). Tumor includes cancer epithelium and stroma tissues in the whole sections. Uncorrected P values are displayed on the Figures (B) Further analysis of a subset of screening samples (n=5 IDH1m, n=19 IDH1 WT) by CD3 and CD8 staining was performed. Representative whole slide biopsy H&E images indicating lower proportions of lymphocytes in the IDH1m CCA tumor via machine learning-derived predictions (Upper Row; Lymphocytes are indicated with dark green marker overlay. MLO=Machine Learning Overlay, representative image for CD3 immunohistochemistry (Middle Row), and representative image for CD8 immunohistochemistry (Bottom Row).



Abstract 552 Figure 2 Differences in CCA tumor microenvironment. Differences in CCA tumor microenvironment based on early disease progression and pre-treatment plasma 2-HG levels. (A) Pre-treatment screening samples from 99 (ivosidenib cohort n=61, placebo cohort n=38) patients treated on the ClarIDHy study were analyzed for association with early disease progression, defined as experiencing progression or death within 1.54 months (47 days) (PFS<1.54 months) Early disease progression was associated with lower proportions lymphocytes over immune cells in cancer epithelium (Upper Row) and higher proportions of macrophages (Bottom Row) over immune cells in cancer epithelium (B) Plasma 2-HG levels were available for 100 IDH1m patients, with sample groups separated based on the median plasma 2-HG level (630 ng/ml). Higher plasma 2-HG levels were associated with lower proportions of lymphocytes in CCA tumor. Uncorrected P values are displayed on the Figures (A and B)

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