**Supplementary Legends**

**Tables:**

**Supplementary Table S1**.  Statistical comparison of basic clinical factors between low-risk and high-risk colitis patients who underwent surveillance colonoscopy with more than one year of follow-up.

**Supplementary Table S2**. Detailed clinical information and pathological grading of colitis patients who underwent surveillance colonoscopy with more than one year of follow-up.

**Supplementary Table S3.** Statistical analysis (low-risk vs. high-risk patient group) of 12 quantitative microscale image features of cell nuclei from the initial biopsies of surveillance colonoscopy of colitis patients.

**Figures:**

**Supplementary Figure S1**. Simulation to illustrate the concept of depth-resolved drOPD imaging to detect small local changes of refractive index.

**Supplementary Figure S2**. Effect of changing refractive index of the scattering object on drOPD.

**Supplementary Figure S3**. Demonstration of depth-resolved capability of drOPD imaging.

**Supplementary Figure S4**. Workflow for nanoscale nuclear architecture mapping (nanoNAM).

**Supplementary Figure S5.** Squared gradient plot versus the axial position of objective lens at the wavelength of 550 nm.

**Supplementary Figure S6**. The dependence of focal plane on the wavelength.

**Supplementary Figure S7**. Correction for chromatic aberration-induced image distortion (shift).

**Supplementary Figure S8**. Image registration based on the transmission phase images of unstained and stained tissue.

**Supplementary Figure S9**. Correction for baseline shift.

**Supplementary Figure S10**. Reproducibility of mean-drOPD value at a single-nucleus level.

**Supplementary Figure S11**. Mouse treatment protocol to induce colitis-associated carcinogenesis.

**Supplementary Figure S12**. nanoNAM performed on cell nuclei from a transgenic mouse model of colon carcinogenesis *Apc*Min/+ mice.