

COLLAGEN REMODELING IN THYROID CARCINOMA ANALYZED WITH THE HOUGH-TTRANSFORM AND SECOND HARMONIC MICROSCOPY

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Papillary carcinoma is the most prevalent type of thyroid cancer [1]. Different imaging techniques can be used to detect and characterize thyroid tumors [2]. In particular polarization sensitive Second Harmonic Generation (SHG) microscopy has been useful to extract information on the ultrastructure of the collagen capsule surrounding the thyroid and malignant nodules [3]. Although the capsule thickness may sometimes indicate malignancy, neither the capsule thickness, nor the collagen distribution within the nodule capsules have been considered to date in thyroid cancer diagnosis. Moreover methods to directly detect the effect and quantify cancer remodeling from microscopic images are scarce. Existing algorithms inform on “average arrangements” of the collagen morphology and they often require well defined regions of interest for a correct and useful analysis. In this work we propose a method based on the Hough transform (HT) [4] to detect structural changes in the collagen capsule surrounding malignant thyroid tumors. The HT is defined as a mathematical algorithm to detect lines which uses an accumulator matrix with dimensions corresponding to the polar coordinates of a straight. The local maxima in the accumulator determine the preferential orientations detected in the image space.

A mode-locked Ti:Sapphire laser (Tsunami, Spectra Physics) was combined with a confocal microscope (Leica TCS SP) [5] for SHG imaging of histological sections of thyroid samples: normal (thyroid capsule) and tumoral (papillary carcinoma). SHG images of benign thyroid samples reveal a wavy collagen distribution with local orientations (Fig. 1a) as detected in the HT matrix (Fig. 1b). On the opposite, as a consequence of the remodeling produced by the tumoral presence, these local undulations disappear turning into an aligned pattern with a preferential and global orientation (Fig. 1c). This capsular collagen realignment can also be observed in the HT matrix as an absence of local orientations (Fig. 1d). The procedure here described represents a useful tool to automatically detect changes in capsular collagen distribution in thyroid cancer by combining the HT with SHG imaging microscopy. The usefulness of the method allows detecting local changes from a whole SHG image which might have potential clinical application in oncology science.

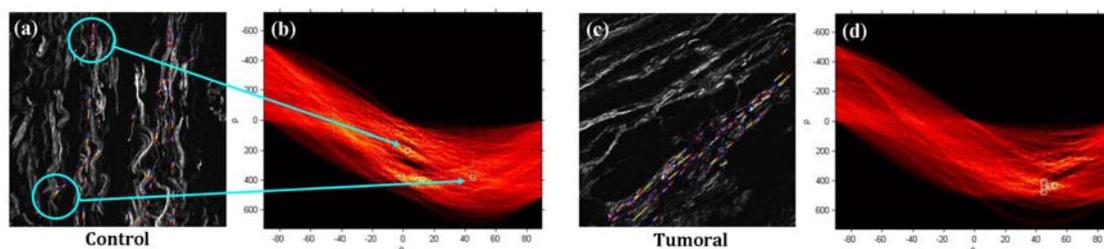


Fig. 1: SHG images of normal (a) and tumoral (c) thyroid histological sections; (b, d), HT matrices.

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[1] Hundahl et al., *Cancer* **83**, 2638 (1998).

[2] Greco et al., *Int. J. Mol. Sci.* **18**, E2731 (2017).

[3] Tokarz et al., *Biom. Opt. Exp.* **6**, 3475 (2015).

[5] Hristu et al., *J. Biophotonics* **10**, 1171 (2017).

[4] Illingworth & Kittler, *Comp. Vis. Graph. Image Proc.* **44**, 87 (1998).