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Characterizing the human thyroid with near-infrared diffuse optics and clinical ultrasound

Researchers published in Biomedical Optics Express the first large dataset characterizing the optical and hemodynamic properties of thyroid tissue using a hybrid device that combines near-infrared spectroscopy with ultrasound imaging.

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Thyroid diseases are one of the most common endocrine pathologies, affecting approximately 200 million people worldwide. In Europe alone, nearly 11% of the population suffers from some form of thyroid dysfunction [1]. In most thyroid pathologies, the vascularization - the number and structure of blood vessels - and hemodynamics are altered. A better understanding of both could help clinicians improve the diagnosis, plan for therapies and follow up treatment response, but the monitoring techniques available in th clinics are not sensitive enough or are impractical for large-scale use

Near-infrared spectroscopy is a cost-effective and non-invasive tool that can be useful t study the properties of thyroid tissue quantitatively. Now, a team of ICFO researchers**Pablo Fernandez Esteberena** (now at Instituto de Fisica Arroyo Seco IFAS), **Lorenzo Cortese**, **Marta Zanoletti, Giuseppe Lo Presti and Dibya Sarangi**, led by **ICREA Prof. Turgut Durduran**, has used the LUCA platform, a device that integrates near-infrared spectroscopy and ultrasound techniques, to characterize the thyroid tissue with simultaneous anatomical measurements. The study, published recently in Biomedical Optics Express, is the first characterization of thyroid properties in a large clinical campaign with healthy subjects and patients with thyroid nodules.

A first thyroid characterization through NIRS

The team studied 65 subjects, including 18 healthy volunteers and 47 patients with thyroid nodules admitted to the Hospital Clinic in Barcelona. Researchers assessed the effects of **demographic factors** such as age, body mass index and sex, **anatomical variables** such as the depth of the thyroid, and **pathological conditions** such as the presence of nodules on the characteristics of thyroid tissue. They also evaluated the capacity of the device to be integrated into the existing screening procedures.

Clinicians placed the integrated monitoring probe on the patients' thyroid, guided by

ultrasound images. The probe used time-domain (TD-NIRS) and diffuse correlation spectroscopy (DCS) to measure **thyroid light absorption and scattering, tissue oxygenation, blood flow** and **oxygen metabolism**.
Results show, for example, that age and body mass index significantly affect optical parameters, reducing the measured oxygen saturation, hemoglobin concentration and blood flow. Besides, a comparison between benign and malignant nodules, limited to the ones evaluated, showed lower oxygen saturation in the benign nodules, a result that is currently being investigated in a larger ongoing clinical campaign.
The reported analysis can be used in future studies as a comprehensive reference of the absolute values of thyroid properties, the precision in their measurement, the variability within and between subjects, and their dependencies on subject characteristics. In this way, these tools can help to improve diagnostic accuracy, allowing doctors to detect thyroid disorders earlier, reduce the reliance on invasive biopsies and support personalized treatments.

[1] The untapped potential of the thyroid axis, The Lancet Diabetes & Endocrinology, Volume 1, Issue 3, 163 & The Incidence and Prevalence of Thyroid Dysfunction in Europe: A Meta-Analysis, Journal of Clinical Endocrinology Metabolism, 99: 923-931, 2014.

- The study is a collaboration of researchers from ICFO, the Hospital Clinic de Barcelona a d the IDIBAPS research centre in Barcelona; the Politecnico di Milano and the University f Birmingham; and the companies IMV Imaging, VERMON and HemoPhotonics.