Editorial

Introduction to focused issue on novel technologies in endocrine surgery

It is my great pleasure to present the Readers another focused issue of *Gland Surgery* dedicated to novel technologies in endocrine surgery. Optimal care for endocrine diseases is provided in a multidisciplinary manner. However, surgery remains the base of radical treatment in many endocrine disease entities. Current progress in endocrine surgery can be consider in several dimensions including improved preoperative workup, availability of alternative non-surgical treatment options for selected patients, widespread use of minimally invasive surgical approaches, development of tools for intraoperative quality control of surgery and advances leading to optimized patients' pathways in the health care system. Herein, well-recognized internationally experts in the field present in this issue a series of reports focused on selected hot topics of novel technological adjuncts in endocrine surgery: European perspective on the use of molecular tests in the diagnosis and therapy of thyroid neoplasms, current state of artificial intelligence for ultrasound assessment of thyroid nodules, recent modalities for parathyroid imaging, technique of high intensity focused (HIFU) ablation for benign thyroid nodules as an alternative to surveillance, a tailored approach in modern surgery for advanced thyroid cancer, advances in intraoperative nerve monitoring shifting current paradigms in thyroid surgery, scarless transoral endoscopic thyroid surgery by vestibular approach (TOETVA) with nerve monitoring of recurrent laryngeal nerves, advantages and limitations of near-infrared autofluorescence (NIRAF) technology for identification and preservation of parathyroid glands during thyroidectomy including robotic approaches, utility of energy-based devices for thyroid surgery, laparoscopy versus open adrenalectomy in patients with metastases from tumor metastases, and an overview of robotic adrenalectomy.

The highlights on the use of molecular tests in the diagnosis and therapy of thyroid neoplasms were addressed and critically appraised from European perspective. Recently developed molecular tests have a potential to improve indeterminate cytological diagnosis and reduce number of diagnostic surgical lobectomies. However, commercially available tests are developed based on the North American population and it is important to validate in further studies whether such tests can be used in the evaluation of, e.g., European population, as well. In addition, the high cost of molecular tests limits their availability in low-income countries (1).

In recent years, well-recognized scientific societies introduced guidelines for ultrasound (US) malignancy risk stratification of thyroid nodules. These guidelines categorize the risk of malignancy in relation to a combination of several US features. Based on these US image lexicons an ultrasound-based computer-aided diagnosis (CAD) systems were developed. The CAD systems may be useful for ruling out malignancy and more appropriate selection of thyroid nodules for FNA cytology assessment at surgical office and more accurate selection for unilateral thyroid surgery. Current artificial intelligence development has a diagnostic performance that is comparable with medical experts, especially in image recognition-related fields like US thyroid imaging. However, future technical improvements in automatic image recognition and diagnosis systems based on deep learning using the neural network may shift the current format of CAD into a brand-new dimension of real artificial intelligence leading to increased accuracy as well as diagnostic efficiency of the CAD imaging modality (2).

Primary hyperparathyroidism is one of the most common endocrine disorders in the world and parathyroidectomy remains the treatment of choice in symptomatic patients. Parathyroid surgical techniques have evolved over the years from bilateral neck exploration to minimally invasive and focused removal of a solitary parathyroid adenoma indexed by preoperative imaging, the approach suitable for the majority but not all patients. These noninvasive localization studies include US, computed tomography (CT), magnetic resonance (MR) and ^{99m}Tc-MIBI scintigraphy combined with single-photon emission computed tomography (SPECT/CT). Among the latest technologies, the 4D-CT scan, PET/CT and PET/MR are very promising, and are going to have surgical implications in the future (3).

HIFU is a new thermoablation technique used to treat benign thyroid nodules. In this method, the ultrasound beam passes through the patient's skin and focuses very precisely on the target lesion at a distance far from the source of ultrasound generation, making HIFU the only truly non-invasive method of thermoablation developed to date. HIFU can therefore be an attractive alternative to surveillance, surgery or other thermoablative techniques in well-selected patients (4).

Surgical treatment of advanced thyroid malignancy can be morbid, compromising normal functions of the upper

aerodigestive tract. The presence of local invasion, bulky cervical nodes, distant metastases or recurrent disease should prompt careful preoperative evaluation and planning. Surgical strategy should evolve from multidisciplinary discussion that integrates individual disease characteristics and patient preference. Intraoperative neuromonitoring has important applications in surgery for advanced disease and should be used to guide surgical strategy and intraoperative decision-making. Recent paradigm shifts, including staged surgery and use of neoadjuvant targeted therapy hold potential for decreasing surgical morbidity and improving clinical outcomes. Modern surgical planning provides optimal treatment for each patient through a tailored approach based on exact extent and type of disease as well as incorporating accurate extent of disease assessment, appreciation of surgical complications, patient preferences and intraoperative findings (5).

Over the past two decades, intraoperative neural monitoring (IONM) has matured into a powerful risk minimization tool (6-8). Aborting contralateral thyroid surgery in case of loss of signal encountered on the first operated side of the neck turned out to be an effective strategy of avoiding the risk of bilateral vocal folds palsy after thyroidectomy (staged thyroidectomy). In addition, the most recent advent of continuous IONM has a potential to aid in preventing permanent traction-related nerve injury by providing a real intraoperative feedback to surgeons by means of alerting about imminent neural injury and allowing for reversing harmful surgical maneuvers on time. This novel technological adjunct has challenged the current paradigms in thyroid surgery warranting a tailored approach to the individual patient guided by this intraoperative quality control measure (5-8).

TOETVA has gained popularity worldwide in recent few years as it is a safe technique with no visible scarring and hence resulting in an excellent cosmetic effect. However, IONM of the recurrent laryngeal nerves is a mandatory component of this operation that minimizes the risk of nerve damage and is essential for safety of this technique (9).

Recently described phenomenon of NIRAF of the human parathyroids may have important clinical implications. To date, studies have investigated the potential of NIRAF detection for: identifying parathyroid gland tissues intraoperatively, locating parathyroid glands before or after dissection, distinguishing healthy from diseased parathyroid glands, and minimizing postoperative hypocalcemia after total thyroidectomy. Because NIRAF-based identification of PG is non-invasive and label-free, the popularity of this approach has considerably surged. However, more concrete and long-term outcome studies with these modalities are essential to determine the impact of this technique on patient outcome and actual cost-benefits (10). In addition, new imaging techniques using NIRAF in combination with remote access thyroidectomy have been studied to determine their utility, with the goal of reducing potential complications. Diversity of available remote access techniques and considerations on the advantages and potential disadvantages of indocyanine green in remote access thyroidectomy may help to better understand the future prospects in the field (11).

It is also important to stress that without energy-based devices for hemostasis which are recognized as a flywheel of minimally invasive endoscopic and laparoscopic techniques, the modern endocrine surgery would not have been existing (12).

Currently laparoscopic adrenalectomy is considered to be the preferred technique of management of most adrenal tumors including metastases to adrenal glands (13,14). However, robotic adrenalectomy can be an alternative to laparoscopic adrenalectomy in high-volume endocrine surgical centers for selected patients. This approach seems to be feasible and safe but high-level evidence of its benefits is still lacking. Nevertheless, the robotic approach can be considered to be most suitable for obese patients, patients with a large adrenal tumor and in complex cases (14).

I am sure that further development of novel technologies in the field will continuously challenge and modify our surgical practice in the forthcoming years warranting improved outcomes of surgery and quality of life for patients with surgical endocrine diseases.

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Footnote

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