European Review for Medical and Pharmacological Sciences 2022; 26: 4550-4556

Ethical and medico-legal issues of TOETVA procedure and simulation on cadavers: a scoping review

A. OLIVA[1], S. GRASSI[1,2], M. ZEDDA[1], G. DIONIGI[3], O. MAKAY[4], L. FILOGRANA[5], F. CAZZATO[1], C. DE CREA[6], S. CELIK[7], A.G. SPAGNOLO[8], R. BELLANTONE[6], M. RAFFAELLI[8]

[1]Legal Medicine, Department of Health Surveillance and Bioethics, Università Cattolica del Sacro Cuore, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Rome, Italy
[2]Section of Forensic Medical Sciences, Department of Health Sciences, University of Florence, Florence, Italy
[3]Division of Endocrine and Minimally Invasive Surgery, University of Messina, Messina, Italy
[4]Department of General Surgery, Division of Endocrine Surgery, Ege University Hospital, Izmir, Turkey
[5]Department of Radiological Sciences, Fondazione PTV Policlinico Tor Vergata, Rome, Lazio, Italy
[6]U.O. Chirurgia Endocrina e Metabolica, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Università Cattolica del Sacro Cuore, Rome, Italy
[7]Department of Anatomy, Ege University Hospital, Izmir, Turkey
[8]Bioethics, Department of Health Surveillance and Bioethics, Università Cattolica del Sacro Cuore, Rome, Italy

Antonio Oliva and Simone Grassi equally contributed and thus should be regarded as co-first authors

Abstract. – Conventional open thyroidectomy is still considered the gold standard for thyroid surgery. Transoral endoscopic thyroidectomy vestibular approach (also known as TOETVA) is often considered to be more advantageous than the other approaches, such as minimally invasive video assisted thyroidectomy, thyroidectomy *via* breast/axillary/retroauricular access, bilateral axillo-breast approach and axillo-bilateral breast approach. In this scoping review, we discuss the risks and the benefits of this surgical approach and its medico-legal and ethical implications, particularly focusing on the importance of practice on cadavers. Currently, there is little scientific evidence supporting TOETVA, since there are few papers on the comparison with the traditional open thyroidectomy that have been published and thus little data on the long-term outcomes of TOETVA are available. Since the better cosmetic outcome currently represents the main indication for this surgical technique, substantial medico-legal and ethical issues arise. Moreover, practice on cadavers can help surgeons to develop the technical and non-technical skills required to perform efficiently and safely this new surgical procedure.

Key Words:
TOETVA, Thyroidectomy, Medical malpractice, Ethics, Cadaver lab.

Introduction

Conventional "open" thyroidectomy is still considered the standard for thyroid surgery. Alternative surgical approaches to the thyroid have been developed to avoid neck scars for the last two decades[1]. In particular, minimally invasive thyroidectomy[2] and remote access endoscopic or robotically assisted thyroidectomy do not require visible incisions. Transoral endoscopic thyroidectomy vestibular approach (TOETVA), which has been recently developed and described[1], could be even more advantageous from a cosmetic point of view than other approaches, such as minimally invasive video assisted thyroidectomy (MIVAT)[3], thyroidectomy *via* breast access, *via* axillary access, *via* retroauricular access[4-7], bilateral axillo-breast approach (BABA)[8] and axillo-bilateral breast approach (ABBA)[9]. Patients who prefer to undergo TOETVA are particularly concerned by

Corresponding Author: Massimo Zedda, MD; e-mail: massimo.zedda01@icatt.it

Table I. TOETVA novel complications and possible medico-legal implications.

Complication	Reference	Incidence	Cause/ mechanism	Consequences of medico-legal interest
Mental nerve injury	1, 10, 18, 34	0-7%	• Oral vestibular mucosa and muscular tearing • Mental nerve branches cutting, compression, thermal injury	• Sensory deficit of lower lip and lower chin • Temporary or permanent
Bruise over zygoma	49	1-2%	Accidental compression of zygoma by surgical instruments	• Visible skin lesion • Temporary or permanent • May require frequent dressings • May require plastic surgery
Chin flap perforation	18, 34, 49	1-2%	Wrong axial (perpendicular) vestibular dissection with electrocautery	• Visible skin lesion • Temporary or permanent • Frequent dressings • May require plastic surgery
Neck flap perforation	18, 34, 49	1-2%	Wrong axial (perpendicular) vestibular dissection with electrocautery	• Visible skin lesion • Temporary or permanent • Frequent dressings • May require plastic surgery
Mouth commissure tearing	49	1-2%	Excessive oral lateral port movements	• Lip asymmetry • May require plastic surgery
Sense of tension/ stiffness in the chin, neck	1, 10, 18, 34	5%	• Postoperative adhesions • Patient did not follow the advice of physiotherapy and postoperative neck and chin massages	• Patient discomfort

a negative cosmetic outcome. However, this approach has limited indications and is still at an investigational level. Indeed, it is burdened with a significant medico-legal risk, because it is a technically demanding procedure and is associated with a potential wider spectrum of complications with respect to the standard and other minimally invasive/remote access procedures (Table I)[1,10]. Unlike other remote accesses, novel complications, especially due to the vestibular access, could be clearly visible to the patient in the postoperative period, in the wide area that goes from the zygoma, lower lip, to the chin up to the neck. In this paper, we discuss the risks and the benefits of this approach and its medico-legal and ethical implications.

General Considerations

The increased incidence of thyroid pathology among young women and the increasing attention to the cosmetic outcome brought to the development of alternative surgical approaches[11-17]. Transoral approach represents a technological advancement in minimally invasive endocrine surgery. According to current evidence, this technique would allow to achieve excellent cosmetic results because the skin incision is in a natural orifice (mouth), avoiding any visible scar[1,10]. However, in the Western countries this technique is mostly limited to highly specialized centres[18]. Moreover, there is little evidence supporting this procedure, long-term outcomes, and possible advantages over traditional open thyrodectomy[18]. Anuwong et al[19] compared these two different surgical approaches and found that TOETVA had similar recurrent laryngeal nerve (RLN) lesion and hypoparathyroidism rates to the open technique. Thus, the two techniques were equivalent in terms of safety and outcomes, with TOETVA not being associated with an increased risk of wound infection or other permanent complications. Their results also showed that TOETVA was associated with a significantly longer operating time, but with less postoperative pain. However, this study had two limitations: it is a retrospective study conducted in a single Asian center with an unbalanced population between the two groups of patients; furthermore, most patients had benign lesions, so there were not enough data regarding thyroid cancer. According to this evi-

dence, TOETVA could be an option for selected patients, after further long-term studies have confirmed the safety and efficacy of this approach, including in patients with thyroid cancer[19]. Another recent cross-sectional study, published by Grogan et al[20], investigated how many patients undergoing thyroid and parathyroid surgery were eligible for scar-free transoral surgery, applying the current exclusion criteria. An admissibility of 56% suggests that TOETVA can be applied to a large number of patients (about 140,000 patients per year in the USA) and that it could be considered a routine surgery in the near future; in this study the authors considered patients treated at academic institutions of endocrine surgery, and this limits the reliability of this work because currently most thyroidectomies are still performed in private facilities[20].

Errors in Thyroid Surgery

General surgery is one of the most exposed fields to medical malpractice claims[21-28]. The high exposition to medico-legal claims is also due to the fact that in general surgery most of the errors are considered preventable[29,30]. Thyroid surgery is associated with minor and major risks. The minor risks are: delayed bleeding, haematoma of the superficial and deep layers[19], scars[1]. The major risks are represented by: bleeding, RLN injury[19], lesion of the external branch of superior laryngeal nerve[30], hypoparathyroidism[19]. Some of these complications could be avoided by improving technical skills. For instance, hypoparathyroidism could be a less frequent complication by performing a more accurate dissection, avoiding the use of hot blades, and identifying the parathyroid glands with specific techniques (e.g., indocyanine green)[19,31,32]. Moreover, intraoperative RLN monitoring has been advocated to reduce the risk of RLN injury, even if definitive data are not available[33]. According to Promberger et al., one of the factors increasing the risk of developing haemorrhage after thyroidectomy is incorrect haemostasis performed by the surgeon[34]. Therefore, improving technical skills is essential to reduce the risk of complications. New complications have been observed with the vestibular approach, rarely found with traditional surgery, so TOETVA involves additional risks[10]. A unique complication of this procedure is paralysis or injury to the mental nerve, which causes transient -or even permanent- sensory disturbances of lower lip and chin, with lack of sensitivity to hot liquids. The correct execution of standard 5 mm vestibular incisions, located just below lower lip lateral to the canine teeth, prevents damages to the mental nerve[10,35].

The Advantages of Practice on Cadavers

The use of cadavers represents a model close to reality that allows an effective understanding of human anatomy. Moreover, cadavers allow to perform new surgical techniques safely and to fulfil them in the living later. In detail, simulation allows replicating aspects of the real world in an interactive way. Simulation-based training allows trainees to learn technical and non-technical skills while avoiding risking patient safety[36]. Pfandler et al[37] investigated the correlation between technical skills (TS) and non-technical skills (NTS) in a simulated spine procedure and noticed that they are interconnected. In the operating room, errors often occur because of failure in NTS[36]. NTS include intraoperative communication, situational awareness, leadership, teamwork and decision-making. Low levels of NTS have been found to be associated with an increased probability of making technical errors[38,39]. In addition, according to Gaba[36], simulation may have considerable power in improving technical skills as it allows surgeons to gain experience with even uncommon clinical or anatomical presentations. Furthermore, Rashid et al[40] analyzed the emerging role of simulation in urological surgery and concluded that simulation is the best instrument in surgical education. Currently cadaveric dissection is one of the techniques of surgical simulation[41]. Lewis et al[42] proved that the use of cadavers is an efficient way to improve surgical skills and is not only a good tool for training residents but also a great exercise that allows increasing confidence in performing operations. Indeed, performing surgery on cadaver allows a better visualization of anatomical structures, which can in turn help during endoscopic procedures, where organs are usually displayed on a screen in two dimensions[42]. Reed et al[43] investigated the possible use of fresh cadavers in vascular surgery training and stated that using fresh frozen cadaver is advantageous because tissue planes are preserved. For this reason, tissue handling is very realistic, and has enabled improved suturing skills. Ocel et al[44] reported that students appreciated simulation on cadavers, preferring it over simulation with inanimate trainers, and felt more confident and efficient after training with cadavers. A very interesting example of the use of cadaver is the live cadaver model which combines human anatomy with pulsatile blood-flow[45]. In their study, Pacca

et al[46] evaluated the live cadaver model for ICA (Internal Carotid Artery) injury simulation in endoscopic endonasal skull base surgery. The Authors found that live cadaver model is an excellent means of simulating a surgical crisis and improving skills in the management of an intraoperative endoscopic endonasal ICA rupture. Olabe et al[47] advocated training on cadavers after they performed microneurosurgical procedures on four human cadaveric brains. McCrary et al[48] considered the use of cadavers in teaching medical students to practice a US-guided breast biopsy which was a very effective method. Practice on cadavers to test minimally invasive endocrine surgery procedures on the thyroid gland has already been performed in the past. In particular, oral vestibular approach was first described by Richmon et al., using three oral doors in the oral vestibule, assisted by da Vinci robot (Intuitive Surgical, Inc. Sunnyvale, CA, USA) in cadavers[49]. In a recent paper, Oliva et al[50] simulated thyroid surgery in a cadaver laboratory. Six individuals (four were males and two females) underwent thyroidectomy using TOETVA technique, which allows transoral access to the thyroid gland (Table II). The Authors performed each step of the procedure as they would have done in the operating room, repeating the entire operation six times. Repetition of the procedure is the best tool to become familiar with the performance of surgery and to improve technical and non-technical skills[51-54].

Medico-Legal Considerations

The cadaver model is important to allow the forensic pathologists to appreciate in detail all the surgical steps of the TOETVA. In this way, the medical examiner can learn the new surgical technique in person. The forensic pathologist can have an overview of the advantages and limitations of this technique. Furthermore, the interaction between the medical examiner and the surgeon can foster discussions on possible alternatives, preventive interventions and solutions to avoid surgical errors. Moreover, as said before, TOETVA is not the golden standard for thyroidectomy (national and international guidelines generally recommend open surgery, MIVAT or transaxillary approach) and is associated to more complications than the traditional approaches. Because of these issues, in case of malpractice claims, it is hard for the defendant (the surgeon) to prove to have complied with the standard of care and thus to prevail[55-57]. The surgeons who choose this approach must know all its possible complications and carefully adopt all the interventions of primary and secondary prevention (Table III). Exercitations on cadaver allow to carefully evaluate and learn all the aspects of this approach.

Table II. TOETVA surgical procedure.

Description of TOETVA surgical steps
1) The neck is kept in slight extension with the tongue retroflexed to expose vestibular region[12].
2) A 10 mm transoral access is created above the frenulum labii inferioris with two 5 mm vertical lateral incisions laterally to the canine teeth[13].
3) The subplatysmal layer is elevated off the strap muscles and subplatysmal space is enlarged[1].
4) Three trocars are positioned[14,15].
5) A working space below the subplatysmal layer is obtained and maintained thanks to CO2 insufflation[12].
6) The strap muscles are incised, and local vessels are tied.
7) The upper pole of the gland is lifted, and recurrent laryngeal nerve (RLN) and the parathyroid glands are identified in order to preserve them. The thyroid is put into an endobag and removed[12].

Ethical Issues

As discussed, TOETVA seems to be a promising technique with some advantages in comparison with other approaches. However, currently it is requested by patients because it provides a better aesthetic outcome than the open technique. This consideration implies substantial ethical issues since it is associated to additional risks for the patient and only few centers have the experience and the expertise needed to perform it correctly and safely. As showed by our paper, technical and non-technical skills can play a pivotal role in avoiding errors and significantly improve when the surgeon has the possibility to learn and practice the technique on cadavers. In other words, practice on cadavers can help surgeons to avoid more errors and thus to reduce the medico-legal risk. Anyway, the fact that this very complex technique is indicated mainly because of aesthetic reasons generates a serious ethical dilemma, since it exposes patients to more risks in absence of benefits for their health.

Conclusions

TOETVA is an innovative procedure, but it is still at an investigational level and is far to be considered the gold standard. TOETVA should be performed in high volume centers and by sur-

Table III. TOETVA complications and possible interventions of primary/secondary prevention.

Complication	Prevention/Solution
Mental nerve injury	• Careful vestibular tunnelling for tracer insertion • No use of electrocautery
Bruise over zygoma	• Protective sponge on the entire face
Chin/neck flap perforation	• Careful axial and parallel dissection • Use of blunt mosquito forceps • No use of electrocautery
Mouth commissure tearing	• Oral mucosal commissure protection sutures • Plaster application over commissures
Broken teeth	• Use of mouthguards
Sense of tension/stiffness in the chin, neck	• Early postoperative physiotherapy and massages extended to chin and neck
Injury of the tongue (and migration of secretions and clots to the airways)	• Placing gauze in the mouth and pushing the tongue down

geons who have extensive experience in endocrine and endoscopic procedures. Therefore, it is necessary to train and improve surgical skills. In our experience, cadaver simulation proved to be an effective training modality to perform minimally invasive surgery and to gain confidence in operationa.

Conflict of Interest

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Funding

This work has been supported by Fondi di Ateneo, Linea D1 – Università Cattolica del Sacro Cuore, grant No. R4124500772.

Authors' Contribution

AO, RB and MR developed the project. All the authors participated in reviewing the literature and writing the draft.

Data Availability Statement

Data are available on reasonable request to the corresponding author.

Ethics Approval

The described procedures were performed during routine post-mortem diagnostic procedures in the setting of a post-graduate teaching program issued and approved by the Faculty of Catholic University of the Sacred Heart, School of Medicine.

Consent for Publication

Not required.

References

1) Anuwong A, Sasanakietkul T, Jitpratoom P, Ketwong K, Kim HY, Dionigi G, Richmon JD. Transoral endoscopic thyroidectomy vestibular approach (TOETVA): indications, techniques and results. Surg Endosc 2018; 32: 456-465.
2) Ferzli GS, Sayad P, Abdo Z, Cacchione RN. Minimally invasive, nonendoscopic thyroid surgery. J Am Coll Surg 2001; 192: 665-668.
3) Miccoli P, Berti P, Conte M, Bendinelli C, Marcocci C. Minimally invasive surgery for thyroid small nodules: preliminary report. J Endocrinol Invest 1999; 22: 849-851.
4) Ikeda Y, Takami H, Niimi M, Kan S, Sasaki Y, Takayama J. Endoscopic thyroidectomy by the axillary approach. Surg Endosc 2001; 15: 1362-1364.
5) Choe JH, Kim SW, Chung KW, Park KS, Han W, Noh DY, Oh SK, Youn YK. Endoscopic thyroidectomy using a new bilateral axillo-breast approach. World J Surg 2007; 31: 601-606.
6) Wang C, Feng Z, Li J, Yang W, Zhai H, Choi N, Yang J, Hu Y, Pan Y, Cao G. Endoscopic thyroidectomy via areola approach: summary of 1,250 cases in a single institution. Surg Endosc 2015; 29: 192-201.
7) Park JO, Kim SY, Chun BJ, Joo YH, Cho KJ, Park YH, Kim MS, Sun DI. Endoscope-assisted facelift thyroid surgery: an initial experience using a new endoscopic technique. Surg Endosc 2015; 29: 1469-1475.
8) Chand G, Johri G. Extracervical Endoscopic thyroid surgery via Bilateral Axillo-Breast approach (BABA). J Minim Access Surg 2019; 16: 190-194.
9) Bärlehner E, Benhidjeb T. Cervical scarless endoscopic thyroidectomy: Axillo-bilateral-breast approach (ABBA). Surg Endosc 2008; 22: 154-157.
10) Zhang D, Park D, Sun H, Anuwong A, Tufano R, Kim HY, Dionigi G. Indications, benefits and risks of transoral thyroidectomy. Best Pract Res Clin Endocrinol Metab 2019; 33: 101280.
11) Chen LW, Razavi CR, Hong H, Fondong A, Ranganath R, Khatri S, Mydlarz WK, Mathur A, Ishii

M, Nellis J, Shaear M, Tufano RP, Russell JO. Cosmetic outcomes following transoral versus transcervical thyroidectomy. Head Neck 2020; 42: 3336-3344.

12) Dionigi G, Bacuzzi A, Lavazza M, Inversini D, Pappalardo V, Boni L, Rausei S, Barczynski M, Tufano RP, Kim HY, Anuwong A. Transoral endoscopic thyroidectomy via vestibular approach: operative steps and video. Gland Surg 2016; 5: 625-627.
13) Park D, Shaear M, Chen YH, Russell JO, Kim HY, Tufano RP. Transoral robotic thyroidectomy on two human cadavers using the Intuitive da Vinci single port robotic surgical system and CO2 insufflation: Preclinical feasibility study. Head Neck 2019; 41: 4229-4233.
14) Witzel K, Hellinger A, Kaminski C, Benhidjeb T. Endoscopic thyroidectomy: the transoral approach. Gland Surg 2016; 5: 336-341.
15) Anuwong A. Transoral Endoscopic Thyroidectomy Vestibular Approach: A Series of the First 60 Human Cases. World J Surg 2016; 40: 491-497.
16) Tan CT, Cheah WK, Delbridge L. "Scarless" (in the neck) endoscopic thyroidectomy (SET): an evidence-based review of published techniques. World J Surg 2008; 32: 1349-1357.
17) Dionigi G, Boni L, Duran-Poveda M. Evolution of endoscopic thyroidectomy. Surg Endosc 2011; 25: 3951-3952.
18) Duek I, Duek OS, Fliss DM. Minimally Invasive Approaches for Thyroid Surgery-Pitfalls and Promises. Curr Oncol Rep 2020; 22: 77.
19) Anuwong A, Ketwong K, Jitpratoom P, Sasanakietkul T, Duh QY. Safety and Outcomes of the Transoral Endoscopic Thyroidectomy Vestibular Approach. JAMA Surg 2018; 153: 21-27.
20) Grogan RH, Suh I, Chomsky-Higgins K, Alsafran S, Vasiliou E, Razavi CR, Chen LW, Tufano RP, Duh QY, Angelos P, Russell JO. Patient Eligibility for Transoral Endocrine Surgery Procedures in the United States. JAMA Netw Open 2019; 2: e194829.
21) Studdert DM, Bismark MM, Mello MM, Singh H, Spittal MJ. Prevalence and Characteristics of Physicians Prone to Malpractice Claims. N Engl J Med 2016; 374: 354-362.
22) Physician Insurers' Association of America Data sharing report, Rockville, MD, (2000).
23) National Practitioner Data Bank. Public use data files. Available at: http://www.npdb-hipdb.com/publicdata.html (2006).
24) Studdert DM, Mello MM, Gawande AA, Gandhi TK, Kachalia A, Yoon C, Puopolo AL, Brennan TA. Claims, errors, and compensation payments in medical malpractice litigation. N Engl J Med 2006; 354: 2024-2033.
25) Filograna L, Thali MJ, Marchetti D. Forensic relevance of post-mortem CT imaging of the haemopericardium in determining the cause of death. Leg Med (Tokyo) 2014; 16: 247-251.
26) Oliva A, Caputo M, Grassi S, Vetrugno G, Marazza M, Ponzanelli G, Cauda R, Scambia G, Forti G, Bellantone R, Pascali VL. Liability of Health Care Professionals and Institutions During COVID-19 Pandemic in Italy: Symposium Proceedings and Position Statement. J Patient Saf 2020; 16: e299-e302.
27) Voultsos P, Oliva A, Grassi S, Palmiero D, Spagnolo AG. Are errors in otorhinolaryngology always a sign of medical malpractice? Review of the literature and new perspectives in the SARS-CoV-2 (COVID-19) era. Acta Otorhinolaryngol Ital 2020; 40: 157-163.
28) Gualniera P, Mondello C, Scurria S, Oliva A, Grassi S, Pizzicannella J, Alibrandi A, Sapienza D, Asmundo A. Experience of an Italian Hospital Claims Management Committee: A tool for extrajudicial litigations resolution. Leg Med (Tokyo) 2020; 42: 101657.
29) Gawande AA, Thomas EJ, Zinner MJ, Brennan TA. The incidence and nature of surgical adverse events in Colorado and Utah in 1992. Surgery 1999; 126: 66-75.
30) Griffen FD, Turnage RH. Reviews of liability claims against surgeons: what have they revealed? Adv Surg 2009; 43: 199-209.
31) Lavazza M, Liu X, Wu C, Anuwong A, Kim HY, Liu R, Randolph GW, Inversini D, Boni L, Rausei S, Frattini F, Dionigi G. Indocyanine green-enhanced fluorescence for assessing parathyroid perfusion during thyroidectomy. Gland Surg 2016; 5: 512-521.
32) Lang BH, Wong CK, Hung HT, Wong KP, Mak KL, Au KB. Indocyanine green fluorescence angiography for quantitative evaluation of in situ parathyroid gland perfusion and function after total thyroidectomy. Surgery 2017; 161: 87-95.
33) Randolph GW, Dralle H; International Intraoperative Monitoring Study Group, Abdullah H, Barczynski M, Bellantone R, Brauckhoff M, Carnaille B, Cherenko S, Chiang FY, Dionigi G, Finck C, Hartl D, Kamani D, Lorenz K, Miccolli P, Mihai R, Miyauchi A, Orloff L, Perrier N, Poveda MD, Romanchishen A, Serpell J, Sitges-Serra A, Sloan T, Van Slycke S, Snyder S, Takami H, Volpi E, Woodson G. Electrophysiologic recurrent laryngeal nerve monitoring during thyroid and parathyroid surgery: international standards guideline statement. Laryngoscope 2011; 121 Suppl 1: S1-16.
34) Promberger R, Ott J, Kober F, Koppitsch C, Seemann R, Freissmuth M, Hermann M. Risk factors for postoperative bleeding after thyroid surgery. Br J Surg 2012; 99: 373-379.
35) Zhang D, Fu Y, Dionigi G, Pontin A, Caruso E, Antonella P, Sun H. Human cadaveric model for studying the preservation of mental nerve during transoral endoscopic thyroidectomy. Surg Radiol Anat 2020; 42: 55-62.
36) Gaba DM. The future vision of simulation in health care. Qual Saf Health Care 2004; 13 Suppl 1(Suppl 1): i2-10.
37) Pfandler M, Stefan P, Mehren C, Lazarovici M, Weigl M. Technical and Nontechnical Skills in Surgery: A Simulated Operating Room Environment Study. Spine (Phila Pa 1976) 2019; 44: E1396-E1400.

38) Hull L, Arora S, Aggarwal R, Darzi A, Vincent C, Sevdalis N. The impact of nontechnical skills on technical performance in surgery: a systematic review. J Am Coll Surg 2012; 214: 214-230.

39) McCulloch P, Mishra A, Handa A, Dale T, Hirst G, Catchpole K. The effects of aviation-style non-technical skills training on technical performance and outcome in the operating theatre. Qual Saf Health Care 2009; 18: 109-115.

40) Rashid P, Gianduzzo TR. Urology technical and non-technical skills development: the emerging role of simulation. BJU Int 2016; 117 Suppl 4: 9-16.

41) Arbatli H, Cikirikcioglu M, Pektok E, Walpoth BH, Fasel J, Kalangos A, Bruszewski W, Numan F. Dynamic human cadaver model for testing the feasibility of new endovascular techniques and tools. Ann Vasc Surg 2010; 24: 419-422.

42) Lewis CE, Peacock WJ, Tillou A, Hines OJ, Hiatt JR. A novel cadaver-based educational program in general surgery training. J Surg Educ 2012; 69: 693-698.

43) Reed AB, Crafton C, Giglia JS, Hutto JD. Back to basics: use of fresh cadavers in vascular surgery training. Surgery 2009; 146: 757-762; discussion 762-763.

44) Ocel JJ, Natt N, Tiegs RD, Arora AS. Formal procedural skills training using a fresh frozen cadaver model: a pilot study. Clin Anat 2006; 19: 142-146.

45) Pham M, Kale A, Marquez Y, Winer J, Lee B, Harris B, Minnetti M, Carey J, Giannotta S, Zada G. A Perfusion-based Human Cadaveric Model for Management of Carotid Artery Injury during Endoscopic Endonasal Skull Base Surgery. J Neurol Surg B Skull Base 2014; 75: 309-313.

46) Pacca P, Jhawar SS, Seclen DV, Wang E, Snyderman C, Gardner PA, Aboud E, Fernandez-Miranda JC. "Live Cadaver" Model for Internal Carotid Artery Injury Simulation in Endoscopic Endonasal Skull Base Surgery. Oper Neurosurg (Hagerstown) 2017; 13: 732-738.

47) Olabe J, Olabe J, Roda JM, Sancho V. Human cadaver brain infusion skull model for neurosurgical training. Surg Neurol Int 2011; 2: 54.

48) McCrary HC, Krate J, Savilo CE, Tran MH, Ho HT, Adamas-Rappaport WJ, Viscusi RK. Development of a fresh cadaver model for instruction of ultrasound-guided breast biopsy during the surgery clerkship: pre-test and post-test results among third-year medical students. Am J Surg 2016; 212: 1020-1025.

49) Richmon JD, Pattani KM, Benhidjeb T, Tufano RP. Transoral robotic-assisted thyroidectomy: a preclinical feasibility study in 2 cadavers. Head Neck 2011; 33: 330-333.

50) Oliva A, Grassi S, Minelli N, Zedda M, Arena V, Romaniello N, Dionigi G, Makay Ö, De Crea C, Celik S, Spagnolo AG, Bellantone R, Raffaelli M. Transoral endoscopic thyroidectomy by a vestibular approach: cadaver simulation experience and ethicolegal issues. Br J Surg 2021: znab 325.

51) Celik S, Makay O, Yoruk MD, Bayzit Kocer I, Ozdemir M, Kilic KD, Tomruk C, Bilge O, Uyanikgil Y, Dionigi G. A surgical and anatomo-histological study on Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA). Surg Endosc 2020; 34: 1088-1102.

52) Aquila I, Sacco MA, Abenavoli L, Malara N, Arena V, Grassi S, Ausania F, Boccuto L, Ricci C, Gratteri S, Oliva A, Ricci P. Severe Acute Respiratory Syndrome Coronavirus 2 Pandemic. Arch Pathol Lab Med 2020; 144: 1048-1056.

53) Oliva A, Flores J, Merigioli S, LeDuc L, Benito B, Partemi S, Arzamendi D, Campuzano O, Leung TL, Iglesias A, Talajic M, Pascali VL, Brugada R. Autopsy investigation and Bayesian approach to coronary artery disease in victims of motor-vehicle accidents. Atherosclerosis 2011; 218: 28-32.

54) Crotti L, Hu D, Barajas-Martinez H, De Ferrari GM, Oliva A, Insolia R, Pollevick GD, Dagradi F, Guerchicoff A, Greco F, Schwartz PJ, Viskin S, Antzelevitch C. Torsades de pointes following acute myocardial infarction: evidence for a deadly link with a common genetic variant. Heart Rhythm 2012; 9: 1104-1112.

55) Campuzano O, Sarquella-Brugada G, Fernandez-Falgueras A, Coll M, Iglesias A, Ferrer-Costa C, Cesar S, Arbelo E, GarcíaÁlvarez A, Jordà P, Toro R, Tiron de Llano C, Grassi S, Oliva A, Brugada J, Brugada R. Reanalysis and reclassification of rare genetic variants associated with inherited arrhythmogenic syndromes. EBioMedicine 2020; 54: 102732.

56) Oliva A, Grassi S, Vetrugno G, Rossi R, Della Morte G, Pinchi V, Caputo M. Management of Medico-Legal Risks in Digital Health Era: A Scoping Review. Front Med (Lausanne) 2022; 8: 821756.

57) Mates J, Mademont-Soler I, Fernandez-Falgueras A, Sarquella-Brugada G, Cesar S, Arbelo E, García-Álvarez A, Jordà P, Toro R, Coll M, Fiol V, Iglesias A, Perez-Serra A, Olmo BD, Alcalde M, Puigmulé M, Pico F, Lopez L, Ferrer C, Tiron C, Grassi S, Oliva A, Brugada J, Brugada R, Campuzano O. Sudden Cardiac Death and Copy Number Variants: What Do We Know after 10 Years of Genetic Analysis? Forensic Sci Int Genet 2020; 47: 102281.