



ELSEVIER

Available online at

ScienceDirect

www.sciencedirect.com

Elsevier Masson France

EM|consulte

www.em-consulte.com/en



CLINICAL RESEARCH

Transoesophageal echocardiography current practice in France: A multicentre study

Pratique de l'échocardiographie transoesophagienne en France : une étude multicentrique

Augustin Coisne^{a,1,*}, Julien Dreyfus^{b,1},
Yohann Bohbot^{c,1}, Vincent Pelletier^{d,1},
Edouard Collette^{e,1}, Arthur Cescau^{f,1}, Eve Cariou^{g,1},
Cécile Alexandrino^{h,1}, Sophie Coulibaly^{i,1},
Aurélien Seemann^{j,1}, Clément Karsenty^{k,1},
Alexis Theron^{l,1}, Thibault Caspar^{m,1},
Laurie Soulat-Dufour^{n,1}, Julien Ternacle^{d,1}

^a Department of clinical physiology and echocardiography, Heart Valve Clinic, Institut Cœur-Poumon, CHU de Lille, 59000 Lille, France

^b Department of cardiology, Centre Cardiologique du Nord, 93200 Saint-Denis, France

^c Department of cardiology, Amiens University Hospital, 80054 Amiens, France

^d Department of cardiology, SOS Endocardites, Henri-Mondor Hospital, 94010 Creteil, France

^e Department of cardiology, CHU de Rennes, 35000 Rennes, France

^f Department of cardiology and radiology, Lariboisière Hospital, 75010 Paris, France

^g Department of cardiology, CHU de Toulouse, 31059 Toulouse, France

^h Department of cardiology, CHU de Bordeaux, 33604 Pessac, France

ⁱ Department of cardiology, CHU de Tours, 37000 Tours, France

^j NCT+ Saint Gatien Alliance, Institut Cardiologique Saint-Gatien, 37000 Tours, France

^k Department of cardiology, European Hospital Georges-Pompidou, 75015 Paris, France

^l Department of cardiac surgery, La Timone Hospital, Aix-Marseille University, 13005 Marseille, France

^m Nouvel Hôpital Civil, Strasbourg University Hospital, 67091 Strasbourg, France

ⁿ Department of cardiology, Saint-Antoine Hospital, 75012 Paris, France

Received 16 December 2017; received in revised form 29 January 2018; accepted 20 March 2018

Abbreviations: EACVI, European Association of Cardiovascular Imaging; GA, General Anaesthesia; SOP, Standardized Operating Procedure; TOE, Transoesophageal Echocardiography/Echocardiogram; VAS, Visual Analogue Scale.

* Corresponding author.

E-mail address: augustin.coisne@chru-lille.fr (A. Coisne).

¹ All authors are members of the Young Group of the French Society of Cardiovascular Imaging.

<https://doi.org/10.1016/j.acvd.2018.03.014>

1875-2136/© 2018 Published by Elsevier Masson SAS.

Please cite this article in press as: Coisne A, et al. Transoesophageal echocardiography current practice in France: A multicentre study. Arch Cardiovasc Dis (2018), <https://doi.org/10.1016/j.acvd.2018.03.014>

KEYWORDS

TOE;
Complication;
Practice

Summary

Background. – Few data are available on the application of transoesophageal echocardiography (TOE) recommendations in daily practice.

Aims. – To evaluate TOE practice based on echocardiography societies' guidelines, and to determine complication rates and factors associated with patient feelings.

Methods. – Between April and June 2017, we prospectively included all consecutive patients referred to 14 French hospitals for a transoesophageal echocardiogram (TOE). A survey was taken just after the examination, which included questions about pre-procedural anxiety, and any pain, unpleasant feeling or breathing difficulties experienced during the examination.

Results. – Overall, 1718 TOEs were performed, mainly for stroke evaluation. A standardized operating procedure checklist was completed in half of the patients before the examination. TOE was unpleasant for 62.4% of patients, but was stopped for agitation or intolerance in 3.5 and 1.4% of cases, respectively. We observed one severe complication (pulmonary oedema). The mean TOE duration was short (9.2 ± 4.6 minutes), but was longer with residents than with more experienced physicians (11 ± 4.7 vs. 8.8 ± 4.7 minutes for junior physicians [$P=0.0027$]; vs. 8.9 ± 4.8 minutes for senior physicians [$P=0.0013$]; and vs. 7.5 ± 4.1 minutes for associate professors/professors [$P<0.0001$]). The visual analogue scale (VAS) score after TOE was good (8.3 ± 1.7 out of 10), and was better in patients with general anaesthesia (GA) than in those without GA (9.3 ± 0.9 vs. 8.1 ± 1.7 ; $P<0.0001$). In patients without GA, the VAS score was similar with and without local anaesthesia (8.1 ± 1.7 vs. 8.2 ± 1.6 ; $P=0.19$). After multivariable adjustment, absence of anxiety before TOE and greater operator experience were consistently associated with a higher VAS score.

Conclusions. – TOE is safe, with a low rate of complications and few stops for intolerance. A shorter TOE duration and better patient feelings were observed for experienced operators, highlighting the importance of the learning curve, and paving the way for teaching on a TOE simulator.

© 2018 Published by Elsevier Masson SAS.

MOTS CLÉS

Échocardiographie
transoesophagienne ;
Complication ;
Pratique ;
France

Résumé

Contexte. – Il existe peu de données sur l'application des recommandations sur l'échocardiographie transoesophagienne (ETO) en pratique quotidienne.

Objectifs. – Évaluer la pratique de l'ETO selon les recommandations des sociétés savantes d'échocardiographie et déterminer le taux de complications et les facteurs associés au ressenti du patient.

Méthodes. – Entre avril et juin 2017, nous avons inclus prospectivement tous les patients adressés pour une ETO dans 14 hôpitaux français. Une enquête a été réalisée juste après l'examen afin d'évaluer l'anxiété avant la procédure, la douleur, les sensations désagréables ou les difficultés respiratoires ressenties pendant l'examen.

Résultats. – Au total 1718 ETO ont été réalisées, principalement pour l'évaluation d'accidents vasculaires cérébraux. Une *checklist* standardisée a été réalisée chez la moitié des patients avant l'examen. L'ETO était considérée comme désagréable chez 62,4 % des patients, mais elle n'a été arrêtée pour une agitation ou une intolérance que dans 3,5 et 1,4 % des cas, respectivement. Nous avons observé une complication sévère (œdème pulmonaire). La durée moyenne de l'ETO était courte ($9,2 \pm 4,6$ minutes) mais plus longue chez les internes que chez les médecins plus expérimentés ($11 \pm 4,7$ vs. $8,8 \pm 4,7$ minutes pour les chefs de cliniques [$p=0,0001$]; vs. $8,9 \pm 4,8$ minutes pour les praticiens hospitaliers [$p=0,0013$]; et vs. $7,5 \pm 4,1$ minutes pour les maîtres de conférences et professeurs des universités [$p<0,0001$]). Après l'examen, la note de l'échelle visuelle analogique (EVA) était bonne ($8,3 \pm 1,7$ sur 10), meilleure chez les patients sous anesthésie générale (AG) que sans AG ($9,3 \pm 0,9$ vs. $8,1 \pm 1,7$; $p<0,0001$). Chez les patients sans AG, l'EVA était identique avec et sans anesthésie locale ($8,1 \pm 1,7$ vs. $8,2 \pm 1,6$; $p=0,19$). Après un ajustement multivarié, l'absence d'anxiété avant l'ETO et une expérience plus importante de l'opérateur étaient indépendamment associés à une EVA plus élevée.

Conclusions. – L'ETO est un examen sûr, avec un faible taux de complications et peu d'arrêts prématurés pour une intolérance. L'examen était plus court et mieux vécu lorsqu'il était pratiqué par un opérateur expérimenté, soulignant l'importance de la courbe d'apprentissage et ouvrant la voie à l'enseignement sur le simulateur d'échocardiographie.

© 2018 Publié par Elsevier Masson SAS.

Background

Since its first description by Frazin et al. in 1976 [1], transoesophageal echocardiography (TOE) has become an indispensable standard examination in routine daily practice in cardiology departments. Although TOE use is widespread, it is a semi-invasive and unpleasant procedure, with very rare but potentially serious complications [2], and should not be used for routine screening. Nevertheless, TOE is highly recommended whenever transthoracic echocardiography (TTE) is inconclusive, such as for infectious endocarditis, systemic embolisms or valvular heart disease [3,4]. Moreover, the use of TOE has become essential with the recent emergence of structural heart interventions [5], for both feasibility assessment before and monitoring during the procedure. To reduce patient discomfort and complications, recommendations regarding TOE practice have been published by the European Association of Cardiovascular Imaging (EACVI) [6,7] and the American Society of Echocardiography [8]. These guidelines highlighted the importance of individual competence and learning, established the minimum standards for an echocardiography laboratory, detailed the indications and patient preparation, and described precautions and complications. However, there are few data regarding the application of these recommendations in daily practice, the amount of training needed to be competent and patient feelings. Moreover, local practices can be highly heterogeneous.

Our objective was to conduct a prospective multicentre study in French public and private hospitals to evaluate current TOE practice, and to determine procedure tolerance, rates of complications and factors associated with patient feelings.

Methods

Study population

We prospectively included all consecutive patients, hospitalized or not, who were referred to the echocardiography laboratory of 14 French hospitals (12 public and two private) for a TOE between April and June 2017. TOE indication was determined by the physician referring the patient, and was categorized according to 10 main indications notified in the survey. TOEs performed outside the echocardiography laboratory (operative or in the interventional cardiology room) were not included in the study.

Information collected before TOE

Patient conditions associated with risk of complications were assessed by a survey before TOE: risk of inhalation, including swallowing or neurological disorders, chest radiotherapy or oesophagus injury. Information about patient medical status, TOE indication and preparation was also obtained. The use of a local dedicated standardized operating procedure (SOP) checklist and a document mentioning the risk of Creutzfeldt-Jakob disease before starting the examination was also assessed. The local ethics committees approved the protocol, and patients gave informed consent.

Course of the TOE

There was no change in local routine practice; thus, all the usual operators in each centre participated in the study. A resident was defined as a medical student without a medical degree, who had performed < 120 examinations/year, and a junior physician was defined as a graduate medical doctor with < 2 years of experience. TOE preparation could be no anaesthesia, local anaesthesia alone, local anaesthesia plus sedation, sedation alone or general anaesthesia (GA). The type of anaesthesia was left to the discretion of the physician in charge of the patient, according to the policy of each centre. Patient positioning and monitoring during TOE were performed according to local practice. TOE duration was recorded from the introduction to the removal of the probe. Both two-dimensional and three-dimensional probes were used, according to the operator's wishes and the available equipment. Information about the use of dedicated local and subglobal analgesia treatment (or hypnosis preparation) was retrieved.

Evaluation after TOE

Information about fasting and monitoring outside the echocardiography laboratory was given. If necessary, patients were monitored in the echocardiography laboratory, and data on any complications were collected before hospital discharge. A survey was taken just after the examination, covering patient anxiety and questions before TOE, and any pain, unpleasant feeling or breathing difficulties experienced during the examination. Patients completed a visual analogue scale (VAS) just after the examination, ranging from 0 to 10, with 0 indicating the worst experience and 10 the best experience. Finally, patients were asked if they were willing to repeat the examination, if necessary.

Statistical analysis

Continuous variables were tested for normality with the Shapiro–Wilk test, and are given as means \pm standard deviations. A *t* test and linear regression were performed for bivariate analysis. Categorical variables are given as percentages of individuals. Linear regression was used to explore the link between global rating and patient or TOE characteristics. Multivariable linear regression analysis was performed to identify variables independently associated with global rating. Variables with a *P* value < 0.05 on bivariate analysis were entered into the multivariable models. Two multivariable models were performed: one for patients without GA (model 1) and one for patients with GA (model 2). A value of *P* < 0.05 was considered statistically significant. Statistical analyses were performed using MedCalc, version 16.4 (MedCalc Software, Olstead, Belgium).

Results

Patients and indications for TOE

Overall, 1718 patients were included (62.8% male; mean age 65 ± 15 years). Most patients were hospitalized (79.0%), and their characteristics are summarized in Table 1. The

Table 1 Patient characteristics and anticipated risks before transoesophageal echocardiography (*n* = 1718).

Male sex	1079 (62.8)
Age (years)	64.8 ± 14.6
Height (cm)	169.6 ± 9.6
Weight (kg)	77.2 ± 17.5
BMI (kg/m ²)	26.1 [23.2–29.4]
Hospitalized patient	
No	361 (21.0)
Yes	1357 (79.0)
Anticipated risks before TOE	
Checklist	875 (51.0)
Risk of Creutzfeldt–Jacob disease	635 (38.0)
Risk of inhalation	193 (11.2)
Radiotherapy	6 (0.3)
Oesophagus injury	6 (0.3)
Swallowing test	598 (34.8)
Peripheral intravenous access	1019 (59.3)

Data are expressed as number (%), mean ± standard deviation or median [interquartile range]. BMI: body mass index; TOE: transoesophageal echocardiography.

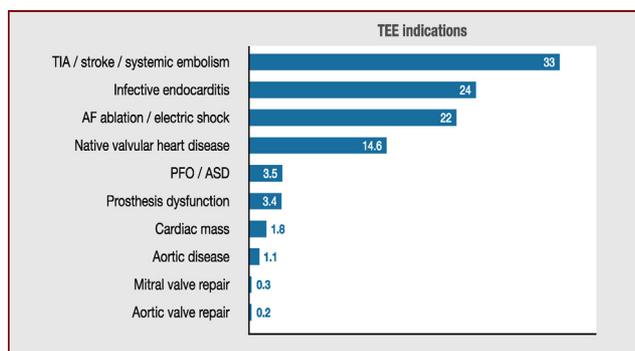


Figure 1. Transoesophageal echocardiography (TOE) indications. Data are expressed as percentages. AF: atrial fibrillation; ASD: atrial septal defect; PFO: patent foramen ovale; TIA: transient ischaemic attack.

majority of TOEs were performed for the exploration of transient ischaemic attack, stroke or systemic embolism (33.0%), suspicion of infective endocarditis (24.0%), or before supraventricular tachycardia ablation or electric cardioversion (22.0%) (Fig. 1). A bubble study was performed systematically in case of transient ischaemic attack or stroke. Other indications included exploration of native valvular heart disease (14.6%), patent foramen ovale or atrial septal defect (3.5%), prosthesis dysfunction (3.4%), cardiac mass (1.8%), aortic disease (1.1%), and before mitral or aortic valve repair (0.5%).

Risk evaluation before TOE

The risks of TOE complications and Creutzfeldt–Jacob disease were evaluated using a checklist in 875 patients (50.9%) and 653 patients (38.0%), respectively. The anticipated risk of TOE complications was low. History of chest radiotherapy or oesophagus injury was observed in 0.3% of patients, and risk of inhalation in 11.2%. Among the 193 patients with a

Table 2 Operator, preparation and equipment (*n* = 1718).

Operator	
Resident	84 (4.9)
Junior physician	557 (32.4)
Senior physician	905 (52.7)
Associate professor/professor	88 (5.1)
Consultant	84 (4.9)
Type of anaesthesia	
General	295 (17.2)
Sedation	286 (16.6)
Local	1072 (62.4)
Gel	127 (11.9)
Number	1.4 ± 0.6
Spray	57 (5.3)
Number	1.5 ± 0.9
Both	888 (82.8)
No anaesthesia	218 (12.7)
Premedication	
Anxiolytic	45 (2.6)
Antiemetic	6 (0.3)
Nitrous oxide	32 (1.9)
Midazolam	272 (15.8)
Dosage (mg)	2 [1–2]
Propofol	294 (17.1)
Dosage (mg)	120 [100–150]
Patient position	
Seated	406 (23.6)
Supine	6 (0.3)
Left lateral decubitus	1292 (75.2)
Right lateral decubitus	14 (0.9)

Data are expressed as number (%), mean ± standard deviation or median [interquartile range].

risk of inhalation, a swallowing test was performed in 47.2% (*n* = 91), a SOP checklist was completed in 73.6% (*n* = 142) and 90 patients (46.6%) had an intravenous access. TOE-related precautions in these selected patients were more frequent than in the overall population. In the global population, 1019 patients (59.3%) had an intravenous access, mainly for a stroke/transient ischaemic attack indication (42.0%) and/or for GA.

TOE examination

TOE was mainly performed by a senior physician (52.7%) or a junior physician (32.4%) (Table 2). GA was used in 17.2% of patients (100% using propofol, and only one patient using both propofol and midazolam), sedation in 16.6% (100% using midazolam) and local anaesthesia alone in 62.4%, mainly with both lidocaine gel and spray (82.8%). TOE was performed without any anaesthesia in 218 patients (12.7%). Few patients had antiemetic premedication. Oxygen therapy was used in 22.0% of patients (99.3% in case of GA).

Three-quarters of patients were in the left lateral decubitus position, and one-quarter was seated. Only a few patients were in the supine or right lateral decubitus position (0.3 and 0.9%, respectively). A nurse helped the operator in 79.0% of cases, a caregiver in 8.6% of cases,

Table 3 Course of the transoesophageal echocardiography ($n = 1718$).

Help	
Nurse	1356 (79.0)
Caregiver	148 (8.6)
Anaesthetist/nurse anaesthetist	251 (14.6)
Probe introduction	
Inflected neck	1349 (78.5)
Help with finger	663 (38.6)
Number of attempts	
1	1436 (83.6)
2	180 (10.5)
3	62 (3.6)
> 3	40 (2.3)
Failure	22 (1.3)
Premature stop because of:	
Agitation	60 (3.5)
Intolerance	24 (1.4)
TOE duration (minutes)	9.2 ± 4.6

Data are expressed as number (%) or mean ± standard deviation. TOE: transoesophageal echocardiography.

and an anaesthetist or nurse anaesthetist in 14.6% of cases (Table 3). A TOE bite guard was used for all patients. The neck was inflected in 1349 patients (78.5%), and the fingers were needed to guide the probe in 663 patients (38.6%). Probe introduction was successful after the first attempt in 83.6% of patients, and only 1.3% of attempts failed. TOE was performed using a three-dimensional probe in 1410 patients (82%), and its use did not lengthen the duration of the examination significantly: 9.1 ± 4.6 vs. 9.2 ± 4.6 minutes ($P = 0.87$). TOE was stopped in only 3.5% of patients for agitation and 1.4% for intolerance.

Mean TOE duration was 9.2 ± 4.6 minutes. TOE duration was not different between patients with and without GA (9.2 ± 4.5 vs. 8.7 ± 4.9 minutes, respectively; $P = 0.10$), but it was longer with residents than with more experienced physicians (11 ± 4.7 vs. 8.8 ± 4.7 minutes for junior physicians [$P = 0.0027$]; vs. 8.9 ± 4.8 minutes for senior physicians [$P = 0.0013$]; and vs. 7.5 ± 4.1 minutes for associate professors/professors [$P < 0.0001$]). We did not observe a difference between the other groups.

Monitoring and complications

After TOE, monitoring was performed in the echocardiography laboratory in 598 patients (34.8%), with a median duration of 30 minutes. Vomiting during TOE occurred in four patients (0.2%), inhalation in three, throat trauma in one and dental trauma in one (Table 4). We observed only one severe complication (pulmonary oedema). None of the TOE-related complications was fatal. Information about the need to avoid eating or drinking during the 2 hours after the examination was given in 59.7% of patients. The characteristics of the 10 patients who developed complications are summarized in Table 5.

Patients with blood on the probe ($n = 58$) did not differ from patients without, regarding position ($P = 0.22$ for seated and $P = 0.09$ for left lateral decubitus) or operator

Table 4 Monitoring and complications ($n = 1718$).

Monitoring	
Instructions given	1668 (97.1)
Fasting duration (hours)	1.5 ± 0.8
Swallowing test	606 (35.3)
Monitoring in the echocardiography laboratory	598 (34.8)
Monitoring duration (minutes)	30 [30–60]
Complications	
Blood on the probe	58 (3.4)
Vomiting	4 (0.2)
Inhalation	3 (0.2)
Ear, nose and throat trauma	1 (0.06)
Dental trauma	1 (0.06)
Pulmonary oedema	1 (0.06)
Others	0 (0)

Data are expressed as number (%), mean ± standard deviation or median [interquartile range].

Table 5 Characteristics of patients who had complications ($n = 10$).

Male sex	4 (40.0)
Age (years)	70.6 ± 11.2
BMI (kg/m ²)	26 [23.2–30.8]
Hospitalized patient	9 (90.0)
Indication	
TIA/stroke/systemic embolism	4 (40.0)
Infective endocarditis	4 (40.0)
Native valvular heart disease	2 (20.0)
Anticipated risks before TOE	
Checklist	3 (30.0)
Risk of inhalation	4 (40.0)
Radiotherapy	0 (0)
Oesophagus injury	0 (0)
Swallowing test	3 (30.0)
Operator	
Junior physician	6 (60.0)
Senior physician	4 (40.0)
Type of anaesthesia	
General	1 (10.0)
Sedation	1 (10.0)
Local	8 (80.0)
Patient position	
Seated	6 (60.0)
Left lateral decubitus	4 (40.0)
TOE duration (minutes)	4.5 [1–12.5]
Anxiety before the examination	7 (70.0)
Pain/10	1 [0–6.5]
VAS score/10	7.6 ± 1.3

Data are expressed as number (%), mean ± standard deviation or median [interquartile range]. BMI: body mass index; TIA: transient ischaemic attack; TOE: transoesophageal echocardiography; VAS: visual analogue scale.

experience ($P=0.09$). Conversely, higher numbers of cases of probe introduction and local anaesthesia were associated with a higher frequency of blood on the probe ($P<0.0001$ and $P=0.0001$, respectively).

Survey and TOE global rating

The VAS score was obtained in 1600 patients (93.1%). Language problem was the main cause of failure to complete the VAS evaluation (54.0%). Half of the patients were anxious before the examination, but only 8.1% searched for information on the Internet (Table 6). Nevertheless, 95.4% of patients felt that the explanations given before the examination were sufficient. TOE was considered more unpleasant (62.4%) than painful (24.4%). Patients described nausea in 38.6% of cases, and 16.6% experienced difficulty in breathing. The VAS score is presented in Fig. 2 (Fig. 2A for patients without GA and Fig. 2B for patients with GA). The VAS score was good (8.3 ± 1.7 out of 10), and was better in patients with than without GA (9.3 ± 0.9 vs. 8.1 ± 1.7 ; $P<0.0001$). This high score was supported by the fact that 93.1% were ready to repeat the examination if necessary. Surprisingly, in patients without GA, the VAS score was not different in patients with and without local anaesthesia (8.1 ± 1.7 vs. 8.2 ± 1.6 ; $P=0.19$).

A probe cover was used in 449 patients (26.1%). In patients without GA, the use of a probe cover was associated with more nausea (48.2 vs. 35.7%; $P=0.0009$), but not with more discomfort (74.4 vs. 73.9%; $P=0.89$) or a lower VAS score (8.1 ± 1.7 vs. 8.1 ± 1.7 , $P=0.95$).

A GE Healthcare (Little Chalfont, UK) probe was used in 1007 patients (58.6%), and a Philips Healthcare (Best, Netherlands) probe in 711 patients (41.4%). In patients without GA, we did not find differences in VAS score based on the model of TOE probe (8.2 ± 1.7 for GE Healthcare vs. 8 ± 1.7 for Philips; $P=0.09$).

Determinants of TOE global rating

TOE duration was not associated with global feeling, with or without GA. In patients without GA, univariate analysis showed a higher global rating in case of older age ($P=0.0077$), absence of anxiety before TOE ($P=0.0001$),

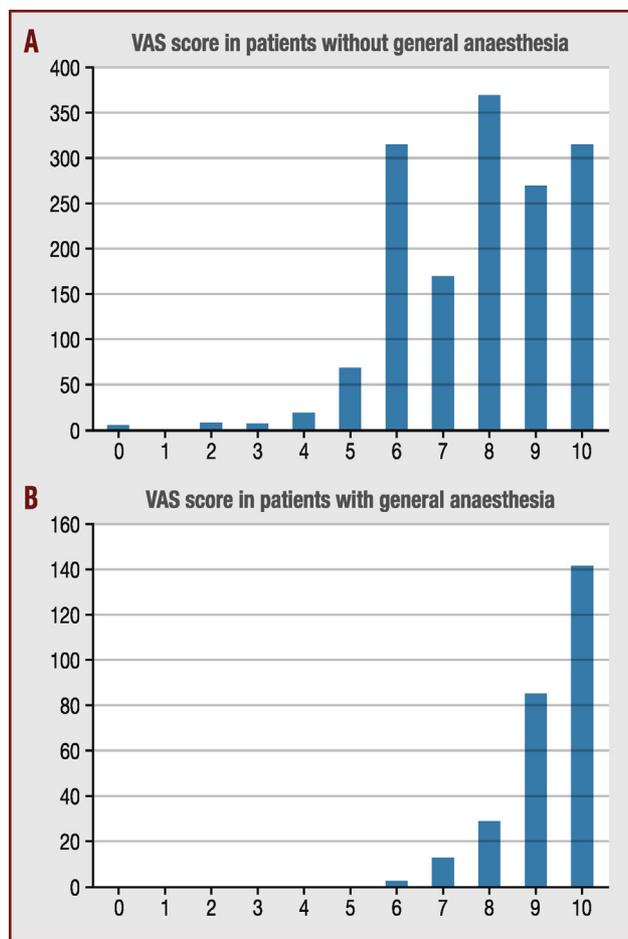


Figure 2. Visual analogue scale (VAS) score. A. VAS score in patients without general anaesthesia. B. VAS score in patients with general anaesthesia.

ambulatory status ($P=0.002$), greater operator experience ($P=0.0058$) and a lower number of attempts to introduce the probe ($P<0.0001$) (Table 7). After multivariable adjustment, all these variables were associated with a higher VAS score after TOE. In patients with GA, in the univariate analysis, a higher VAS score after TOE was associated with male sex ($P=0.037$), older age ($P=0.022$), absence of anxiety before TOE ($P=0.0004$), greater operator experience ($P=0.0015$), absence of inflected neck ($P=0.049$) and absence of help with a finger ($P=0.01$) (Table 7). After multivariable adjustment, absence of anxiety before TOE, greater operator experience and absence of help with a finger were associated with a higher VAS score after TOE.

TOE tolerance and age

Older age (>80 years, $n=241$) was not associated with a higher frequency of anxiety before TOE ($P=0.87$), premature stop for intolerance ($P=0.41$) or complications ($P=0.07$). Moreover, the VAS score was not different from that in younger patients (8.2 ± 1.8 vs. 8.3 ± 1.7 ; $P=0.29$).

Table 6 Survey ($n=1600$).

Anxiety before the examination	752 (47.0)
Searched for information on internet	130 (8.1)
Sufficient explanation given	1526 (95.4)
Unpleasant	998 (62.4)
Nausea	618 (38.6)
Difficulty in breathing	266 (16.6)
Painful	390 (24.4)
Pain/10	1 [0–5]
VAS score/10	8.3 ± 1.7
Would agree to a redo examination under the same conditions	1490 (93.1)

Data are expressed as number (%), median [interquartile range] or mean \pm standard deviation. VAS: visual analogue scale.

Table 7 Univariate and multivariable logistic regression analyses to assess determinants of the visual analogue scale score in patients with and without general anaesthesia.

	Patients without GA (n = 1329)				Patients with GA (n = 271)			
	Univariate analysis		Multivariable analysis		Univariate analysis		Multivariable analysis	
	$\beta \pm SE$	P	$\beta \pm SE$	P	$\beta \pm SE$	P	$\beta \pm SE$	P
Male sex				0.14	-0.24 ± 0.12	0.037		
Age (years)	0.008 ± 0.003	0.0077	0.007 ± 0.0033	0.02	-0.01 ± 0.004	0.022		
Hospitalization	-0.36 ± 0.11	0.002	-0.28 ± 0.11	0.014		0.055		
Anxiety before TOE	8.3 ± 0.07	0.0001	-0.38 ± 0.09	< 0.0001	9.4 ± 0.06	0.0004	-0.38 ± 0.13	0.031
Operator	0.15 ± 0.05	0.0058	0.11 ± 0.05	0.045	-1.3 ± 0.4	0.0015	-1.22 ± 0.40	0.0025
Sedation		0.48						
Local		0.24						
Seated		0.47						
Left lateral decubitus		0.91						
Right lateral decubitus		0.16						
Type of probe		0.59				0.07		
Inflected neck		0.09			-0.31 ± 0.15	0.049		
Help with finger		0.97			-0.43 ± 0.17	0.01	-0.39 ± 0.17	0.006
Number of attempts	-0.41 ± 0.07	< 0.0001	-0.40 ± 0.06	< 0.0001		0.46		
TOE duration		0.41				0.77		

GA: general anaesthesia; TOE: transoesophageal echocardiography; SE: standard error.

Discussion

Exploring current TOE practice in France in a large multi-centre cohort of consecutive patients, we found that TOE is safe, with a very low rate of complications, despite the lack of use of a checklist in half of the patients. Even if the conduct of TOE was heterogeneous, the VAS score was high, supported by a large proportion of patients who were ready to repeat TOE if necessary. Better patient feeling was independently and consistently associated with greater operator experience.

Populations, indications and anticipated risks

Our study was performed in 14 public and private hospitals throughout France, without change in local routine practice; it is, therefore, a good reflection of current practice in our country. As expected, most of the patients were hospitalized. As described in the European guidelines, TOE indications were stroke or systemic embolism, infective endocarditis or before cardioversion in more than three-quarters of cases. Other indications were less frequent, including valvular heart disease evaluation (14.6%). However, we did not include TOE performed during cardiac surgery or structural heart procedures, which represents an increased proportion of TOE nowadays. Pre-procedural screening for the risk of TOE complications was far from optimal, as a checklist was only performed in half of cases, and screening for Creutzfeldt–Jacob disease was done in 38% of cases. Even if the prevalence of this disease is low, the consequences could be disastrous. Thus, the routine use of a SOP checklist, including Creutzfeldt–Jacob disease detection, must be a standard for European accreditation of echocardiography laboratories [9]. This highlights a jeopardized TOE practice, and points to the need for a checklist that is adaptable, quick and feasible in daily routine. We therefore propose a pre-procedural checklist to standardize TOE practice and evaluation (Supplementary data).

Patient preparation and equipment

Even if the VAS score was slightly lower in patients without GA, TOE is a well-tolerated examination. Moreover, systematic GA is expensive, and the cost is mainly driven by the need to have an anaesthesiologist present during the examination. Thus, TOE under GA should be reserved for cases of failure of probe introduction or in patients who are very anxious or non-cooperative. European recommendations consider that sedation should precede the examination. In our study, sedation was not associated with a better global rating. Thus, we believe that sedation should not be used systematically, but could be relevant for anxious patients or if repeated TOE is necessary. Local anaesthesia was also not associated with the VAS score, possibly because of the absence of swallowing disorder or lack of fasting after the examination. The equipment in the hospitals participating in the study was in line with standards of good practice, as the probes used were almost systematically multiplane [6–9]. Finally, although the use of hypnosis is marginal for the moment, this technique seems to be an

efficient alternative or complementary method for improving patient comfort during TOE [10].

Complications and competence

Serious complications were very rare in our study (0.06%), represented by only one pulmonary oedema. This result is in line with a recent review published by Côté et al. [11], and reflects good pre-procedural screening. In their review, complications were mainly driven by gastrointestinal and cardiac complications, which were not observed in our study. The incidence of probe introduction failure ranged from 0 to 1.9%, which is close to the incidence in our study (1.3%). These failures were mainly linked to lack of patient cooperation or operator experience. In a multicentre survey that included 10,419 TOE examinations, Daniel et al. found a premature stop for intolerance in 65 patients (0.9%), which is in line with our study (1.4%) [12]. Even if TOE was unpleasant, the duration of the examination was not associated with patient feeling, suggesting good preparation and a relatively short examination duration. The same results were observed in patients aged > 80 years. Finally, greater operator experience and a lower number of attempts to introduce the probe were predictive of a higher VAS score. These data, as well as the literature, highlight the importance of the learning curve, paving the way for teaching on a TOE simulator.

Study limitations

To stay as close to reality as possible, we included all consecutive patients referred to our echocardiography laboratory, without changing the local practice of each centre. A short survey was taken and any complications were recorded after the examination. We did not perform mid- or long-term follow-up, but patients and practitioners were informed of the need to warn the echocardiography laboratory in case of complications. French centres are currently non-EACVI accredited, but that is advisable and something that could be encouraged, taking into account the good results of the present evaluation. Progress remains to be made in sticking perfectly to the recommendations, especially in terms of the SOP checklist.

Clinical perspectives

Although TOE is safe, the risk of complications should be evaluated systematically using a checklist, as recommended by the guidelines. TOE is mainly well tolerated, and GA should be reserved for very anxious and non-cooperative patients or when iterative TOE is necessary. Physicians who perform TOE must be experienced, to avoid poor tolerance of the examination related to multiple attempts at probe introduction. For young physicians, teaching and training on a TOE simulator should be a standard learning process before moving on to patients.

Conclusions

TOE is safe, with a low rate of complications and few stops for intolerance. The use of a SOP checklist for safety screening before TOE is mandatory according to guidelines,

but was performed in only 50% of the patients. Shorter TOE duration and better patient feeling were observed for experienced operators, highlighting the importance of the learning curve, and paving the way for teaching on a TOE simulator.

Sources of funding

None.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.acvd.2018.03.014>.

Disclosure of interest

The authors declare that they have no competing interest.

References

- [1] Frazin L, Talano JV, Stephanides L, Loeb HS, Kopel L, Gunnar RM. Esophageal echocardiography. *Circulation* 1976;54:102–8.
- [2] Daniel WG, Mugge A. Transesophageal echocardiography. *N Engl J Med* 1995;332:1268–79.
- [3] Habib G, Lancellotti P, Antunes MJ, et al. 2015 ESC guidelines for the management of infective endocarditis: the task force for the management of infective endocarditis of the European Society of Cardiology (ESC). Endorsed by: European Association for Cardio-Thoracic Surgery (EACTS), the European Association of Nuclear Medicine (EANM). *Eur Heart J* 2015;36:3075–128.
- [4] Lancellotti P, Tribouilloy C, Hagendorff A, et al. Recommendations for the echocardiographic assessment of native valvular regurgitation: an executive summary from the European Association of Cardiovascular Imaging. *Eur Heart J Cardiovasc Imaging* 2013;14:611–44.
- [5] Zamorano J, Goncalves A, Lancellotti P, et al. The use of imaging in new transcatheter interventions: an EACVI review paper. *Eur Heart J Cardiovasc Imaging* 2016;17 [835-af].
- [6] Flachskampf FA, Badano L, Daniel WG, et al. Recommendations for transoesophageal echocardiography: update 2010. *Eur J Echocardiogr* 2010;11:557–76.
- [7] Flachskampf FA, Wouters PF, Edvardsen T, et al. Recommendations for transoesophageal echocardiography: EACVI update 2014. *Eur Heart J Cardiovasc Imaging* 2014;15:353–65.
- [8] Hahn RT, Abraham T, Adams MS, et al. Guidelines for performing a comprehensive transesophageal echocardiographic examination: recommendations from the American Society of Echocardiography and the Society of Cardiovascular Anesthesiologists. *J Am Soc Echocardiogr* 2013;26:921–64.
- [9] Popescu BA, Stefanidis A, Nihoyannopoulos P, et al. Updated standards and processes for accreditation of echocardiographic laboratories from the European Association of Cardiovascular Imaging. *Eur Heart J Cardiovasc Imaging* 2014;15:717–27.
- [10] Corman I, Bouchema Y, Miquel B, et al. Hypnosis to facilitate transesophageal echocardiography tolerance: the I-SLEPT study. *Arch Cardiovasc Dis* 2016;109:171–7.
- [11] Cote G, Denault A. Transesophageal echocardiography-related complications. *Can J Anaesth* 2008;55:622–47.
- [12] Daniel WG, Erbel R, Kasper W, et al. Safety of transesophageal echocardiography. A multicenter survey of 10,419 examinations. *Circulation* 1991;83:817–21.