Ultrasonography and Italian anesthesiology: a national cross-sectional study

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Abstract

Purpose In recent years, ultrasound has seen a rapid development with numerous applications in anesthesia, intensive-care medicine, and pain medicine, increasing efficacy and safety of procedures. We investigated the prevalence of ultrasound use among Italian anesthesiologists.

Methods A cross-sectional prevalence study was carried out on a sample of 735 anesthetists. The research was conducted during the ultrasound training in anesthesia and intensive care, in the Italian Associazione Anestesiisti Rianimatori Ospedalieri – Emergenza Area Critica “SimuLearn®” training centre (Bologna, Italy).

Results The overall prevalence of a dedicated ultrasound devices in the operating room was 70% [95% CI 66–73%], while 74% [95% CI 69–78%] in northern Italy, 61% [95% CI 52–68%] in southern Italy, and 70% [95% CI 63–77%] in central Italy, indicating a significant difference between the north and south of Italy. The prevalence of regular use of ultrasound was high for regional anesthesia and for central venous cannulation [82–95% CI 79–85%] and low for pain therapy procedures [7–95% CI 6–10%]. Multivariate logistic analysis showed that the presence of a dedicated ultrasound device and high expertise were factors associated with routine use of ultrasound for regional anesthesia in upper and lower limb blocks and in vascular access.

Conclusion The appropriate training in the use of ultrasound in anesthesia, intensive-care medicine, and pain therapy should be implemented in south of Italy to make uniform the widespread of ultrasonography in anesthesia, in all Italian regions.

Keywords Ultrasound · Regional anesthesia · Vascular access

SOMMARIO

Introduzione Negli ultimi anni l’ecografia ha visto un rapido sviluppo con numerose applicazioni in anestesia, terapia intensiva e del dolore, con aumento dell’efficacia e della sicurezza delle procedure. Abbiamo studiato la prevalenza dell’uso dell’ecografo tra gli anestesisti italiani.

Metodi E’ stato condotto uno studio di prevalenza “cross-sectional” su un campione di 735 anestesisti. La ricerca è stata condotta durante i corsi di ecografia in anestesia e terapia intensiva, presso il centro di formazione “SimuLearn®” (Bologna, Italia) dell’Associazione Italiana Anestesiisti Rianimatori Ospedalieri - Emergenza Area Critica.

Risultati La prevalenza complessiva di un ecografo dedicato in sala operatoria era del 70% [IC 95%: 66% -73%]; nel Nord Italia la prevalenza era del 74% [IC 95%: 69% -78%], mentre era del 61% [CI 95%: 52% -68%] nell’Italia meridionale e del 70% [IC 95%: 63% -77%] nell’Italia centrale, indicando una differenza significativa tra il nord e il sud del paese. Per l’anestesia regionale e il posizionamento di un accesso venoso centrale la prevalenza dell’uso regolare degli ultrasuoni era alta [82% -95% IC: 79% -85%], mentre era bassa per le procedure di terapia del dolore [7% -95% IC: 6% -10%]. L’analisi logistica multivariata ha mostrato che la presenza di un dispositivo ecografico dedicato e di un’elevata esperienza erano fattori associati all’uso di routine degli ultrasuoni per l’anestesia regionale nei blocchi degli arti superiori e inferiori e nell’accesso vascolare.

Conclusione La formazione appropriata sull’uso degli ultrasuoni in anestesia, medicina intensiva e terapia del dolore, dovrebbe essere implementata al fine uniformare la diffusione dell’ecografia in anestesia, in tutte le regioni italiane.

Introduction

In recent years, there has been a rapid spread of new technologies in anesthesia, intensive-care medicine, and pain therapy. The introduction of ultrasound (US) has improved efficacy and safety, in anesthetic procedures. Ultrasound-guided (USG) loco-regional techniques have reduced the risk of local anesthetic systemic toxicity (LAST) and of diaphragmatic hemiparesis [1]. Moreover, in the last years, US has seen an extensive use in many fields of anesthesiology and has led to the rapid development of new techniques, although not all supported by a high level of scientific evidence [1]. Central venous cannulation has received major benefits from the US visualization of the target, with a consequent improvement in success rate and a reduction in time, number of attempts, and related complications both in the adult and pediatric patient [2, 3].

In Italy, there are no studies that document the current use of US in anaesthesiology.

Although the literature lacks univocal consensus on the best learning method of USG techniques, all scientific societies underline the importance of appropriate training. Most likely, simulation courses, both on dummy and cadavers, may guarantee faster learning than the conventional methods alone [4, 5]. The aim of this study is to evaluate the prevalence of ultrasound use among Italian anesthetists.

Materials and methods

Study design

A cross-sectional prevalence study was carried out.

Study population

The eligible study population consisted of all the participants of the ultrasound training in anesthesia, intensive-care medicine, and pain therapy, in the Italian Associazione Anestesiisti Rianimatori Ospedalieri—Emergenza Area Critica (AAROI-EMAC) “SimuLearn®” training centre (Bologna, Italy).

Sampling

There was no a priori sample size estimate, because all of the past attendees of the simulation trainings were included.

Data collection

Two ultrasound trained anesthetists and two trained research assistant held the simulation trainings. The courses lasted 2 days.

From November 2015 to December 2016, all participants of the trainings were enrolled in the study.

Ethical standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. This article does not contain any studies with human participants or animals performed by any of the authors.

Informed consent was obtained from all the individual participants included in the study. (Interviews took place from November 2015 to December 2016.)

Measures

Subjects enrolled were investigated using an anonymous self-administered questionnaire (SimuLearn questionnaire). The SimuLearn questionnaire consisted of 12 items and required a self-assessment on the theoretical practical knowledge of ultrasound and investigated the clinical practice in the participants of all the courses on USG procedures in regional anesthesia, in central vascular access, and in pain therapy and the relative incidence of complications and other uses of US in operating theaters (Fig. 1).

A final question was diversified according to the type of course: to participants of the course in “Ultrasound in regional anesthesia with simulation systems” the final question was “Do you think that after this course you will change your clinical practice?” while the participants of all the other courses were asked to answer the following question: “Do you think that a specific course on ultrasound-guided regional anesthesia could be useful to your clinical practice?”.

In addition to the SimuLearn questionnaire, the study gathered information on demographic variables (age and gender) and the location of employment (city and region).

Statistical analysis

Statistical analysis was performed with the STATA 14/MP software. Descriptive statistics were calculated for all the variables in the study. Categorical data were analysed using Chi-square tests or Fisher’s exact test, and means for the continuous variables were compared using *t* tests or two-sample Wilcoxon rank-sum (Mann–Whitney) tests.

Participants were classified into two groups, the “Ultrasound Loco-regional Anesthesia with Simulation Systems” course participants (ULASS group) and those from the other proposed courses (NoULASS group) and their answers to the SimuLearn questionnaire were compared.

QUESTIONS	ANSWERS
Q1: Is there an echograph dedicated to anesthetists in your operating rooms?	☐ Yes, ☐ No
Q2: How often do you use ultrasound in peripheral nerve blocks?	
Upper limb	☐ Never, ☐ Rarely, ☐ Often, ☐ Always
Lower limb	☐ Never, ☐ Rarely, ☐ Often, ☐ Always
Q3: For which types of peripheral nerve blocks do you use them?	
Q4: How often do you use ultrasound in the fascia blocks?	☐ Never, ☐ Rarely, ☐ Often, ☐ Always
Q5: For which types of nerve block blocks do you use them?	
Q6: How often do you use ultrasound for cannulation of central venous?	☐ Never, ☐ Rarely, ☐ Often, ☐ Always
Q7: For which type of central venous access does the echograph?	
Q8: How often do you use ultrasound for pain therapy?	☐ Never, ☐ Rarely, ☐ Often, ☐ Always
Q9: How would you define your experience in the use of ultrasound?	☐ Low, ☐ Discreet, ☐ Good, ☐ Excellent
Q10: Have you ever had complications while using these methods?	☐ Yes, ☐ No
Q11: If YES which?.	
Q12: Do you use ultrasound in the operating room for other procedures?	☐ Yes, ☐ No

Fig. 1 SimuLearn questionnaire items

The percent prevalence of US devices dedicated to anesthesia in the operating room was computed overall, by group (ULASS vs NoULASS) and by residence (southern and islands, central, northern Italy). The variables indicating the use of US for regional anesthesia were categorized in “regular use” (yes/no) in: upper limb, lower limb, fascia block, cannulation of vascular access, and pain therapy, and were investigated separately with multivariate logistic regression model, using the backward stepwise procedures ($p = 0.15$, $Pr = 0.20$). Age ($\geq 45 / < 45$ years), gender, participant’s residence (southern and islands, central, northern Italy), presence of US devices to anesthesia in the operating room (yes/no), and self-reported expertise (low/high), were considered as covariates in the multivariate logistic model. The results were expressed as odds ratios (OR) with 95% CIs. The alpha level for all analyses was set to $p < 0.05$.

Objectives

The objectives of the present study were: (i) to estimate the prevalence of US use for regional anesthesia, pain therapy, and central vascular access among Italian anesthetists, and (ii) to identify risk factors for anesthetic procedures.

Results

A total of 735 out of 789 participants completed the survey. Fifty individuals were excluded because of denial to participate and forty questionnaires were not analysed because of missing data. The refusal rate was 6% (50/789).

Participants were aged 47 ± 9.7 years, 436 (60%) were males, 364 (55%) were from northern Italy, 166 (45%) from central Italy and 134 (20.18%) from southern Italy and the

islands, 212 (29%) were from the ULASS group, and 523 (71%) from the NoULASS group. There were neither gender (Chi-square test = 0.0011; $P = 0.974$) nor residence differences (Chi-square test = 3.0402; $P = 0.219$) between ULASS and NoULASS groups.

The prevalence of “US devices for anesthesia in the operating room” was 70% [95% CI 66–73%], 36% of the ULASS group participants reported not having US devices versus 28% of NoULASS group ($p = 0.043$). Members of ULASS group reported that they performed upper and lower limb blocks less frequently than members of NoULASS group ($p = 0.0481$; $p = 0.0040$). There was a significant difference between groups with respect to “fascia blocks” but not regarding “cannulation of central veins” ($p = 0.9907$). Participants in the NoULASS group were more skilled in US use than their colleagues in the ULASS group ($p = 0.0000$) (Table 1).

97% of the participants of the ULASS group stated that the course would change their clinical practice and 95% of the members of NoULASS group declared that a specific course on US would be useful in their clinical practice.

The prevalence of “US devices for anesthesia in the operating room” was 74% [95% CI 69–78%] in northern Italy, 61% [95% CI 52–68%] in southern Italy, and 70% [95% CI 63–77%] in central Italy, indicating a significant difference between north and south (data not in table).

Data analysis showed that anesthetists from north Italy performed USG-guided techniques for peripheral blocks of the upper and lower limbs ($p = 0.0080$), fascia blocks, and cannulation of central veins ($p < 0.05$) more frequently than their colleagues from the south of Italy, but not for pain therapy ($p = 0.9140$).

The prevalence of routine use of US for regional anesthesia was: 47% [95% CI 43–51%] in the upper limb, 33% [95% CI 29–37%] in the lower limb, 19% [95% CI 16–22%] in fascia blocks, 82% [95% CI 79–85%] in cannulation of vascular access, and 7% [95% CI 6–10%] in pain therapy procedures.

Multivariate logistic analysis showed that the presence of US devices and high expertise were factors associated with regular use of US for regional anesthesia in upper limb, in lower limb, and in cannulation of vascular access. Residence in the north of Italy was a factor associated with regular use in upper and lower limbs. Expertise was a factor associated with pain therapy (Table 2).

Discussion

Our study examined routine use of ultrasound among Italian anesthetists.

This is the first experience that investigates the ultrasound use in anesthesia, intensive care, and pain therapy, actually in Italy. The prevalence of US devices in Italian anesthesia

and intensive-care units was 70%. The study also revealed a geographical heterogeneity in distribution of ultrasound devices, showing a north–south gradient with a significant difference between the north (74%) and south (61%) of Italy. The different distribution of US machines was associated with a greater ability of northern anesthetists to perform the USG procedures in regional anesthesia and in the cannulation of central veins. No differences between in the north and south of Italy were noted regarding the use of US in pain therapy; these data could be related to the fewer number of specialists in analgesic procedures, especially with ultrasound guidance.

Different results were observed between the ULASS and NoULASS groups: NoULASS anesthetists have a higher level of training than ULASS colleagues and more frequently perform USG regional anesthesia techniques. No differences were reported regarding the cannulation of peripheral veins

The upper limb blocks are those most frequently performed with US guidance, especially in the northern Italy. Younger anesthetists are more skilled in the USG techniques and also perform a greater number of procedures compared to the older colleagues. This could be related to their experience during residency. Older anesthetists are more trained with landmark or neurostimulator guidance; so they experience more difficulties with ultrasound devices.

It is possible to postulate that, for the same reason, younger anesthetists are more skilled for USG lower limb anesthetic block, if compared with older colleagues; they prefer to perform spinal anesthesia. These speculations can be extended to central veins cannulation.

Myo-fascial blocks for postoperative analgesia demonstrate a different trend, maybe, because have of low incidence of complications. These procedures have a good safety and efficacy, but if they not correctly performed, the percentage of failure is very high, as shown by Fusco et al. [6]

The availability of an US machine and the opportunity to receive adequate training, in ultrasound-guided procedures, is the determinant factor influencing the widespread of US in anaesthesiology.

This is a not randomized study and this is one of the most important limits of the research. However, the study population was homogeneous with respect to gender and geographical distribution. The survey represents a valuable tool that allows insight into clinical practice on a rather large part of the population that otherwise would remain hidden [7, 8].

Another drawback of our research is the lack of a comparison between the incidence of complications between the two groups (ULASS and NoULASS). Further effort could be made to design a study highlighting difference in the incidence of complications between the group of less experienced and the one with more experience and more active practice in the ecoguide. Therefore, it would be useful to assess this point,

Table 1 Theoretical practical knowledge of ultrasound by all participants and by groups

Variables	Groups			
	All	ULASS	NoULASS	ULASS vs NoULASS
	<i>n</i> (%) or median (range)	<i>n</i> (%) or median (range)	<i>n</i> (%) or median range	<i>p</i> value**
Echograph dedicated to anesthetists				
Yes	507 (70%)	136 (64%)	371 (72%)	0.043
No	222 (30%)	76 (36%)	146 (28%)	
Ultrasound use in peripheral:				
Upper limb	1 (0–3)	1 (0–3))	2 (0–3)	0.0481
Lower limb	1 (0–3)	1 (0–3)	1 (0–3)	0.0040
Types of peripheral nerve blocks				
Brachial plexus (yes)	407 (55%)	125 (59%)	282 (54%)	0.213
Sciatic (yes)	173 (24%)	58 (27%)	115 (22%)	0.120
Femoral (yes)	237 (32%)	71 (33%)	166 (22%)	0.646
Popliteal sciatic b (yes)	14 (2%)	14 (7%)	0 (0%)	–
Ultrasound use in the fascial blocks	0 (0–3)	0 (0–3)	0 (0–3)	0.0043
Types of nerve block blocks				
Tap-block (yes)	131 (18%)	63 (30%)	68 (13%)	0.000
Paravertebral (yes)	2 (0.27%)	1 (0.47)	1 (0.19%)	0.494
Pecs (yes)	16 (2%)	7 (3.3%)	9 (1.72%)	0.262
Qlb (yes)	2 (0.27)	1 (0.47)	1 (0.19%)	0.494
Fascia iliaca (yes)	9 (1.22)	4 (1.89%)	5 (0.96%)	0.289
Ultrasound use for cannulation of central venous	3 (0–3)	3 (0–3)	3 (0–3)	0.9907
Type of central venous access				
Midline	81 (11%)	21 (10%)	60 (11%)	0.539
Jugular	48 (7%)	48 (23%)	0 (0%)	–
Femoral	222 (30%)	42 (20%)	180 (34%)	0.000
Subclavian	115 (%)	16 (8%)	99 (19%)	0.000
Brachiocephalic	5 (0.68%)	5 (2%)	0 (0%)	–
Not specified access	99 (13%)	42 (20%)	57 (11%)	0.001
Ultrasound use for pain therapy	0 (0–3)	0 (0–3)	0 (0–3)	0.0348
Experience in the use of ultrasound	2 (1–4)	1 (1–4)	2 (1–4)	0.0000
Complications				
Yes	63 (9%)	13 (7%)	50 (10%)	0.129
No	731 (91%)	184 (93%)	435 (90%)	
Type of complication				
Phrenic nerve block	4 (0.54%)	0 (0%)	4 (0.76%)	–
Failure	5 (0.68%)	0 (0%)	5 (0.96%)	–
Pnx	15 (2%)	2 (13%)	13 (2%)	
Axonal damage	1 (0.14%)	1 (047%)	–	–
Vascular puncture	31 (4%)	6 (19%)	25 (5%)	0.233
LAST	3 (0.41%)	3 (1.42%)	0 (0%)	–
Ultrasound use in the operating room for other procedures				
Yes	522 (78%)	39 (20%)	112 (23%)	0.379
No	151 (22%)	154 (80%)	368 (77%)	

*Data are not 735 because of Missing values, **Chi-square test or Fisher's exact test for categorical data, and two-sample Wilcoxon rank-sum (Mann–Whitney) test for rank data

Table 2 Factors associated with regular use of ultrasound for regional anesthesia (adjusted ORs)

	Odds ratio	<i>p</i>	95% CI
Regular use for upper limb			
Dedicated echograph			
No	1		
Yes	5.1	0.000	3.31–7.90
Expertise			
Low	1		
High	4.77	0.000	2.80–8.11
Residence			
South	1		
North	1.88	0.001	1.30–2.73
Age			
≥ 45 years	1		
< 45 years	0.63	0.001	0.43–0.91
Regular use for lower limb			
Dedicated echograph			
Yes	1		
No	7.3	0.000	4.03–13.21
Expertise			
Low	1		
High	6.75	0.000	4.14–11.01
Residence			
South	1		
North	1.38	0.112	0.93–2.08
Age			
≥ 45 years	1		
< 45 years	0.58	0.008	0.38–0.87
Regular use for cannulation of central venous			
Dedicated echograph			
Yes	1		
No	4.25	0.000	2.58–6.70
Expertise			
Low	1		
High	16.18	0.006	2.20–118–79
Age			
≥ 45 years	1		
< 45 years	0.51	0.010	0.31–0.85
Regular use for fascial blocks			
Dedicated echograph			
Yes	1		
No	5.12	0.000	2.43–10.79
Expertise			
Low	1		
High	5.85	0.000	3.54–9.65
Residence			
South	1		
Centre	4.13	0.001	1.76–9.66
North	2.17	0.058	0.97–4.82
Age			
≥ 45 years	1		

Table 2 (continued)

	Odds ratio	<i>p</i>	95% CI
< 45 years	0.65	0.082	0.40–1.06
Gender			
Female	1		
Male	0.70	0.148	0.43–1.13
Regular use for pain therapy			
Expertise			
Low	1		
High	2.91	0.001	1.50–5.61

but it was not considered among the endpoints, when the study was designed, because it is very difficult to obtain from the participants objective data about the iatrogenic complications.

International scientific literature is quite clear about the efficacy of ultrasound-guided loco-regional anesthetic techniques to reduce the risk of complication, such as LAST. Ultrasound guidance is the safe and effective method for peripheral nerve block, as the supraclavicular brachial plexus block. Incidence of complications is less as ultrasound provides real-time visualization of underlying structures and the spread of local anesthetic, as shown by Honnannavar et al. [9]. Finlayson and colleagues demonstrated the efficacy of the anesthetic ultrasound-guided procedures, compared with the fluoroscopy-guided techniques in peripheral blocks [10, 11].

Our study was focused to evaluate the prevalence of ultrasound use among Italian anesthetists, and despite we neglected to assess the incidence of complications of the anesthetic procedures with and without echo-guide, our data respect the suggestions by the international literature. In effect, a review by Lewis et al. [12] underlines that peripheral nerve blocks performed by ultrasound guidance are superior in terms of improved sensory and motor block, reduced need for supplementation and fewer minor complications reported. Unfortunately, nowadays, the scientific literature is unable to determine whether these findings reflect the use of ultrasound both in experienced hands and for less experienced anesthetists in the ecoguide [12] and these speculations are beyond the scope of our research. It could be considered another limit of this study.

However, this is the first cross-sectional study that actually shown the state of art, regarding the use, the distribution, and the knowledge of ultrasound in Italy.

Conclusion

We believe that this study could increase and make uniform the widespread of ultrasonography in anesthesia, intensive care, and pain therapy in all the Italian regions, especially

in south of Italy. It is desirable that a better distribution of the instruments on the territory could guarantee uniform and standard level of care for all the patients [1–3].

We aim to further develop this study, especially to evaluate if ultrasonography could decrease the medical disputes related with iatrogenic complications.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Human and animal rights This article does not contain any studies with animals performed by any of the authors.

Informed consent Informed consent was obtained from all the individual participants included in the study.

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