

Worldwide sedation strategies for atrial fibrillation ablation: current status and evolution over the last decade

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Catheter ablation for atrial fibrillation (AF) has become one of the most common procedures in the electrophysiology lab with rapidly increasing volumes. Peri-procedural anaesthesia for AF ablation varies between centres, from general anaesthesia to deep or conscious sedation. The aim of this survey was to assess current sedation practices for AF ablation worldwide and its evolution over the last decade. Centres regularly performing AF ablation responded to an online survey. A total of 297 centres participated in the survey. Overall, the median (interquartile range) number of AF ablation procedures increased from 91 (43–200) to 200 (74–350) per year ($P < 0.001$) between 2010 and 2019. The proportion of cryoablation also increased from 17.0% to 33.2% ($P < 0.001$). In 2019, the most used sedation technique was general anaesthesia (40.5%), followed by conscious sedation (32.0%) and deep sedation (27.5%). Between 2010 and 2019, the proportion of procedures performed under general anaesthesia (+4.4%; $P = 0.02$) and deep sedation (+4.8%; $P < 0.01$) increased, whereas the use of conscious sedation decreased (–9.2%; $P < 0.001$). The most commonly used hypnotic drugs were propofol and midazolam, whereas the most commonly used opioid drugs were remifentanyl and fentanyl. This worldwide survey shows that the number of AF ablation procedures has more than doubled over the last decade and general anaesthesia remains most commonly used. Studies comparing outcomes between different sedation strategies are needed to guide optimal decision-making.

Keywords Atrial fibrillation • Sedation • General anaesthesia • Deep sedation • Conscious sedation • Cryoablation • EHRA survey

Introduction

Catheter ablation has emerged as a cornerstone of modern therapy for atrial fibrillation (AF)¹ and the number of such procedures is increasing rapidly.^{2,3}

The best modality of sedation for AF ablation is a matter of debate and guidelines offer no advice on this topic.^{1,4} While general

anaesthesia represents the standard in some centres,⁵ procedures may also be carried out under deep or conscious sedation, especially when general anaesthesia is not readily available.⁶ General anaesthesia has several potential benefits such as improved patient comfort, and lack of patient movement allowing better catheter stability and lesion formation.⁷ On the other hand, it could be argued that general anaesthesia is associated with increase in overall procedure time and

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What's new?

- Between 2010 and 2019, the average number of atrial fibrillation ablation procedures per centre has more than doubled worldwide.
- The use of cryoballoon increased from 17% to 33%.
- The sedation technique most used both in 2010 and 2019 was general anaesthesia, followed by conscious sedation and deep sedation.
- The proportion of procedures performed under general anaesthesia and deep sedation increased significantly whereas procedures under conscious sedation decreased.

potential complications such as intubation-related injuries, aspiration, or anaphylaxis with neuromuscular blocking drugs. Finally, legislation concerning anaesthesia and the use of sedatives/anaesthetic drugs differs across countries and the sedation strategy often depends on resource availability and logistics of the hospital.

The aim of this survey was to study the current sedation practices for AF catheter ablation worldwide and its evolution over the last 10 years. Understanding the present scenario would help guide future comparative studies to optimize outcomes for patients undergoing AF ablation.

Methods

Study settings

A dedicated online questionnaire was prepared and administered via SurveyMonkey. The participation in this survey was offered to the European Heart Rhythm Association (EHRA) scientific network centres, Latin American Heart Rhythm Society (LAHRS) centres, and Asia Pacific Heart Rhythm Society (APHRS) centres and on direct email invitations. Responses were collected from the 2 February 2021 to the 12 March 2021. This study complied with the European General Data Protection Regulation law. All centres taking the survey agreed to participate to the study.

Data collected

The questionnaire collected information about the type of centre (academic vs. private), country of location, the number of AF catheter ablation procedures in 2010 and 2019 with the proportion of general anaesthesia, deep sedation, and conscious sedation used, details on staff requirements to perform deep sedation and drugs used for the different sedation approaches (Supplementary material online, Appendix S1). We chose to collect the 2019 and not the 2020 data because many electrophysiology centres were impacted by the COVID-19 pandemic, consequently reducing the number of AF ablation procedures in 2020.⁸ We compared it to 2010 data in order to have an overview of the last 10 years and because AF ablation procedures started to become more and more available at that time.

The sedation techniques were defined as follows:

General anaesthesia: complete loss of consciousness during which the patient is not arousable even by painful stimulation and requiring endotracheal intubation and positive pressure ventilation.

Deep sedation: patient cannot be easily aroused but responds purposefully following repeated or painful stimulation. May require assistance in maintaining a patent airway but not needing endotracheal intubation.

Conscious sedation: patient drowsy but responds purposefully to verbal commands. No interventions are required to maintain a patent airway.⁹

Statistical analysis

Categorical data were reported as numbers and percentages. Continuous data were reported as mean \pm standard deviation or median and interquartile range for normally and non-normally distributed data, respectively. Comparisons used the χ^2 or Fisher's exact test for categorical variables and Student's *t*-test or Mann–Whitney–Wilcoxon test, when appropriate, for continuous variables. Centres with missing data were excluded. Low- and high-volume centres were defined for the purposes of this survey as those performing \leq or $>$ the median number of procedures (overall) in 2010 ($n = 91$). A two-tailed *P*-value < 0.05 was considered statistically significant. All data were analysed using SPSS v 20.0 (SPSS Inc., Chicago, IL, USA) and R software, version 3.6.3 (R Project for Statistical Computing). The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Participating centres characteristics and procedure number evolution

A total of 297 centres participated in the study [Europe: 162 (54.5%), Asia: 37 (12.5%), Middle-East: 34 (11.4%), South America: 28 (9.4%), North America: 20 (6.7%), Oceania: 11 (3.7%), and Africa: 5 (1.7%)]. One hundred and eighty (60.6%) were university hospitals, 54 (18.2%) were private hospitals, 43 (14.5%) were specialized public hospitals, and 19 (6.4%) were district/community hospitals.

Between 2010 and 2019, the number of AF ablation procedures per centre increased significantly from 91 (43–200) (234 centres) to 200 (74–350) procedures (297 centres) ($P < 0.001$) (Figure 1). Over the same time period, the proportion of cryoablation increased from 17.0% in 2010 to 33.2% in 2019 ($P < 0.001$). In 2010, the proportion of cryoablation was 13.6% in low-volume centres and 20.4% in high-volume centres ($P < 0.001$), whereas in 2019, this proportion was 35.1% in low-volume centres and 32.9% in high-volume centres ($P = 0.82$). In the same way, in 2010, the proportion of cryoablation was 20.1% in university hospitals and 11.1% in non-university hospitals ($P < 0.01$), whereas in 2019 this proportion was 39.2% in university hospitals and 23.9% in non-university hospitals ($P < 0.001$).

Sedation strategy

In 2019, general anaesthesia was the most utilized sedation technique (40.5%) followed by conscious sedation (32.0%) and deep sedation (27.5%) respectively. The most commonly used technique in each country is represented in Figure 2.

Between 2010 and 2019, the proportion of procedures performed under general anaesthesia (36.1–40.5%; $P = 0.02$) and deep sedation (22.7–27.5%; $P < 0.01$) increased, whereas the use of conscious sedation decreased (41.2–32.0%; $P < 0.001$) (Figure 3A). When comparing sedation strategy according to the volume of procedures performed, low-volume centres increased the use of deep sedation and reduced conscious sedation between 2010 and 2019. High-volume centres

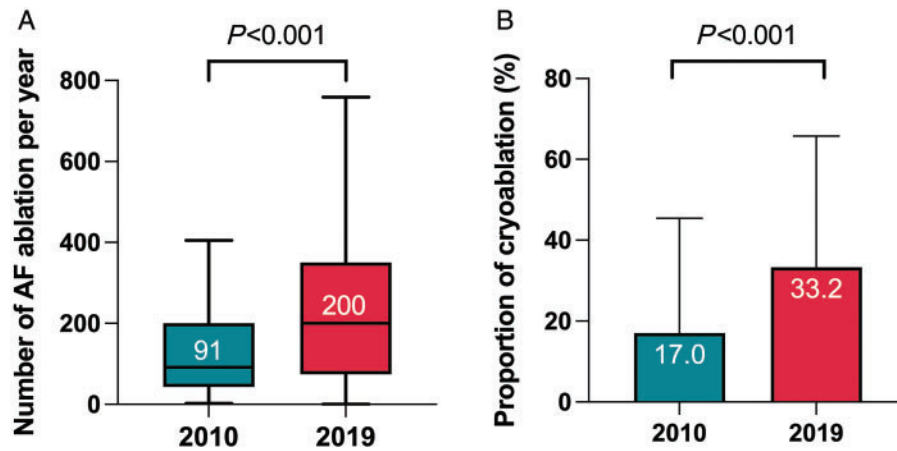


Figure 1 Number of AF ablations per year (A) and proportion of cryoablation in 2010 and 2019 (B). AF, atrial fibrillation.

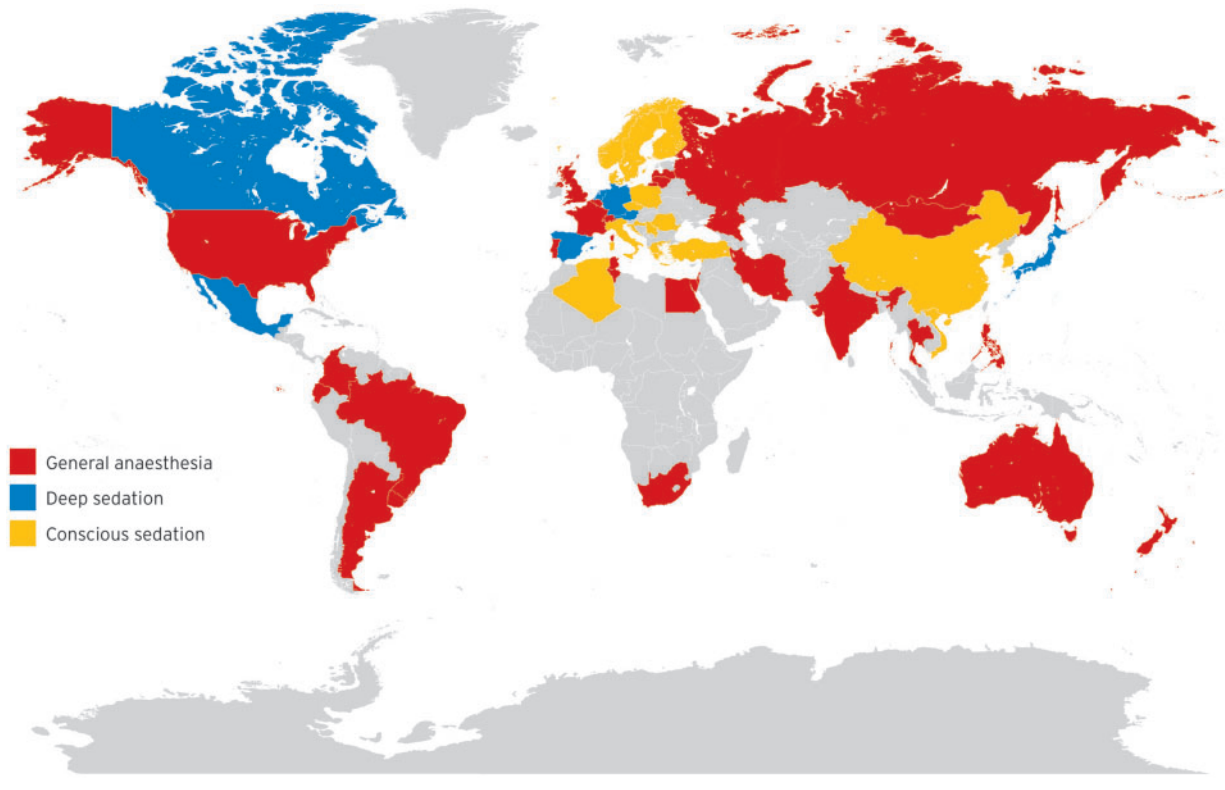


Figure 2 World map showing the most used sedation technique in each country in 2019.

increased the proportion of general anaesthesia while decreasing conscious sedation (Figure 3B and C). The sedation strategy in 2019 according to continents is in [Supplementary material](#) online, *Table S1*.

The most frequently used hypnotic drugs were propofol and midazolam irrespective of the sedation technique used

(propofol: 64.0%, 57.2%, and 19.2%; midazolam: 35.7%, 48.1%, 58.6% for general anaesthesia, deep sedation, and conscious sedation, respectively). The opioid drug most commonly used was remifentanyl or fentanyl (48.8%, 49.5%, and 49.5% for general anaesthesia, deep sedation, and conscious sedation respectively)

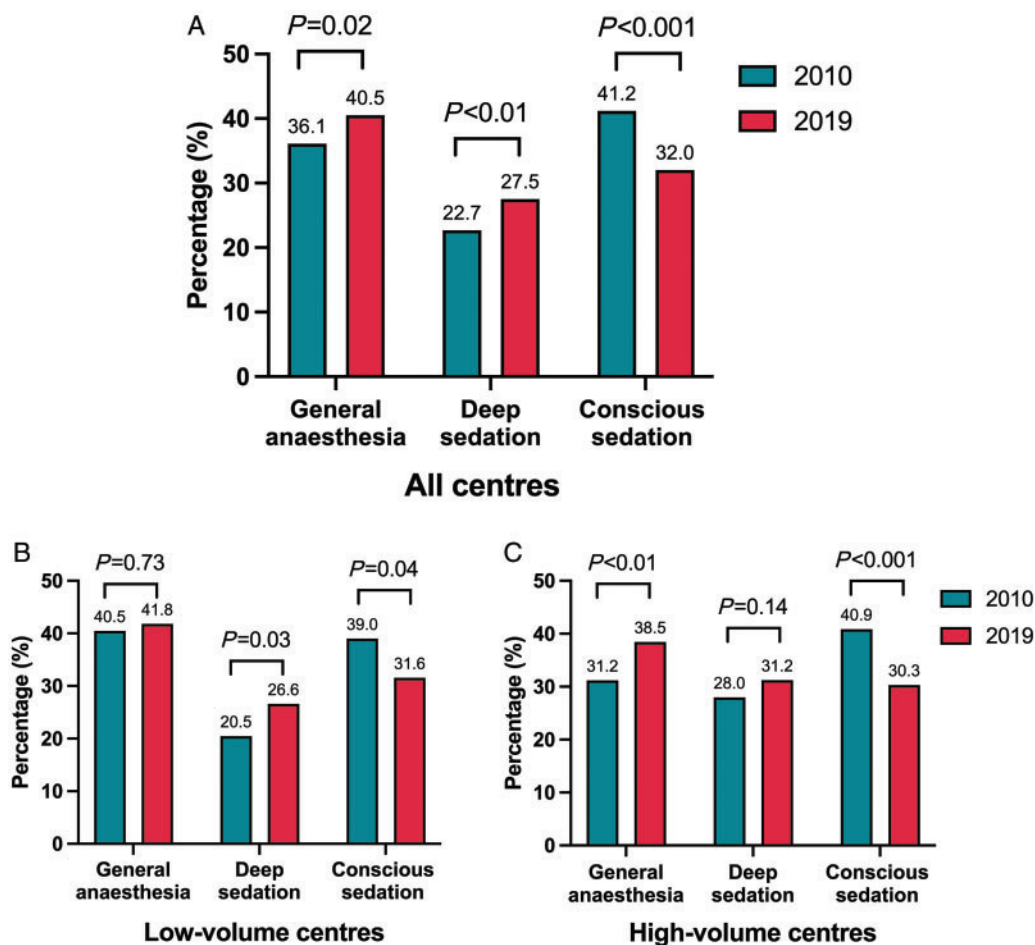


Figure 3 Proportion of procedures using general anaesthesia, deep sedation and conscious sedation in 2010 and 2019 in all centres (A), in low-volume (B) and high-volume centres (C).

(Figure 4). Finally, 79 (26.6%) centres used a different sedation protocol for radiofrequency and cryoablation, 175 (58.8%) centres used the same protocol, and 43 (14.6%) centres used only one of these two techniques (either radiofrequency or cryoballoon).

Legal requirements for the performance of deep sedation

Concerning the legal requirements for deep sedation to be performed, 177 centres (59.6%) stated that the presence of an anaesthesiologist was necessary, 50 (16.8%) centres stated that a specially trained nurse could perform deep sedation without the presence of an anaesthesiologist, 35 centres (11.8%) responded that the presence of a second physician in the electrophysiology (EP) lab allowed them to perform deep sedation without an anaesthesiologist, while the remaining 35 centres (11.8%) answered that the electrophysiologist could perform deep sedation by himself without an anaesthesiologist, special nurse or second physician in the EP lab.

Discussion

The results of this worldwide survey show that the number of AF ablations has more than doubled in the past decade with a significant increase in the proportion of cryoablation. While general anaesthesia was the sedation technique most used in 2019, it was performed in less than 50% of the patients undergoing AF ablation. On the other hand, deep sedation was the technique least utilized in 2019 but had increased the most from 2010 to 2019. Finally, the legislation regarding sedation seems to be variable across the countries.

Increase in the number of AF ablation

The significant increase in the number of AF ablation procedures between 2010 and 2019 seen in our survey is in line with the literature as Holmqvist *et al.*¹⁰ found an increase of 430% between 2006 and 2015 in Sweden and Gandjbakhch *et al.*² reported a 36-fold rise in left atrial ablation procedures in France. AF ablation has expanded majorly in the past few years with increasing worldwide experience and concurrently improved safety.¹¹ At the same time, cryoablation has

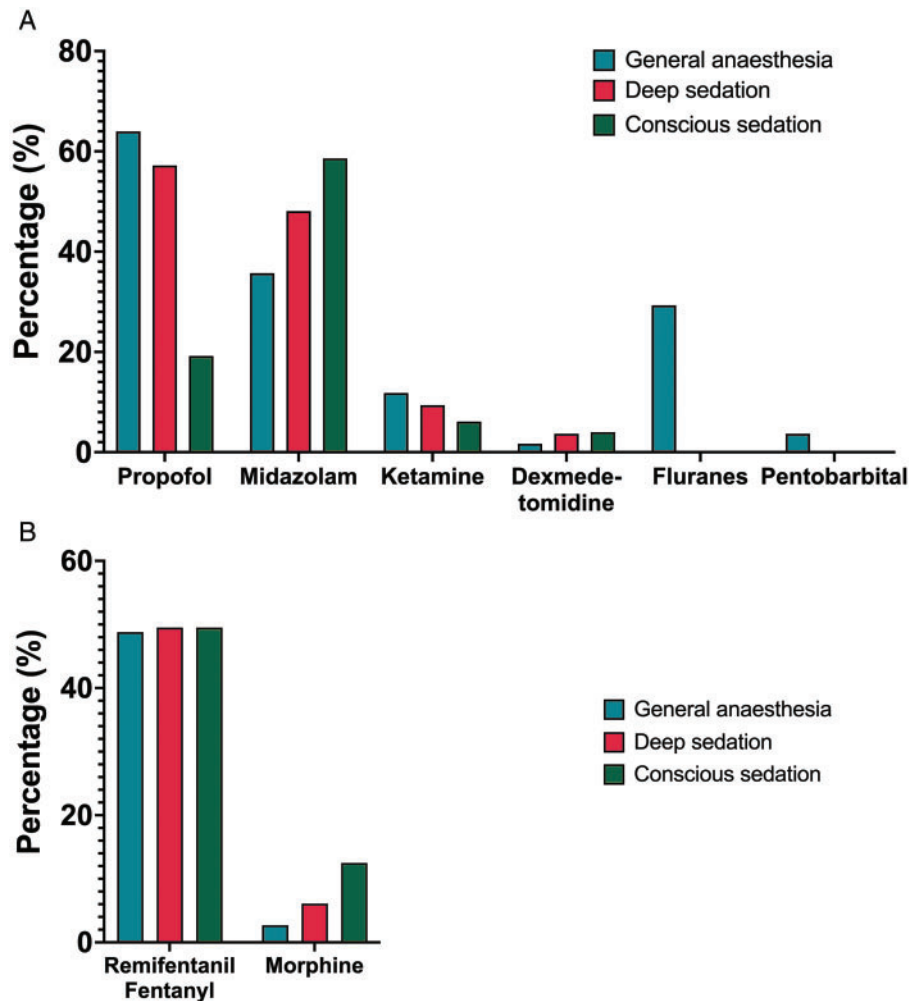


Figure 4 Hypnotic drugs (A) and opioid drugs (B) use in 2019.

clearly gained ground in the last decade with comparable results and potentially more simplified procedure.^{12,13} This technique which is more reproducible seems to be less painful compared to radiofrequency ablation and explains why one centre out of four used a different sedation protocol for radiofrequency and cryoablation.¹⁴

Sedation strategy during AF ablation

In addition to patient comfort, deep sedation and general anaesthesia allow for better stability and lesion formation as the patient is motionless. The current survey clearly showed an increase in general anaesthesia and deep sedation during the last decade (+4.4% and +4.8% respectively), whereas conscious sedation conversely declined (−9.2%). This might reflect the fact that conscious sedation is considered less appropriate for AF ablation especially when radiofrequency is used because of the pain provoked by radiofrequency and because of distortions of the left atrium reconstruction by the electroanatomical mapping system during spontaneous ventilation. Nevertheless, in 2019, 32% of the procedures were performed using

conscious sedation. This could be due to a lack of resources, including access to a dedicated cardiac anaesthetist. As AF ablation proves to be a very effective treatment, the number of procedures will probably continue to grow in the next few years. Then, appropriate trials comparing the three anaesthetic techniques should be carried out to ensure the best outcomes for patients.

Finally, propofol remained the most commonly chosen hypnotic drug for both general anaesthesia and deep sedation. Despite the risk of respiratory depression, it is still used in nearly 20% of conscious sedation procedures given the excellent sedation it ensures and it is also implemented in standard protocols for AF ablation in some centres.¹⁵

Regulation

In many countries such as France, Spain, or Italy, it is not legally possible to perform deep sedation without the presence of an anaesthesiologist inside the operation room. Whereas in other countries, such as Germany, deep sedation with propofol has been implemented in

Table 1 Advantages and disadvantages of using general anaesthesia, deep sedation, and conscious sedation for AF ablation.

	General anaesthesia	Deep sedation	Conscious sedation
Advantages	Absence of pain during the procedure	Absence/less pain during the procedure	
Drawback	Assisted ventilation allows better mapping Availability of anaesthesiologist, greater resource consumption Intubation-related injuries Increases procedure duration and turnaround time Anaphylaxis with neuromuscular blocking drugs		Pain and discomfort during ablation

standard protocols for AF ablation without anaesthetists since several years.^{15,16} In our survey, nearly 60% of the centres reported that the presence of an anaesthesiologist was required to perform deep sedation. Nevertheless, this technique of sedation might be a reasonable compromise to improve patient comfort when general anaesthesia resources are lacking and could be more widely implemented if propofol was allowed to be used in the absence of an anaesthesiologist in every country.

Weighing the risks and benefits

Deep sedation and general anaesthesia reduce or abolish patient's pain and enhance both patient and electrophysiologist comfort during the procedure. Pros and cons are summarized in Table 1. A single-centre study performed on persistent AF ablation reported that general anaesthesia was more cost-effective compared to conscious sedation.¹⁷ Nevertheless, a recent study reported the contrary.¹⁸ In the context of general anaesthesia availability and legislation forbidding cardiologists to perform deep sedation, alternative techniques, such as hypnosis or virtual reality, are being developed.^{19–21} Nevertheless, the extent to which the development of those alternative techniques will change future practices and bring complementary solutions to address the lack of anaesthesia availability in some centres or decrease general anaesthesia-related complications is still unknown.

Limitations

The survey was voluntary which might have resulted in a selection bias with only more academically inclined centres responding. However, we had overall a good number of participating centres, representing high- and also low-volume centres with a fair number of private hospitals too, thereby reflecting a good mix. The data were self-reported with no independent confirmation; however it is likely adequate to broadly indicate the practice patterns and trends over the past decade.

Conclusion

This worldwide survey revealed that the number of AF ablation procedures more than doubled over the last decade, with an increasing proportion of cryoablation. General anaesthesia and deep sedation

were the techniques that increased in proportion over time, whereas conscious sedation declined. Stronger evidence regarding the different sedation strategies, their respective safety profiles and cost-effectiveness is required to better guide decision-making and improve patient outcomes in AF ablation.

Supplementary material

Supplementary material is available at *Europace* online.

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Data availability

Data will be shared on request to the corresponding author.

Conflict of interest: none declared.

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