

Vascular and Interventional Radiology Training; International Perspectives and Challenges

Gregory C. Makris^{1,2}  · Victoria Burrows³ · Fiona Lyall⁴ · Andrew Moore⁵ · Mohamad S. Hamady⁶

Received: 24 June 2020 / Accepted: 13 October 2020 / Published online: 10 November 2020

© Springer Science+Business Media, LLC, part of Springer Nature and the Cardiovascular and Interventional Radiological Society of Europe (CIRSE) 2020

Abstract

Purpose Assess international interventional radiology (IR) training standards and trainee satisfaction to identify challenges and drive positive change.

Materials and Methods An anonymous survey was created using Survey Monkey and distributed as a single-use web link via eight IR national and international societies around the world. It consisted of two parts: the first assessed the general exposure of radiology trainees to IR and whether this influenced their decision to pursue a career in IR; the second focussed on satisfaction and quality of training by those who are in training or have recently completed an IR training program.

Results There were 496 participants of which 274 were eligible to complete part one of the survey and 222 were eligible to complete the whole survey. UK and Europe contributed 52% of the responses. The USA and Middle East contributed 23%, and the rest of the world 9%. Over half of responders expressed that exposure early in their career was the main inspiration to pursue a career in IR. Overall satisfaction with training was high across all regions; however, satisfaction regarding vascular training varied. The negative impact of competition from other specialities ranged from 9% (USA) to 61% (UK). Great variability was reported regarding the amount of time spent dedicated to IR and IR on call.

Conclusion Despite significant progress in creating structured and comprehensive IR training, there is still room for improvement. Early promotion of IR is essential for ongoing high-quality recruitment. Monitoring and standardization of the training environment at a national and international level are necessary to equip IR trainees and to consolidate IR's speciality status in the medical field.

Electronic supplementary material The online version of this article (<https://doi.org/10.1007/s00270-020-02688-y>) contains supplementary material, which is available to authorized users.

✉ Gregory C. Makris
G.makris09@doctors.org.uk

¹ Department of Vascular and Interventional Radiology, Guy's and St Thomas' Hospital, NHS Foundation Trust, London, UK

² Alfa Institute of Biomedical Sciences, Neapoleos 9, Marousi, Athens, Greece

³ Interventional Radiology Department, Sheffield Vascular Institute, Sheffield Teaching Hospitals, Sheffield, UK

⁴ Imaging Department, Derriford Hospital, University Hospitals Plymouth NHS Trust, Plymouth, UK

⁵ Radiology Department, Integris Baptist Medical Center, Oklahoma City, USA

⁶ Vascular and Interventional Radiology Department, Imperial College Healthcare NHS Trust, London, UK

Keywords Interventional radiology · Training · Residency

Introduction

The recent growth of interventional radiology (IR) has made it possible to mould training to the current needs of the medical world [1, 2]. As these needs differ considerably from country to country, training schemes need to reflect

this diversity. It is also important to incorporate the necessary clinical skills to ensure that interventional radiologists are able to undertake primary clinical responsibility for their patients [3]. Work by interventional radiology societies across the globe is on-going to provide curricula and structure to training programmes with measurable outcomes and methods of assessment [4–6]. Studies have also been performed which examine why recruitment in some parts of the world is poor and identify strategies for improvement [7, 8].

Understanding international and local IR training standards across Europe and across the world is very important in order to identify challenges, drive positive change and address issues which impede the evolution of IR training. This is a dynamic process that requires constant monitoring, communication and adjustment at a national and international level. A recent pan-European report focusing on IR training in Europe [9] showed that indeed there is progress in terms of acquiring subspecialty status for IR in European countries; however, the duration, structure and certification of IR training remain remarkably heterogeneous across the continent. In addition, issues such as entry pathways to the specialty and opportunities for clinical training remain largely unresolved, with significant variations among European countries even with regards to core competencies of the IR curriculum such as endovascular training [10].

The purpose of this survey was to gather both objective and subjective data from around the globe with regard to the current state of IR training in an attempt to encapsulate an overview which can form a basis for improvement moving forward.

Materials and Methods

Design and Distribution of the Survey

This was a cross-sectional survey designed by the XXXXXXXX Society of Interventional Radiology trainee committee using the Survey Monkey platform (www.surveymonkey.co.uk). It was distributed electronically to eight IR societies around the world and subsequently to their junior membership (List of involved societies in Appendix 2). A single-use anonymous web link was used to ensure only one response could be submitted by any individual. The survey was available from November 2019 until March 2020. A filtering question was used to ensure only radiology trainees and junior consultants could respond. A further filtering question allowed junior trainees and non-IR senior trainees to complete part one and comment about exposure to IR in early training and the impact this may have/have had on career choice. It also allowed

senior trainees/junior consultants (who were completing/had completed dedicated IR training) to continue to complete the full, detailed survey, which focussed on the perceived quality of training. Forty-eight questions were included covering various aspects including demographics, exposure to techniques, competition from other specialties and overall satisfaction (Appendix 1).

Inclusion and Exclusion Criteria

To be eligible to participate in the survey, the following had to apply:

- Be a radiology trainee (eligible to participate in part one of the survey)
- Be an interventional radiology trainee (eligible to participate in both parts of the survey)
- Be a junior IR consultant/attending within 2 years of completing dedicated IR training (eligible to participate in both parts of the survey).

Statistical Analysis

The analysis was performed using SPSS software. Data from the entire cohort were analysed with subgroup analysis and comparisons performed between participants from UK, USA, EU and Middle East. These regions were selected for subgroup analysis because they had at least 50 participants in the survey.

Results

A total of 496 radiologists took part in our survey. Of these, 274 were junior/non-IR trainees (third year of training or less or in non-IR training pathway) and thus were only eligible to participate in the first part of the survey. Two hundred and twenty-two participants were eligible to complete the full survey. (Flow chart-Figure 1) The survey was circulated by multiple societies, and it was not possible to calculate the exact number of people who received an invitation. It was therefore not possible to calculate a completion rate. The core characteristics of the participants can be found in Tables 1 and 2.

Exposure to IR During the First Years of Training (Figure 2)

There is overall agreement that early exposure to IR training has a positive impact on career choice and professional orientation. More than 50% of the participants mentioned that exposure during core radiology training was the main inspiration to become an IR and this was

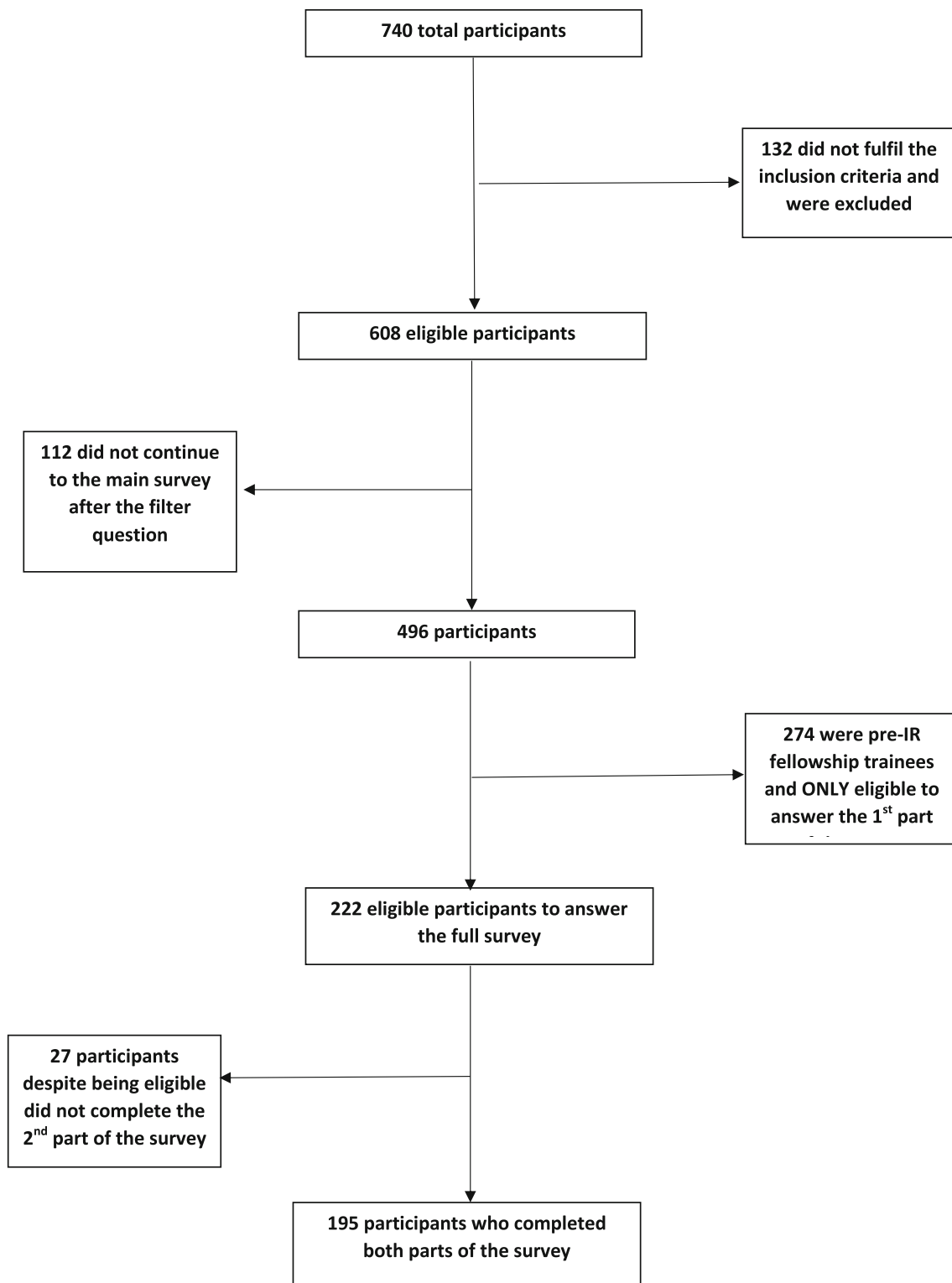


Figure 1 Flow chart of selection of the survey participants'

consistent in the UK, USA, EU and Middle East. Stimulation during the years of medical school appeared to be less relevant since only 10% in the UK, 12% in the USA, 20% and 25% in Europe and Middle East, respectively,

thought they had enough exposure to IR during the undergrad years to inspire them to pursue a career in IR.

Regarding early exposure to IR, it appeared that the USA was leading the way with 55% of the participants

Table 1 Demographics of participants in the main cohort of the survey ($N = 496$)

Characteristics								
Gender	Male	Female	Prefer not to say					
	67%	32%	0.6%					
Additional Qualifications	PhD/ DPhil	EBIR	MSc	MBA				
	4.8%	3.4%	13%	1.6%				
Year of training	1-3rd year	4-5th in DR	4-6th in IR	Consultant*	Other			
	36.6%	15.32%	33.87%	10.89%	3.23%			
Location of training in IR	UK	EU	USA	Middle East	Asia/ Australia	Canada	South America	Not stated
	28.23%	23.79%	11.69%	11.29%	5.45%	2.42%	1.81%	13%
Membership to IR Societies*	BSIR	CIRSE	SIR	PAIRS	CAIRS	IRSA	Not a member	Other
	17.58%	45.66%	16.77%	7.07%	2.02%	2.83%	28.48%	11.52%

*Membership to more than one society was possible

Table 2 Participant characteristics for IR dedicated cohort. ($N = 195$)

Characteristics					
Current work commitment	Full time	Less than full time ~ 80%	Less than Full time ~ 60%	Less than full time—Other	
	83%	6.67%	5.64%	4.62%	
Dedicated IR sessions/week*	0–4	5–8	9–10		
	27.8	48.93%	23.08		
DR sessions/week	1–3	4–6	6 +	Other	
	51.28%	22.05%	13.33%	13.33%	
IR oncall start year	4th year of training	5th year of training	Year 6th of training	After training	No specific arrangement/Don't know
	13.33%	18.97%	21.03%	22.05%	24.61
Case logbook used	Excel spread sheet	Specific app/website	Other		
	71.28%	12.31%	16.41		
Do you intend to sit EBIR exam	Yes	No	Not sure		
	56.63%	15.06%	24.10%		
Intentions after completing training	Apply for a consultant job immediately	Apply for IR fellowship in the same country	Apply for IR fellowship in another country	Don't know	Other
	50.6%	8.43%	26.51%	7.83%	6.63%

reporting that this took place before they actually started their radiology training (UK 35%, EU 19% and ME 16%) and with 86% of the American trainees reporting that they spent more than 4 weeks in IR during their first year in radiology. This was quite different to the experience of European or UK trainees who seem to spend less time in IR during their first year with only 51% and 42%, respectively, reporting that they spent more than a month in IR during year 1 of radiology training.

Overall Satisfaction with IR Training (Figure 3)

The overall satisfaction regarding IR training was high with most of the participants rating it as satisfactory or very satisfactory with only small changes needed (Figure 3A). The majority of trainees would also recommend IR as a specialty to a junior colleague (Figure 3B). Regarding a well-balanced work–life, 64% of UK respondents reported being happy on a weekly basis or at least most of the time. The EU and Middle East felt less satisfied in this area with

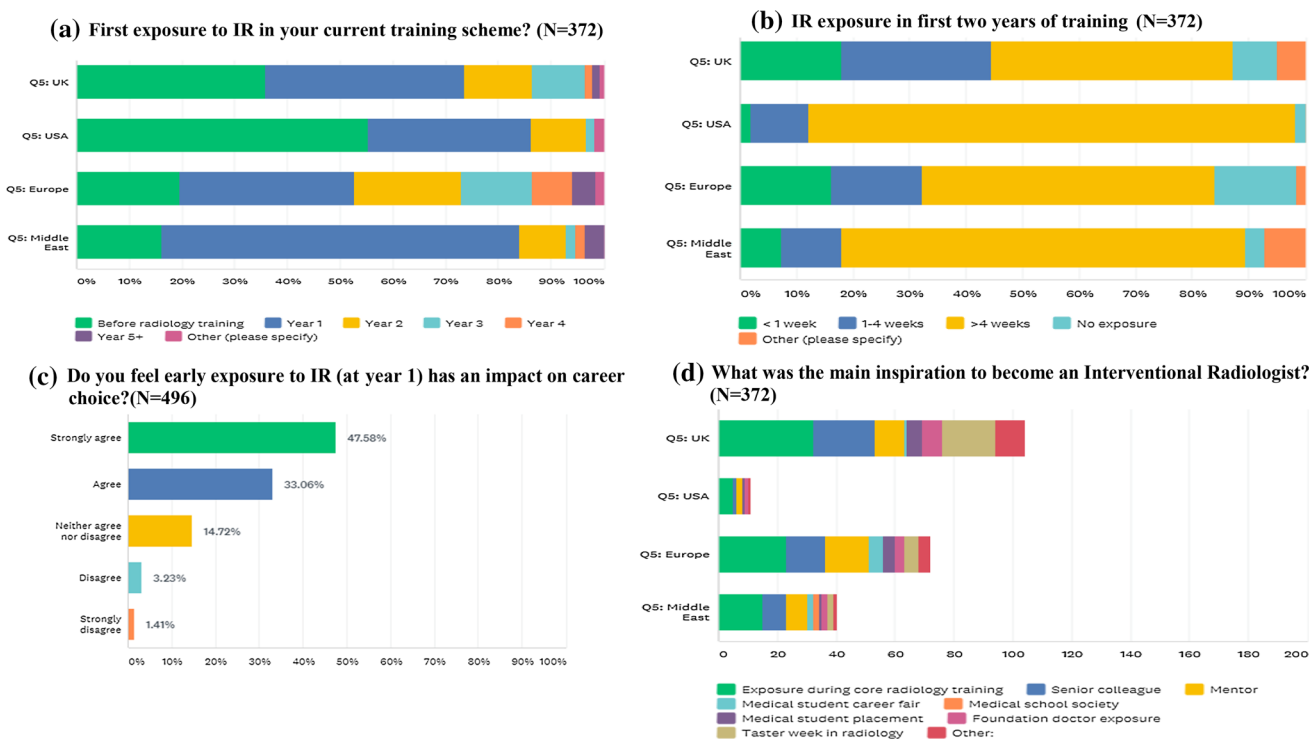


Figure 2 Exposure to IR during the first years of training; trends and insights A First exposure to IR in your current training scheme? (N = 372) B IR exposure in first two years of training (N = 372) C Do

you feel early exposure to IR (at year 1) has an impact on career choice?(N = 496 D What was the main inspiration to become an Interventional Radiologist? (N = 372)

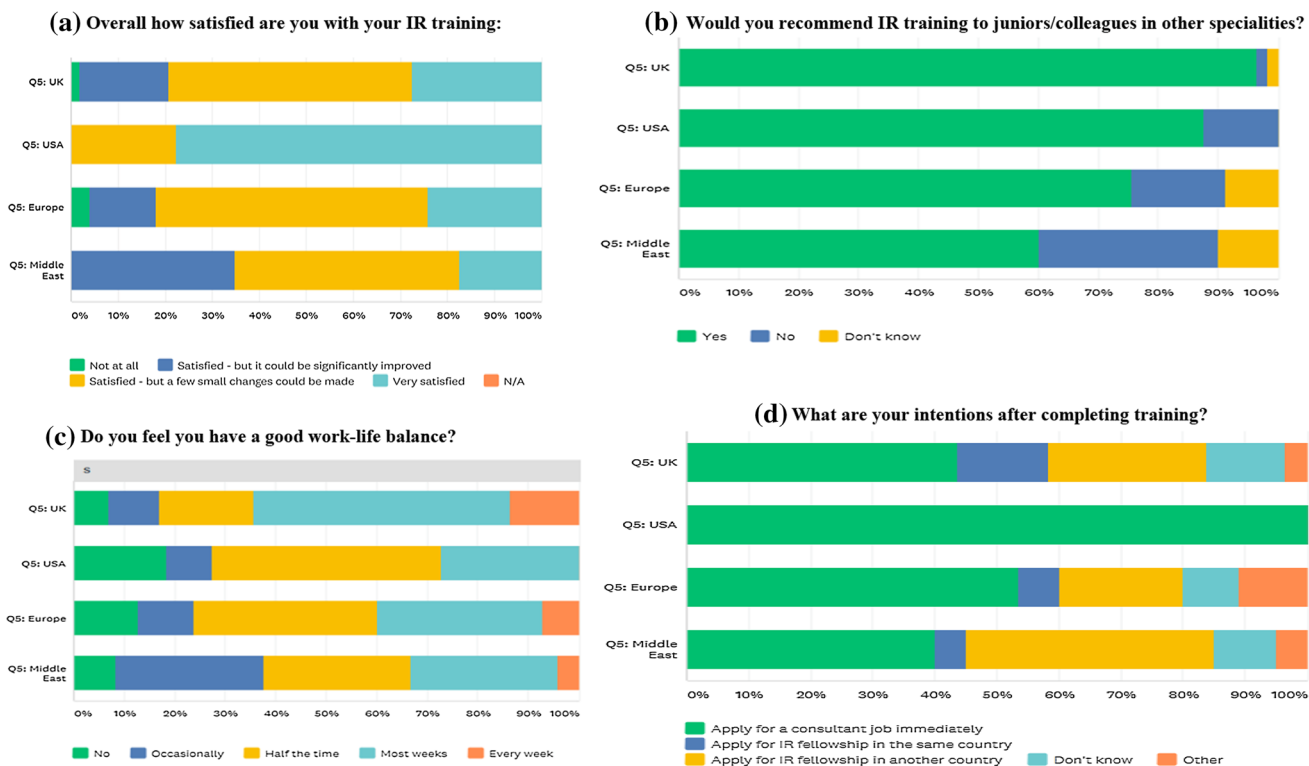


Figure 3 Overall satisfaction questions. A Overall how satisfied are you with your IR training: B Would you recommend IR training to juniors/colleagues in other specialities? C Do you feel you have a good work-life balance? D What are your intentions after completing training?

39% and 33%, respectively, and only 27% of the IR trainees from the USA agreed with the above statement (Figure 3C). Finally, it appeared that most trainees were happy to apply for a consultant/attending post directly after training (Figure 3D), with the Middle Eastern (45%) and UK (40%) trainees, however, being more likely to pursue a post-training fellowship prior to consultancy.

Collaboration with Other Specialties and the Role of Clinical Training (Figure 4)

When participants were asked if trainees from other specialties attend their IR cases for teaching, a significant proportion, ranging from 25% (Middle East) to 65% (UK), said that this was true and mostly these trainees were supervised by IR consultants (Figure 4A). Figure 4B shows that a substantial proportion of IR trainees ranging from 9% (USA) to 61% (UK) felt that the presence of other specialty trainees affected their training in a negative way, and the majority (Figure 4C) thought that they did not receive reciprocal training from other specialties (54–87%).

Another set of questions in our survey addressed the issue of clinical skills training and despite the fact that 86% of the participants thought that more clinical training would be beneficial for their IR training, 43% of them spent no or

very little time in wards or day-case units and 42% of them had no access to outpatient clinic training (Figure 4D).

Satisfaction Regarding Specific Aspects of IR Training—Vascular and Non-Vascular (Figure 5)

Regarding endovascular training to treat peripheral arterial disease (PAD), 40% stated that they felt the training they had received was enough to treat complex PAD with the highest rates of satisfaction observed in the UK (65%) and the lowest in USA and Middle East with 22% and 13%, respectively (Figure 5A). Regarding aortic work, 16% of the participants felt that their training had prepared them for complex EVAR/TEVAR work (Figure 5B) again with the highest rates in the UK (29%).

For non-vascular procedures such as urology and hepatobiliary work, more than 50% of the participants felt that their training prepared them for complex work with over 70% being prepared for standard non-complex cases (Figure 5C, 6C). The highest satisfaction rate in this category of procedures was in the USA where more than 80% of the IR physicians felt they had been trained sufficiently to deal with even the most complex cases. Finally, regarding interventional oncology, 51% of physicians felt their training was sufficient for complex cases, with this percentage dropping to 36% when specifically referring to

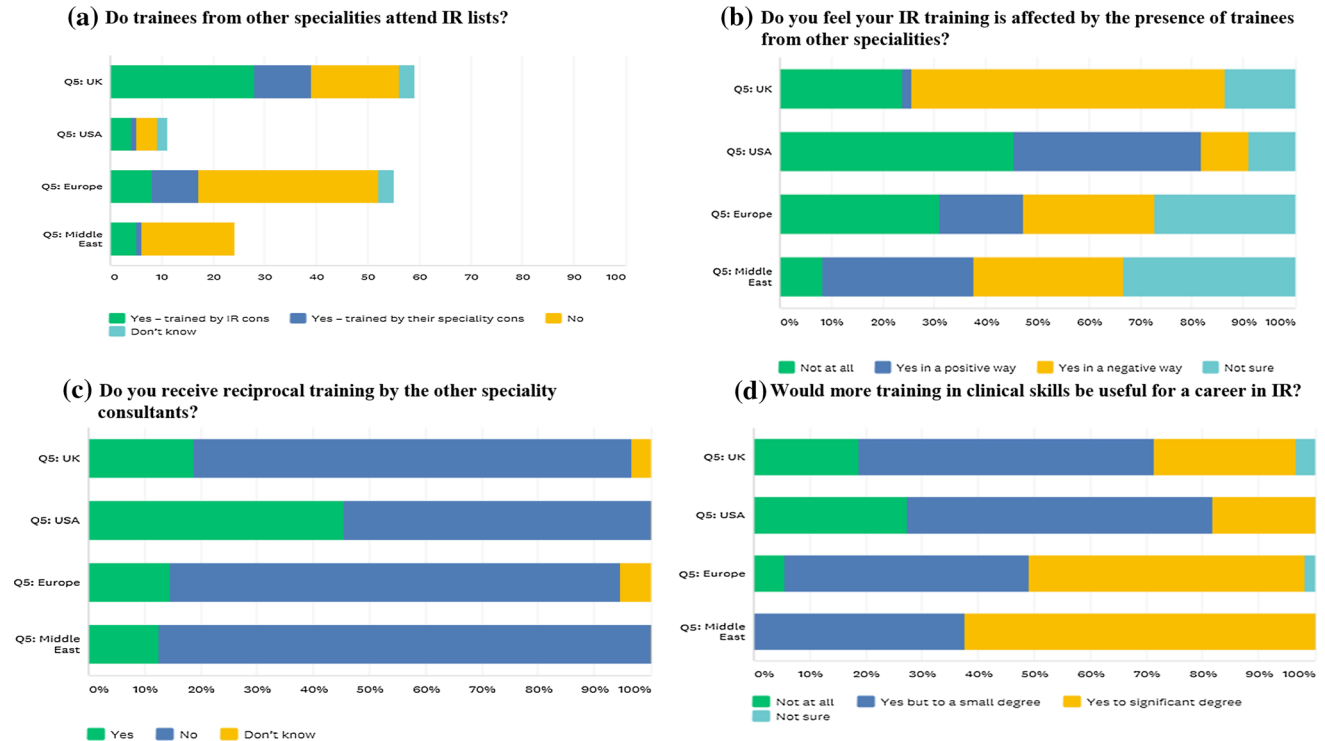


Figure 4 Insights regarding competition with other specialties A Do trainees from other specialties attend IR lists? B Do you feel your IR training is affected by the presence of trainees from other specialties?

C Do you receive reciprocal training by the other speciality consultants? D Would more training in clinical skills be useful for a career in IR?

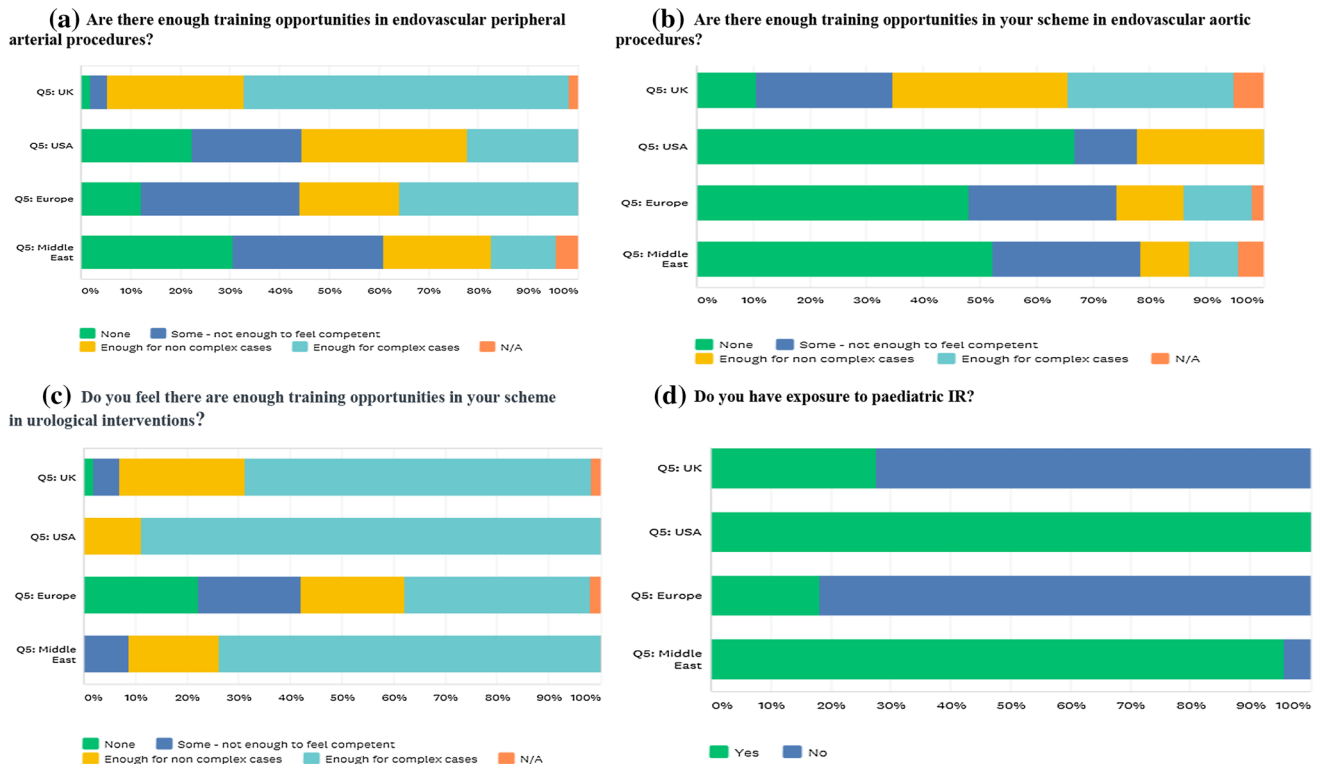


Figure 5 Satisfaction regarding various aspects of IR training A Are there enough training opportunities in endovascular peripheral arterial procedures? B Are there enough training opportunities in your

scheme in endovascular aortic procedures? C Do you feel there are enough training opportunities in your scheme in urological interventions? D Do you have exposure to paediatric IR?

CT-guided ablation training (Figure 6A–B). USA-based IR physicians had the highest levels of confidence regarding their interventional oncology and ablation skills (100% and 66%, respectively) with the lowest levels of confidence in the UK (37% and 22%, respectively).

Finally, 73% of the participants reported that there are procedures that they would like to get more exposure to but are not accessible (Figure 6D) in their institutions with 57% reporting no exposure to paediatric IR procedures, with the worst rates of reported exposure being in the UK and Europe (Figure 5D). Interestingly, 64% of the participants were very or extremely interested in receiving more training in mechanical thrombectomy for stroke patients. Staying competent in a broad spectrum of IR skills was very important for the majority of participants (65%). Research was another area where more training opportunities could be a provided since currently the research exposure that IR trainees received was via case report writing (75%) and participation in clinical audits/quality improvement projects (61%). Regarding the European Board of IR examination, over half of the survey respondents are planning to sit the EBIR examination, with the highest proportion from Australia, the EU and the Middle East (Table 3).

Gender-Specific Subgroup Analysis

One in three participants of this survey was female (32%). Most of the female participants (69.2% vs. 57.5% for the male participants) reported that their main inspiration to consider IR came through their exposure to IR during core radiology training, while only 11.5% of them had some exposure during medical school (versus 16% for male participants). A significant majority of the women in IR (80% versus 83% for men) works full time and 47% of them reported that they are happy with their work life balance most or every week (versus 45% for male IRs). Overall satisfaction with IR training is high in 68.6% of the female participants comparing to 78% for male participants, while when asked if they would recommend IR to junior doctors 88.5% of them agreed that they would. There were no significant observed differences in levels of exposure to the various aspects of IR training (vascular or non-vascular) between the two genders.

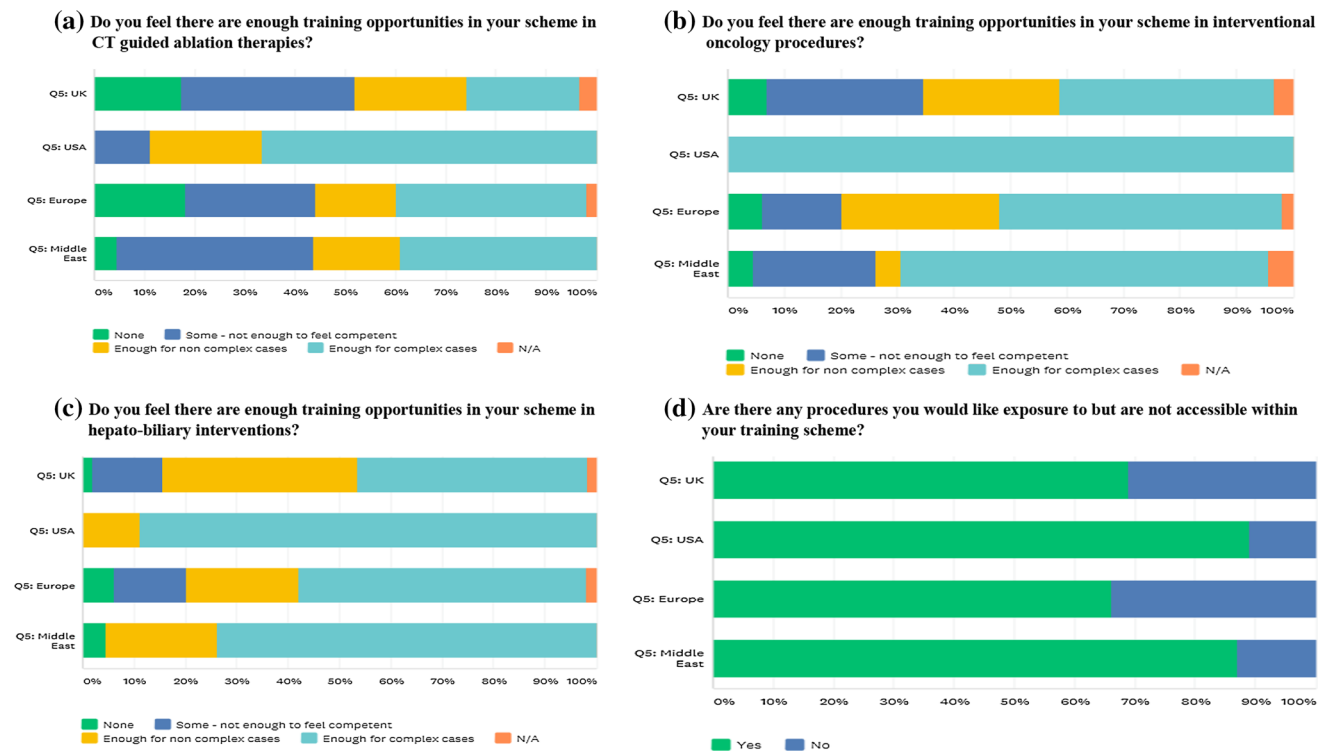


Figure 6 Satisfaction regarding various aspects of IR training **A** Do you feel there are enough training opportunities in your scheme in CT guided ablation therapies? **B** Do you feel there are enough training opportunities in your scheme in interventional oncology procedures?

C Do you feel there are enough training opportunities in your scheme in hepato-biliary interventions? **D** Are there any procedures you would like exposure to but are not accessible within your training scheme?

Table 3 Intention to sit the European Board of interventional Radiology exams (EBIR)

Region	Planning to sit EBIR exam				Total Responders
	Yes	No	Not sure	Other exam	
UK	29 (52.7%)	7 (12.7%)	18 (32.7%)	1 (1.8%)	55
USA	2 (25%)	4 (50%)	0	2 (25%)	8
EU	33 (73.3%)	3 (6.7%)	6 (13.3%)	3 (6.7%)	45
Asia	7 (58.3%)	1 (8.3%)	4 (33.3%)	0	12
Australia	6 (100%)	0	0	0	6
Middle East	13 (65%)	1 (5%)	6 (30%)	0	20
Canada	1 (20%)	2 (40%)	1 (20%)	1 (20%)	5
Other	1 (8.3%)	6 (50%)	5 (41.7%)	0	12
Total	92 (56.4%)	24 (14.7%)	40 (24.5%)	7 (4.3%)	163

UK, United Kingdom, USA, United States of America, EU, European Union

Discussion

This survey aimed to assess the various aspects of IR training on a global scale, performing comparisons between different regions and dedicated IR training programs. The recently published IR training pathway report in Europe [9] showed significant heterogeneity in terms of IR training even within the narrow geographical borders of Europe. This survey demonstrates that this could also be the case at a global level.

Overall, most IR trainees reported that they were satisfied with their training; however, they would welcome some changes. Our subgroup analysis showed that this was the case for both genders, too. The majority felt they enjoy a good work–life balance, and they would recommend the specialty to others. The survey showed the specialty is still male dominated and that more needs to be done to encourage more women to choose IR, though we did not identify any significant differences between the two genders in terms of access to the various aspects of IR training

or regarding exposure to IR during the early years of their radiology training. In addition, almost half of responders mentioned that exposure to IR in their first year of radiology training influenced their career choice. This is clearly a crucial time for recruitment, and although a lot has already been done by trainee committees around the world to reach out and include this subset of trainees, more can be done, especially as we move to a more virtual way of working. Having senior IRs in leadership roles within the education and training scheme hierarchy is also vital to make these changes to the current training programmes.

The majority of participants reported working full-time, mostly with IR dedicated job plans and less diagnostic work. Eight of ten women IRs also reported working full time. This is a positive development since it will allow the IR workforce to invest more time in developing crucial features of IR practice such as outpatient clinics, inpatient ward rounds and IR-related research and development. However, this is not reflected in IR training with many participants feeling that they spent too much time on diagnostic on-call missing out on IR training experience and this trend was observed in both genders. Furthermore with regard to on call, almost half of responders state that either there were no formal arrangements for starting dedicated IR out of hours work or that this did not occur until after training. This is quite remarkable when compared to other specialties where on call and emergency work is part of training from day one.

Despite these features of training, almost half of responders stated they were planning to apply to a consultant post immediately after training. Based on the location of the majority of responders, this could be a reflection of European/UK opinion or may suggest there has either been a change from previous papers based in the USA in 2018 when more than 1 in 3 trainees considered doing another fellowship after their main training, likely to compensate for some of the above deficiencies and in order to get more operating experience [11, 12]. Regarding postgraduate exams, over half of responders expressed an interest in sitting a dedicated IR exam such as the EBIR exam. Thirty-three per cent of those interested were located outside of the UK/EU suggesting the EBIR is an internationally valued qualification.

The issue of collaborative working with other specialties and the resulting competition is a matter of long-term debate.[13, 14]. Our survey identified a significant degree of disappointment from IR trainees regarding shrinking training opportunities, especially in vascular procedures, mostly due to the competition for operating time with trainees of other specialties. Another reason for frustration was the lack of reciprocal training from those other specialties. These findings mirror those of a previous survey of UK trainees completed in 2016 which demonstrated over

30% of IR trainees shared lists with surgical trainees, with almost half reporting that this compromised their own training.[15]. Further trainee surveys should continue to assess the impact of surgical endovascular training on the training of future IRs.

The assessment of satisfaction regarding specific aspects of IR training in vascular and non-vascular procedures was another key objective of this survey. Despite the fact that advanced training in the endovascular management of peripheral arterial and aortic disease is a compulsory feature of both the CIRSE IR curriculum (which is endorsed by many international IR societies [16]) and the Royal College of Radiology UK IR curriculum [17], it appeared that IR trainees from around the world were often struggling to obtain the necessary exposure. The UK was the exception. This is indeed a worrying feature and in agreement with a recent report which showed that in the USA the annual market share in PAD interventions is dominated by surgeons and cardiologists who claim more than 80% of the workload (2011–2017 data) [18].

Regarding non-vascular training, the survey demonstrated better trainee experience with higher rates of satisfaction in urological, hepatobiliary and oncological interventions. The only exception was training in CT-guided ablation where most trainees outside the USA felt that they did not have sufficient exposure for complex procedures. Although the reasons for this were not clear, this could be secondary to several factors such as the relative novelty of the technique and whether the service in some centres is led by diagnostic rather than interventional radiologists. CT-guided ablation training is indeed an area requiring focus to improve the standards of training. Overall, though, it appears that IR trainees get adequate experience in non-vascular intervention which appears to be very important since the majority wish to continue performing in a mixed IR setting. Paediatric IR and stroke intervention are two areas of potential growth for future interventional radiologists. The majority of survey participants expressed interest in these particular fields. Both areas are currently practiced in limited settings which are often highly specialised, and therefore limits access to only a small number of trainees [19].

Training in research has been for long time an important aspect of the development process of medical and surgical specialties training, and IR should not be an exception. For example in a study from the Royal College of Surgeons, UK, four hundred respondents out of the 848 trainee surgeons (47%) had undertaken a postgraduate degree since graduating from medical school, with this proportion rising by the later stages of training to 68% [20]. This was in contrast to our study that showed only 11.3% of the UK IR trainees have a postgraduate qualification with this number reaching 25% in European countries. In addition, it appears

that at the moment the research exposure that IR trainees receive during their training is mostly via case report writing and via participating in clinical audits/quality improvement projects and not so much through original research exposure. This could be addressed by making the selection process more competitive in order to attract the best possible talent and by then providing proper research training opportunities to allow trainees to develop their academic potential for the benefit of the specialty and our patients.

There are some limitations in this study. Firstly, the small number of participants in certain parts of the world, particularly Australasia and South America. This prevented inclusion of these regions in the comparative analysis. Regarding Africa, IR is considered particularly underdeveloped in most parts of the region and there were no survey participants from any of the few countries that have a developed IR service with structured training pathways [21]. Another potential limitation is that the length of the survey may have deterred the number of respondents who dropped out after the first filter question.

Secondly, the responses were to a large extent shaped by the training environment of the responders, as well as the wording of the questions, which was more applicable to UK and European respondents. For example, American IRs are now in dedicated IR training posts and have no reason to do a post-training fellowship unless they want to super-specialise. It is also unsurprising that they do not feel much burden on their training from trainees of other disciplines since it appears that most vascular work has already shifted to cardiology and vascular surgery [18]. US trainees also appear to receive more interventional oncology training than elsewhere, probably for similar reasons. Overall, responses in this survey must be interpreted with caution and in the context of the training scheme in which the responder found himself/herself.

Conclusion

There has been a lot of progress over the last decade in terms of providing more structured and comprehensive IR training opportunities. Nevertheless, this survey sheds light on a number of weaknesses including proportion of time dedicated to interventional radiology training, deficiencies in vascular IR training, lack of structured research support and competition in training with other specialities. These limitations should be addressed without delay in order to provide the highest standards of training and future-proof the speciality for the benefit of our patients.

Acknowledgements We would like to sincerely help the executive committees of the following organizations for their kind help with this

survey: British Society of Interventional Radiology (BSIR), Royal College of Radiology (RCR), Cardiovascular and Interventional Radiology Society of Europe (CIRSE), Society of Interventional Radiology (SIR) Residents and Fellow Section, Canadian Society of Interventional Radiology (CAIRS), Pan Arabi Interventional Radiology Society (PAIRS), Interventional Radiology Society of Australasia (IRSA), Hispanic Society of Vascular and Interventional Radiology (SERVEI) and the Iberoamerican Society of Interventional Radiology (SIDI). We would also like to sincerely thank Dr Daniel Lapointe, Dr. Amol Mujoomdar, Dr Gerard S Goh, Dr Karim Abd El Tawab, Dr Dario Teplisky and Dr Sergio Sierre for their kind help with this survey.

Funding No funding.

Compliance with Ethical Standards

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

Consent for Publication All authors have read and approved the submitted version of the manuscript.

Ethical Approval Not applicable.

Informed Consent Not applicable.

References

1. Baum RA, Baum S. Interventional radiology: a half century of innovation. *Radiology*. 2014;273(2 Suppl):S75-91.
2. The Royal College Radiologists (RCR). Clinical radiology UK workforce consensus 2019 report. RCR report. April 2019.
3. European Society of Radiology (ESR). Summary of the proceedings of the International Forum 2017: Position of interventional radiology within radiology. *Insights Imaging*. 2018. <https://doi.org/10.1007/s13244-018-0594-5>.
4. The Royal College of Radiologists (RCR). Specialty training curriculum in radiology. RCR report. March 2020.
5. European Society of Radiology. European training curriculum for radiology. Vienna. March 2020.
6. Cardiovascular and Interventional Radiology Society of Europe. European curriculum and syllabus for interventional radiology. June 2017.
7. Atiiga PA, Drozd M, Veettil R. Awareness, knowledge, and interest in interventional radiology among final year medical students in England. *Clin Radiol*. 2017;795(e7-795):e12.
8. Agrawal D, et al. Awareness and knowledge of interventional radiology among medical students at an Indian institution. *CVIR Endovascular*. 2019;2:45.
9. Makris GC, Healy GM, Cazzato RL, Benz RM, Bibok A, The European Trainee Committee. Status of vascular and interventional radiology training in Europe—A report by the CIRSE European trainee forum subcommittee. *CIRSE IR News*. May 2020.
10. Li O, Ross M, Wiseman D. Women in interventional radiology: exploring the gender disparity in Canada. *Curr Probl Diagn Radiol*. 2020. <https://doi.org/10.1067/j.cpradiol.2020.02.007>.
11. DePietro DM, Kiefer RM, Redmond JW, Hoffmann JC, Trerotola SO, Nadolski GJ. The 2017 integrated IR residency match: results of a national survey of applicants and program directors. *J Vasc Interv Radiol*. 2018;29(1):114–24. <https://doi.org/10.1016/j.jvir.2017.09.009>.

12. National Resident Matching Program, Results and Data: Charting the Outcomes in the Match[®] Characteristics of U.S. Allopathic Seniors Who Matched to Their Preferred Specialty in the 2018 Main Residency Match. National Resident Matching Program, Washington, DC. 2018.
13. Makris GC, Uberoi R. Interventional radiology-the future: evolution or extinction? *Cardiovasc Intervent Radiol.* 2016;39(12):1789–90.
14. Keller EJ, Collins JD, Crowley-Matoka M, Chrisman HB, Milad MP, Vogelzang RL. Why vascular surgeons and interventional radiologists collaborate or compete: a look at endovascular stent placements. *Cardiovasc Intervent Radiol.* 2017;40(6):814–21.
15. Belli AM. The future of arteriography and vascular interventional radiology. *Br J Radiol.* 1997;1(70):S168-70.
16. Cardiovascular and Interventional Radiology Society of Europe (CIRSE). The European curriculum and syllabus for interventional radiology. CIRSE report. 2nd ed. February 2017.
17. The Royal College of Radiologists (RCR). Interventional radiology specialty training curriculum. RCR report. May 2020.
18. Schramm KM, DeWitt PE, Dybul S, Rochon PJ, Patel P, Hieb RA, Rogers RK, Ryu RK, Wolhauer M, Hong K, Trivedi PS. Recent trends in clinical setting and provider specialty for endovascular peripheral artery disease interventions for the medicare population. *J Vasc Interv Radiol.* 2020;31(4):614-621.e2.
19. Harned RK, Heran MK, Patel M, Barnacle A, Cahill AM, Braswell L, Feola GP, Sierre S, Marshalleck F. Society of pediatric interventional radiology board of directors. Challenges and opportunities for continued success and growth of pediatric interventional radiology A communiqué from the society for pediatric interventional radiology. *Am J Roentgenol.* 2018;211(4):740–3.
20. O’Callaghan J, Mohan HM, Sharrock A, Gokani V, Fitzgerald JE, Williams AP, Harries RL. Cross-sectional study of the financial cost of training to the surgical trainee in the UK and Ireland. *BMJ Open.* 2017;7(11):e018086.
21. Makris GC, Byrne G. Post-partum hemorrhage and maternal mortality in low-income countries and the forgotten role of interventional radiology. *Cardiovasc Intervent Radiol.* 2019;42(12):1810–1.

Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.