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Recommendations from the Association for European Paediatric Cardiology for training in congenital cardiovascular magnetic resonance imaging

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MAGNETIC RESONANCE IMAGING IS A RELATIVELY new modality for imaging that provides clinically useful information in various situations in patients with congenital cardiac malformations. Guidelines for its use in clinical practice have already been prepared by a Consensus panel representing European specialists in resonance imaging and cardiology.[1] In selected situations, the technique may also be considered an excellent scientific tool. In these recommendations, we define the different levels of knowledge and expertise that might be acquired by paediatric cardiologists. All paediatric cardiologists performing magnetic resonance imaging in children should have demonstrated expertise at the recommended second level, this being the level required for obtaining the European Accreditation in Paediatric Cardiovascular magnetic resonance imaging. Training in paediatric cardiovascular magnetic resonance imaging, particularly for those dealing with congenital malformations, should be provided at 3 levels. In order to provide adequate training, co-operation is generally required with those working in other specialities, such as radiologists, cardiologists, magnetic resonance physicists, magnetic resonance technologists, image processing engineers, and so on.

Levels of Training

Basic general level

This is the first level of training. At completion of training at this level, the fellow should be familiar with the commonly used techniques for cardiovascular magnetic resonance imaging (Table 1), and should be cognisant with the guidelines for clinical application of the technique in patients with congenital cardiac disease as laid down by the European consensus panel.[1]

Table 1. Techniques for magnetic resonance imaging commonly used in patients with congenitally malformed hearts

- Tomographic still-frame magnetic resonance imaging for morphology, with or without contrast agent
- Cine magnetic resonance imaging for dynamic studies, including ventricular function at rest, or stress produced pharmacologically or by exercise
- Magnetic resonance angiography of large vessels, with and without the use of contrast agents)
- Velocity mapping for quantification of the flow of blood

Table 2. Additional techniques for magnetic resonance imaging used in patients with congenitally malformed hearts

- Wall motion, including myocardial tagging
- Contrast-enhanced magnetic resonance imaging for myocardial perfusion and/or tissue characterization)
- Magnetic resonance imaging angiography of coronary arteries

Advanced general level

To achieve the second level, in addition to the skills obtained during training for the first level, the fellow should demonstrate the capability of interpreting cardiovascular magnetic resonance imaging studies in patients with congenital cardiac malformations. This requires a basic knowledge of the techniques as set out in Table 2.

Expert level

For accreditation at the third level, in addition to the skills demonstrated in satisfying the requirements of

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the first and second levels, the fellow should demonstrate familiarity with less common applications in clinical practice, as shown in Table 2, and of scientific use of the techniques employed in cardiovascular magnetic resonance imaging. He or she should also have acquired working knowledge of how to perform diagnostic studies using the techniques of cardiovascular magnetic resonance imaging in patients with congenitally malformed hearts.

Structure of programmes for training at the first through third levels

Training in paediatric cardiovascular magnetic resonance imaging should take place within a programme of cardiovascular magnetic resonance imaging that actively involves a paediatric cardiologist accredited by the Association for European Paediatric Cardiology. Accreditation will be organized by an Accreditation Commission. This committee is to be installed when the current requirements for training come into effect. Preferably, the process of accreditation should be similar to that required for cardiologists.

For the purpose of training in paediatric cardiovascular magnetic resonance imaging, the faculty of the laboratory providing facilities for imaging should include a paediatric cardiologist with expertise in cardiovascular magnetic resonance imaging at the third level. The paediatric cardiologist, or cardiologists, with this level of expertise should at least be actively involved in reading and reporting of studies, and be responsible, or co-responsible, for the quality of the diagnostic studies. The laboratory should service a hospital with both in-patient and out-patient facilities for paediatric cardiology. There should be an active programme for paediatric cardiac surgery, a laboratory for paediatric echocardiography functioning at the third level of expertise, and a laboratory for interventional paediatric cardiac catheterization.

The laboratory for paediatric cardiovascular magnetic resonance imaging should perform a sufficient number of studies each year. In future, standards for accreditation for paediatric practise will have to be defined by the Association for European Paediatric Cardiology.

Components of the programme for training

Training at the First Level

The trainee should have sufficient exposure to cardiovascular magnetic resonance in patients with congenital cardiac disease. Trainees should be actively involved in interpretation of at least 50 clinical studies under the direct supervision of a trainer experienced at either the second or third levels, including all the techniques listed in Table 1. Interpretation may be performed on cases previously collected in a teaching file. Magnetic resonance data should be integrated with data from clinical studies and other modalities for imaging, including echocardiography, cardiac catheterisation and X-ray angiography.

Knowledge on guidelines for clinical application, including contra-indications for magnetic resonance imaging, accuracy, sensitivity and specificity, pitfalls and basic physics related to magnetic resonance imaging should be obtained through self-study, teaching sessions, lectures, and/or clinical meetings. This could be obtained in part by attending a dedicated postgraduate course in cardiovascular magnetic resonance imaging, with particular attention to congenital cardiac disease. Knowledge of the basic physics related to magnetic resonance physics should include knowledge of T1 and T2, effects of flow, contrast agents, sources of artefacts such as motion, arrhythmias, and metal objects, and issues of safety. Hands-on experience is not required for training at the first level.

Training at the Second Level

Training at this level is required for those trainees wishing to practice cardiovascular magnetic resonance imaging in paediatric cardiology. To achieve recognition at the second level, the trainee should first have completed training at the first level. Training for the second level should include active involvement in interpretation of the studies in at least 100 clinical cases under the direct supervision of a trainer experienced at the second or third levels of expertise. Through methods as described above for training at the first level, those training for the second level should extend their knowledge of the basic physics related to magnetic resonance imaging, the hardware components, and the imaging sequences. The trainee should perform analysis and interpretation of at least 20 cine magnetic resonance studies of left and right ventricular volumes, wall mass and ejection fraction, at least 20 velocity mapping studies of flow through large vessels or across valves, and at least 20 magnetic resonance angiographic studies.

Training at the Third Level

This level is required for those who profess to lead a programme in research in cardiovascular magnetic resonance for congenital cardiac disease. This level is also required for those aiming to include cardiovascular magnetic resonance imaging in their own active clinical practice. The trainees for this level should have completed training at the first and second levels. Additionally, the trainee should have hands-on experience in cardiovascular magnetic resonance imaging in at least 100 cases. Through methods as described for training at the previous levels, the trainee should

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further extend his or her knowledge on the basic physics of magnetic resonance imaging and imaging sequences.

Access to the magnetic resonance scanner

To complete training at the second and third levels, the trainee should have access to scan time at a dedicated cardiovascular magnetic resonance scanner. Supervision by an experienced magnetic resonance physician is required.

Maintenance of competence

It can be expected that the applications and techniques used in paediatric cardiovascular magnetic resonance imaging will continue to evolve. It is important, therefore, for physicians responsible for the performance and interpretation of paediatric cardiovascular magnetic resonance imaging to follow active and ongoing education. This should be achieved by following scientific meetings, reading scientific journals and attending courses. They should attend at least one conference each year that is partially or wholly dedicated to cardiovascular magnetic resonance imaging. To maintain adequate expertise, the accredited paediatric cardiovascular magnetic resonance cardiologist should perform at least 50 cardiovascular magnetic resonance imaging studies each year.

Institutional and technical facilities for magnetic resonance imaging

Magnetic resonance training should be performed in the setting of a dedicated cardiovascular magnetic resonance imaging programme, performing at least 1 full day of cardiovascular magnetic resonance studies a week. The magnetic resonance hardware should allow all required sequences for diagnostic studies using cardiovascular magnetic resonance. Monitoring of haemodynamics and the state of the cardiac rhythm should be possible during magnetic resonance scanning. For non co-operative patients, facilities should be available to provide general anaesthesia or artificial respiration in the magnetic resonance scanner.

Reference

1. Pennell DJ, Sechtem UP, Higgins CB, et al; Society for Cardiovascular Magnetic Resonance; Working Group on Cardiovascular Magnetic Resonance of the European Society of Cardiology. Clinical indications for cardiovascular magnetic resonance (CMR): Consensus Panel Report. Eur Heart J 2004; 25: 1940–1965.

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