

**International Day of Radiology 2015**  
**Interview on paediatric imaging**  
**Greece / Prof. Marina Vakaki**



**INTERNATIONAL  
DAY OF  
RADIOLOGY**

AN INITIATIVE OF THE ESR, ACR AND RSNA

**Paediatric imaging in Greece**

**An interview with Marina Vakaki, Director of the Radiology Department at P&A Kyriakou Children's Hospital in Athens, Greece.**

**European Society of Radiology: What is paediatric imaging? What age are the patients, and how is it different from regular imaging?**

**Marina Vakaki:** Paediatric imaging is a subspecialty of radiology and involves the imaging of neonates, infants, children and adolescents. Thus, the age of the patients ranges from birth to the end of adolescence. A whole spectrum of imaging modalities are used to evaluate clinical problems of childhood or for the follow-up of prenatal abnormal imaging findings. Paediatric imaging differs from regular imaging (i.e. imaging of adults) because children have different anatomy and physiology.

The dynamics of a growing body, from preterm neonates to large adolescents, where the organs follow growth patterns and phases, also has to be taken into account. Although some diseases seen in paediatrics are the same as those in adults, there are many conditions that are seen only in infants. Furthermore, children's bodies are different to adults', which influenced the capabilities of different imaging modalities (e.g. better sonographic images vs. CT images in young children). I should also note that children are a unique patient population, because they are often difficult and challenging to communicate with. One more essential parameter is that their sensitivity to radiation is increased compared to adults. These aspects impact imaging modalities and techniques.

Finally, being Greek, I couldn't possibly avoid highlighting the Greek origin of the word 'paediatric' (παιδί+ιατρική) (paedi+iatric) (child-medical) while talking of paediatric imaging.

**ESR: Since when has paediatric imaging been a specialty in its own right?**

**MV:** Paediatric radiology is considered the oldest imaging subspecialty; one with a long and rich history. The North American Society for Paediatric Radiology was formed in 1958, and the European Society of Paediatric Radiology in 1963 after the first international paediatric radiology meeting in Paris, in the same year. However, in many countries, as in my own country, paediatric radiology does not officially require specific training and is not yet recognised as a specialty in its own right. Where it exists, paediatric radiologists have usually completed a diagnostic radiology residency, then completed one or two more years of subspecialty fellowship training, before they are eligible to take the board examination for official subspecialty certification (as in Germany, UK and Switzerland, to the best of my knowledge).

**ESR: Which imaging modalities are usually used to examine paediatric patients? Does this change depending on the age of the patient?**

**MV:** Paediatric imaging in daily practice involves conventional radiography, fluoroscopy (i.e. voiding cystourethrograms, upper GI series, and contrast enemas), sonography, computed tomography (CT), and magnetic resonance imaging (MRI). Plain films are the most frequent examinations in radiology, including paediatric radiology. Most imaging of children is centred on conventional radiography and sonography and should continue to be so. CT and MRI have undoubtedly important roles in paediatric imaging.

However, some areas of imaging, such as contrast fluoroscopy, are in decline and others, such as CT, MRI and interventional radiology, are increasingly necessary in support of routine paediatric care pathways. Regarding the age of the patients, there are two major parameters that we have in our minds: first, the younger the children, the better sonographic images are, with excellent anatomic details offering better and more diagnostic information; and second, that radiation protection of young children is our first and most indisputable consideration. Imaging methods which need sedation, such as MRI in the younger age group, are our last option and used only when absolutely necessary.

**ESR: Some imaging techniques, like x-ray and CT, use ionising radiation. What risk does this radiation pose to paediatric patients? What kind of safety measures are in place to protect children?**

**MV:** While no one can point to a single person and say that their cancer was caused by medical radiation, there is strong evidence that exposure to radiation levels found during CT scans may slightly increase the risk of future cancer. The estimated risk for developing cancer is variable, but for every 1,000 children undergoing a single CT scan of the abdomen there will be one cancer caused by CT (risk 1/1000). This needs to be interpreted against the risk of developing cancer over one's lifetime. For those same 1,000 children, 200 will eventually develop cancer regardless of exposure to medical radiation (risk 1/5). So the additional risk is small, and perhaps smaller today with modern CT scanners than in previous decades. However, the best available research indicates that there is indeed some risk. The biological effects of radiation result primarily from damage to DNA and are greatest on the faster growing organisms with rapidly dividing cells: the foetus, infant and young child. As children have more years ahead for the manifestation of radiation induced malignancies and the existence of a threshold dose is unknown, it has been assumed that even the smallest dose involves a proportionately small risk of induction of malignancies and it has further been assumed that the dose acts cumulatively.

Two major advances have lowered the radiation dose of plain films and fluoroscopy today: digital imaging and pulsed fluoroscopy. Nevertheless, radiation time and resultant radiation dose reflect the patient's complexity on the one hand and the radiologist's experience on the other hand. From the paediatric radiologist's and technologist's point of view, we must bear in mind to take an x-ray only when there is a clear medical benefit; to use the lowest amount of radiation, based on the size of the child in order to get images to show the problem; to include in the x-ray only the anatomic area needed; to shield patients when possible; and to repeat scans only when necessary. However, one inevitable rule is that image quality has to be maintained at a level sufficient to answer the relevant diagnostic questions. It is well-known that the modality that delivers the largest dose of ionising radiation is CT. The use of low-dose protocols for CT scanning, modern CT scanners, clear selection of patients for examination, restriction of scan areas, performing single phase scans, as well as the use of radiation protection clothing, help to protect children from ionising radiation.

Modalities that do not use ionising radiation, such as sonography and MRI, represent the safest imaging tools and they are used to avoid radiation exposure to children. Nowadays, sonography is used for guiding many interventions, another aspect that helps to significantly reduce radiation burden to children. After all, it is clear that sonography is of special importance to the paediatric age group and will continue to be so in the future.

Of course, adherence to the ALARA (As Low As Reasonably Achievable) principle always remains a key point of paediatric radiology. Last but not least, an educational resource for healthcare providers, as well as patients and parents, is the *Image Gently* website, started in 2008. This is a collaboration between several radiology, medical physics, paediatrics, and government organisations to increase awareness of radiation safety issues for children and to provide education to all stakeholders caring for children on ways to decrease the ionising radiation exposure to children. There is information for parents that includes basic information brochures that can be printed or downloaded that describe what an x-ray is, what the risks and benefits are, and what can be done to decrease these risks.

I should add at this point that in my country, all paediatric imaging departments are monitored by a radiation medical physicist and the head technologist. Diagnostic radiation exposure levels are measured for standard examinations and sent to the National Agency for Radioprotection and Nuclear Safety. Quality checks of x-ray devices and CT scanners are performed regularly.

**ESR: Do general radiologists always use lower radiation doses when imaging children; are there any guidelines to follow?**

**MV:** The truth is that general radiologists don't always use lower radiation doses when they image children. Some departments that perform x-rays or CT scans on adults do not use radiation dose reduction techniques when scanning children. Unfortunately, this isn't always obvious from the quality of images, especially CT images. I have already mentioned the guidelines in my answer to the previous question. I also have to note that given that children are not simply small adults, many general radiologists and technologists are not comfortable dealing with infants or young children, and this is right. All technologists and radiologists providing children's imaging should have training and experience. Paediatric imaging is not a microcosm of diagnostic imaging in general. That's why my opinion is that paediatric imaging must be recognised as a specialty in its own right in all countries all over the world.

**ESR: How aware are parents and relatives about the risks of radiation exposure? How do you address the issue with them?**

**MV:** Approximately half of the parents and relatives are aware of the potential increased lifetime malignancy risk associated with medical radiation exposure. They are usually anxious about their children. This concerns mainly CT, which involves higher radiation doses compared with other diagnostic imaging modalities. Sometimes, their willingness to proceed with a CT examination is reduced after risk disclosure, but this is only a significant barrier for a small minority of parents. Most of them want to be informed by the radiology staff of potential malignancy risks before proceeding with imaging, though they often report knowledge gained from the media and internet.

We always try to find enough time for discussion with the parents about the necessity of the examination, our diagnostic or therapeutic expectations, as well as the dose reduction methods used at our institution. We have so far realised that parents frequently have a limited sense of the relative difference in the radiation dose of plain radiographs compared to CT (60 to 80 times less). The parents' knowledge is even lower concerning voiding cystourethrograms (VCUGs) and other fluoroscopic radiological examinations. We may therefore have a greater responsibility to initiate conversations with families about the risk/benefit ratio of every radiological exam rather, than doing so only when prompted by them. The ALARA principle and, more recently, the *Image Gently* campaign promote awareness of the potential harmful effects of ionising radiation in children and give answers to the most frequently asked questions by parents or caregivers, physicians or other professionals.

**ESR: Undergoing an imaging examination, especially a long procedure like MRI, can be an uncomfortable and sometimes frightening experience for some children. How can it be made more bearable?**

**MV:** Any imaging examination can be perceived as a stressful event by children and their parents. They may also be anxious about the findings of the examination. Providing good preparatory information and creating a child-friendly environment, in the broadest sense, is the basis for a successful examination. Creating a child-friendly environment starts with the attitude of the whole team, including the nurses, technologists, and doctors. Keeping the waiting time for all children as short as possible should be another priority. The waiting area should be a safe, friendly, and distracting area where children of any age and their parents can wait a short while before the examination. There should be bright wall designs, a television showing short cartoons, as well as books and magazines, a table with paper and crayons and lots of washable toys. A quiet waiting area for very ill, injured children, oncologic and bedridden patients

should be necessary. The examination room should also be an equally friendly environment. Ensuring the room is warm, the lights are low, and the patient is comfortable on the table during the examination would also help.

Taking a few minutes, or depending on the case, enough time to talk with the patient and parents or caregivers prior to the examination, is important. The procedure should be explained at a level appropriate to the child's understanding. The parents are often more worried or anxious than the young patient. Watching at least a part of a previous examination performed on another child, also helps in some cases.

Sedation during MRI is usually necessary in infants and children younger than 5–6 years old. However, adequate patient preparation, with age and intellect-appropriate information for child and parents, with an invitation to one parent to stay with the child, and adaptation of the scanner environment to children, could help to reduce their anxiety and may also reduce the need for sedation.

**ESR: How many imaging exams are performed on paediatric patients in Greece each year?**

**MV:** It is not easy to give a specific answer, since there is no published database on the number of exams in general and certainly no such one on the number of exams for paediatric imaging in Greece.

According to the statistics of the radiology department of P&A Kyriakou Children's Hospital, in 2014 about 57,500 radiological examinations (222 fluoroscopic urological studies and 170 gastrointestinal studies included) and about 8,000 sonographic studies were performed. In the same year in the imaging department of Agia Sofia Children's Hospital, about 2,000 CT and 3,500 MRI examinations were performed. I should note that these are the two major national paediatric referral centres and hence they deal with the largest volume of paediatric imaging. I should add that the numbers of fluoroscopic studies, intravenous urography studies and barium studies are steadily declining.

Classic voiding cystourethrography (VCUGs) examinations are also performed more rarely from year to year, due to changing international guidelines for imaging investigation and management of urinary tract infections, vesicoureteral reflux and paediatric nephropathies.

**ESR: Access to modern imaging equipment is important for paediatric imaging. Are hospitals in Greece equipped to provide the necessary exams?**

**MV:** Yes, modern imaging equipment is available in the Children's Hospitals in Athens, as well as in certain radiology departments in other public and private hospitals, which accept and treat paediatric patients. Fortunately, despite the economic crisis, sympathy for children and their health problems has inspired private organisations and individuals to make private donations. Thus, the children's hospitals are equipped to provide state-of-the-art imaging services.

**ESR: What has changed in paediatric radiology during your lifetime?**

**MV:** In the last 27 years, since my first day as a young resident at P&A Kyriakou Children's Hospital, the field of paediatric radiology has changed tremendously. Beginning from the present and looking back, I should think that multislice CT and MRI – as well as the ever increasing use of sonography – that were once available only to a few university hospitals, are now widely available almost everywhere. However, the evolution of the various imaging methods in recent decades has occurred alongside the realisation that this has a price, not only economic, but most importantly a possible negative effect of ionising radiation on the sensitive age range of childhood. Hence, the adoption of the globally accepted ALARA principle and more recently the *Image Gently* campaign. I would like to focus especially on paediatric sonography, with its ever-increasing potential as a non-invasive and non-ionising alternative imaging modality, offering reliable and comprehensive diagnostic information. The significant technical advances in sonographic equipment and the imaginative approaches taken by many paediatric radiologists have facilitated the continuous expansion of the uses of sonography in children. Furthermore, sonography has also played a major role in facilitating or guiding interventional techniques in children. On the other

hand, the old modalities that use ionising radiation are progressively being replaced; the number of conventional fluoroscopic studies is steadily decreasing and the art of intravenous urography and barium studies will be lost in the near future.

Another change is related to the changing workload, such as increasing management of congenital uropathies due to antenatal diagnosis, or to the different approach and guidelines to classical diseases, such as the management of urinary tract infection (UTI) or vesicoureteral reflux (VUR). The adoption of digital imaging, and the electronic patient records, as well as the increasing impact of the internet on everything we do, have made the specialist's communication easier and faster. Knowledge is extremely easy to find online and the whole world is a smaller place.

**ESR: Where do you see the next developments in your field?**

**MV:** I think that all imaging modalities will continue to develop in the future – from the very important sonography that has already become the mainstay of diagnosis in a lot of cases to the most sophisticated methods such as PET/MRI. The greatest advantage of all modalities is their flexibility and the greatest challenge of the paediatric radiologist is to select the right ones in each situation, and to perform it technically the right way in order to achieve the correct diagnosis.

The pivotal role of sonography in paediatric imaging remains secure despite the advances of other imaging modalities, due to its well known advantages. New sonographic methods are being developed and even higher definition images will be obtained. Contrast-enhanced sonography will soon become part of our daily practice. On the other hand, radiography may offer a better approach in the future, with more information and less radiation burden. CT is constantly being developed in terms of reducing radiation, but also optimising contrast application and tissue characterisation. The recent revolutionary developments in multi-detector CT (MDCT) technology have already contributed to an increase in diagnostic applications and accuracy in children. The applications of MRI have enormously expanded in the past few years and continue to increase every day. Functional investigations combining different methods, such as MR-spectroscopy and diffusion weighted imaging, seem very promising.

It depends, at least partially, on us paediatric radiologists, whether these new developments will become part of our daily practice, particularly under the aspects of economic pressure, either in the public health system or in the private practice. We must keep in mind that the paediatric radiologist plays and should continue to play a central role in diagnostic investigation, in the selection of the best imaging approach, in clinical decisions, and in the treatment of young patients. Therefore communication and collaboration with referring physicians is more indispensable than ever.

Finally, I wish to emphasise that we should raise awareness of our specialty's importance among everyone, including health professionals, parents and children, and all of society. The International Day of Radiology is an excellent opportunity to do this. Being a paediatric radiologist in daily practice for many years, I can say that paediatric imaging is really a great clinical and intellectual challenge, and that all paediatric radiologists are obliged to transfer our knowledge and enthusiasm to our young colleagues, because they represent our future and the 'present' of the next generation.



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*She specialises in paediatric diagnostic and interventional sonography and classic paediatric radiology, and has a PhD degree in paediatric sonography.*

*Dr. Vakaki has vast experience in teaching and has been an invited lecturer or trainer in paediatric radiology on 50 national education programmes and at 33 congresses, conferences, and workshops. She*

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