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Ultrasound: a strategic issue for radiology?

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The year 2008 marks the 60th anniversary of medical diagnostic ultrasound (US) [1]. Radiology is proud to celebrate this anniversary as US nowadays is the most widely used and rapidly growing of all sectional imaging methods and still constitutes a large part of the workload of many radiology departments.

Although US is considered as an imaging technique, the relationship between radiology and US has not always been an easy love story.

At the end of the 1940s, a few pioneers recognized the potential of US energy to provide clinically useful information and, with great effort and extraordinary vision, constructed basic equipment, developed various techniques of transmitting and receiving the signal, and described the first anatomical and pathological findings on B-mode images [2]. They came from a variety of disciplines: engineers, physicists, technical personnel, and physicians with different backgrounds such as internal medicine, ophthalmology, neuroscience, and obstetrics. Several radiologists have been at the forefront of the development of US, made fundamental contributions to its advancement, and had an important role in spreading knowledge on this emerging technique to the whole medical community [3–5].

Nevertheless, in the early 1970s, many radiologists still hesitated about entering this new imaging field, and colleagues of various clinical disciplines established US sections within their institutions. One result is that important fields of application of diagnostic US, for instance cardiology, obstetrics, and gynecology, have been performed for years almost exclusively by non-radiologists. Most academic radiology institutions hurriedly introduced ultrasound in the residency curricula. To help junior and senior radiologists learn about this new technique, several didactic courses were activated, combining both theoretical and practical experience. The objective was to teach the “art” of US, i.e., the complex coordination of the examiner’s mind, eye, and hand that is necessary for practice, in order to display organs, recognize abnormal findings, and answer clinical problems. Motivation, enthusiasm, and a compelling desire to learn allowed those radiologists to set up US services and to supply the diagnostic needs of their patients and their clinical colleagues [6]. Since that time most radiological departments have employed one or more radiologists who have made ultrasound the focus of their profession, assuring high-quality service as well as the active promotion of new technical and clinical developments.

From the 1980s onward, the increasing success of the technique initiated turf battles with clinicians from many disciplines. They claimed that the US probe merely represented an extension of their examination of the patient and that a better understanding of the specific clinical context of a patient gave them superiority over radiologists in performing and interpreting US studies. This “takeover” was somewhat helped by the fact that radiologists were not always readily available for timely examinations. Thus, nowadays, more than 50% of US examinations worldwide are performed by clinical specialists rather than radiologists or technicians working in a radiology department. A survey obtained in 1999 from 17 European academic departments of radiology showed an heterogeneous situation, with countries such as France and the UK where radiologists had a great deal of control of US and others, such as Switzerland, Germany and Austria, where non-radiologists performed the majority of US examinations [7]. New technological advances, such as the recent introduction of small, portable machines with performances adequate for use in the context of emergency, have opened new horizons for competition. After the survey performed by Maitino et al. in which emergency physicians were shown to have a non-substantial role in US and conventional radiographic imaging before 2001 [8], a new international scientific society, the World Interactive Network Focused on Critical Ultrasound (www.winfocus.org), has been established and dedicated to the use of US in emergency. Thus, turf battles and controversies about the use of US are not over, as more and more specialists are going to claim US as part of their everyday work, further undermining the position of radiologists [9]. New surveys should be launched to appreciate the evolution of the situation in Europe during the last years.

Several articles in the radiological literature discuss how to deal with turf battles [7, 9–12]. They stress that studies performed by radiologists or non-radiologists should be of the highest quality, adherent to published standards, and available with efficiency, including rapid and consistent reporting. Furthermore, to remain at the forefront of the technique, radiologists have to be prepared to explore new applications and lead progress [13]. The need for strong support of research by the whole radiological community has been recently stressed [14]. All this is applicable to US.

Research in radiology, in fact, does not simply lead to advancement in knowledge, but has profound effects also on the way we practice our discipline. According to the Intersociety Commission of the American College of Radiology, research improves the quality of clinical practice, develops and validates new practices, furthers the relations among radiology, clinical and basic sciences, attracts and retains the brightest young recruits to our discipline, and retains the credibility of radiology and radiologists’ privileges to the practice of the discipline [13].

In our opinion, the dedication and involvement of radiologists in US research is decreasing. A survey of the papers published from 1991 to 2007 (data collected from

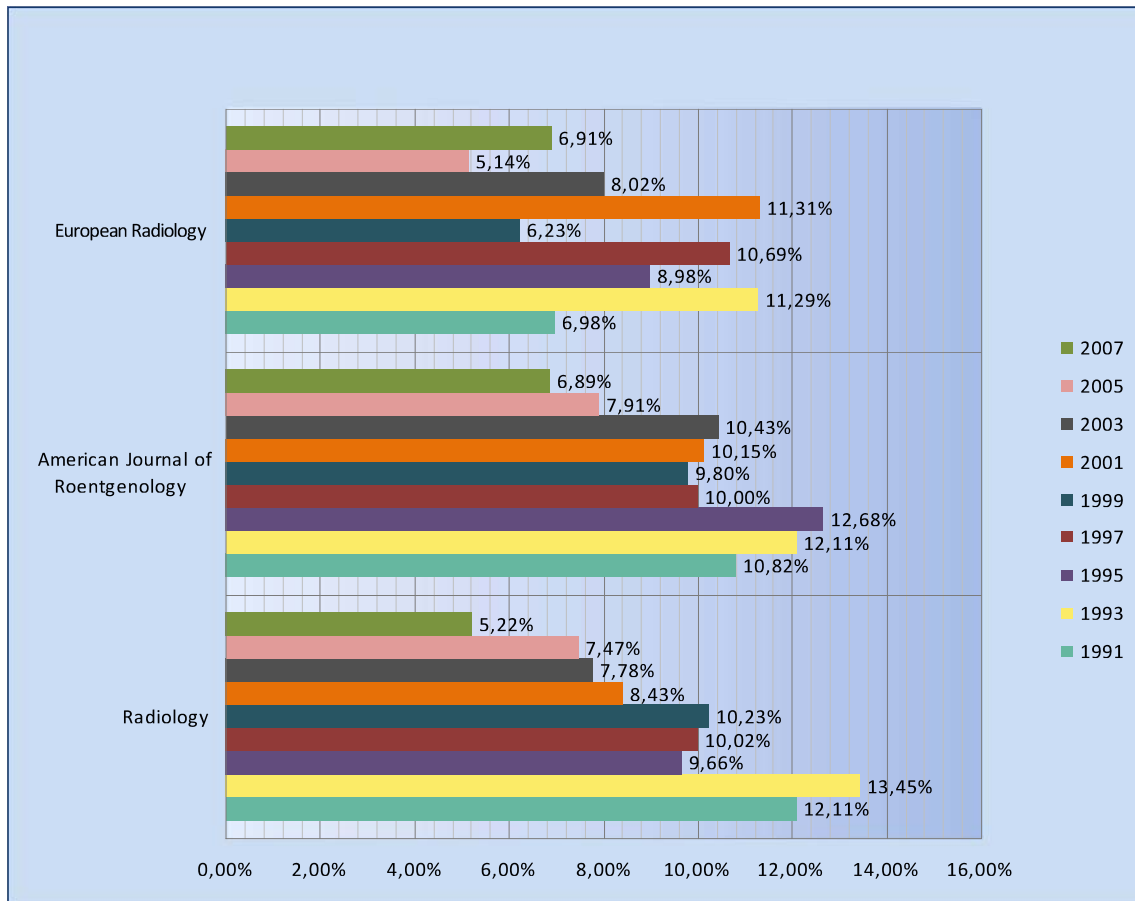
publications in uneven years) in the three major radiological journals (*Radiology*, *American Journal of Roentgenology*, and *European Radiology*) shows that the number of publications dealing with US is decreasing over time (Table 1). Furthermore, attention to US is also getting lower in radiological meetings. A survey of scientific papers presented at the European Congress of Radiology and at the Radiological Society of North American meetings from 1995 to 2007 (data collected in uneven years) shows marked decreases of papers dealing with US. It has to be remembered that, at the European Congress of Radiology, no scientific sessions have been specifically dedicated to US, and scientific contributions on this topic have always been integrated into organ-oriented sessions. Since 2007, the same principle has been introduced to the annual meeting of the Radiological Society of North America. Today US is probably perceived by radiologists as a “mature” specialty, in which there are only few possibilities to advance and little chance to publish or present innovative studies. Postgraduate teaching in US has a somewhat higher profile. At ECR there was a Categorical Course in US in 2002 (repeated in 2003) and a “hands-on” course on musculoskeletal US in 2004 (repeated in 2005 and 2006). At the RSNA, a categorical course was dedicated to US findings in 2002 (repeated in 2003), and “hands-on” courses on US of the musculoskeletal system and on peripheral nerves have been held in 2006 and 2007 (Table 2).

Young radiologists licensed from certificated residency programs are well trained in this technique and are able to perform the most common US examinations, which ensure that US services are maintained in most radiological departments. However, although “routine” services are guaranteed, very few young radiologists make US the “focus” of their career, and little attention is given to advancements in this technique in most radiological departments. In our opinion, more and more radiologists—juniors and seniors—seem to consider US less attractive than CT and MR. In addition, it must be considered that US is often regarded as a stressful activity, more physically demanding than any other radiological examination, given the high number of studies requested, the need for continuous clinical attention, and the requirement of close contact with the patient.

We believe that, in reality, the future of medical diagnostic US looks bright in terms of research opportunities and increasing clinical applications; it will also provide potential financial income for radiology departments. Recent advances have significantly boosted the research horizons of US, as illustrated by the few following examples:

- Contrast-enhanced ultrasound (CEUS), although losing the so-called “non-invasive” profile of ultrasound, has opened new possibilities in the detection and characterization of focal liver lesions and now has a recognized place for other organs (kidney, pancreas,

Table 1 Survey of the papers published in Radiology, American Journal of Roentgenology (AJR), and European Radiology for the period 1991–2007 (data collected from publications in uneven years)



Note: as the survey classified papers according to presence of the word “ultrasonography” (or “US”, or “ultrasound”, or “sonography”) in the title, papers on multimodality imaging, including US but not entitled according to the criterion of our search, were not considered. This could have caused underestimation of the real presence of research involving US in these journals. Results show a decline for Radiology and the AJR, while data from European Radiology are more complex.

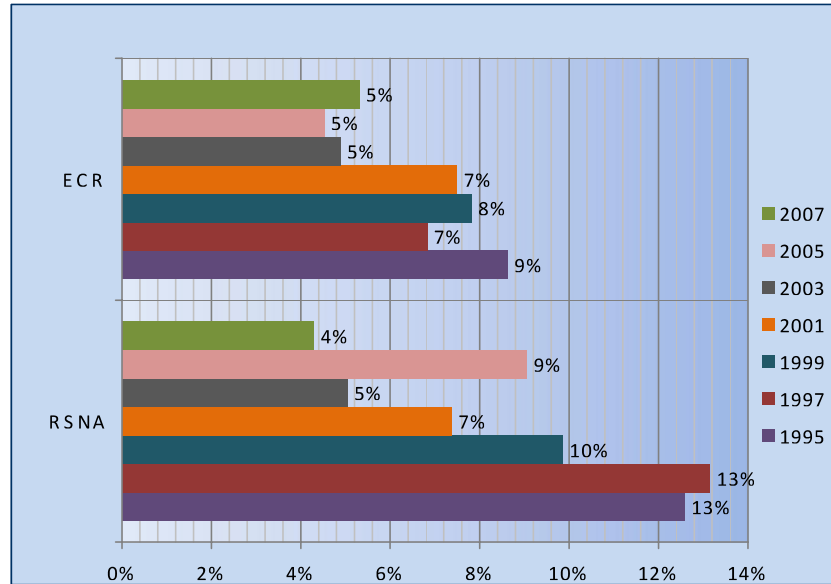
reflux, trauma) [15]. Clearly, this is a way to evaluate the macro- and micro-vasculature of deep and superficial organs in — almost — real-time. We should remain vigilant about potential issues relating to the management of patients allowed by the introduction of CEUS, as well as changes in the indications for CT and MR. The use of CEUS is obviously not restricted to radiologists, and there is a risk of a decrease of the contribution of radiologists in the management of focal liver lesions, to the benefit of clinicians such as hepatologists.

- Three-dimensional (3D) US imaging is becoming more and more widely available and will not be limited to fetal studies [16, 17]. Recently introduced matrix probes provide lower spatial resolution than the mechanical/convex 3D ones, but allow four-dimensional imaging (4D—i.e., 3D in real-time) [17] with a relatively high temporal resolution allowing the study of high speed

motion (such as the cardiac valves and peristaltic movements) in real-time. There is also the possibility to use 4D imaging during contrast enhancement with CEUS. The entire workflow itself should be adapted, with a shorter acquisition time, and some marked time for the post-processing phase. This is relatively new in US, but very similar to what we have been seeing for a few years in CT, including the need for appropriate communication to referring physicians of 3D and dynamic data. Re-analysis of the workflow is therefore required to maintain a high patient flow with quality and expertise. The role of sonographers should be included in this perspective to save time for the radiologist for the post-treatment phase and interpretation.

- Elastography has recently emerged as an additional method for evaluating new parameters of the inner structure of organs and lesions. There is already some experience in the study of breast nodules [18], but new

Table 2 Survey of the scientific papers presented at the RSNA and at ECR for the period 1995–2007 (data collected from books of abstracts in uneven years)



Note: as the survey classified papers according to presence of the word “ultrasonography” (or “US”, or “ultrasound”, or “sonography”) in the title, papers on multimodality imaging, including US but not entitled according to the criterion of our search, were not considered. This could have caused underestimation of the real presence of research involving US in these meetings. Results show a decline for both meetings.

applications, such as the study of the prostate and of the liver in cirrhosis, are now appearing [19–21].

- US is also deservedly within functional and molecular imaging, as we know that targeted agents can be included in or on microbubbles, allowing detection of specific disease or delivery of therapeutic molecules within target organs by local insonication [22].

In terms of clinical practice and benefit/risk ratio, major advantages of US are its wide availability, repeatability, and its non-invasiveness (or, considering CEUS, its low invasiveness). Ultrasound remains the optimal initial investigation in a large variety of clinical problems. Keeping control of the initial US referral means that radiologists continue to be the physicians who guide decisions in the imaging workup of patients, allowing a more appropriate choice of subsequent imaging procedures. Furthermore, US does not use ionizing radiation, which is very important in view of the increasing debate on medical irradiation issues in the medical literature [23] and in the lay press [24]. Radiologists are now strongly advised to use alternative techniques that do not use ionizing radiation (e.g., US and MR) whenever possible.

It is our opinion that radiological US has special characteristics that differentiate it from that performed by other physicians and favor the quality of the service offered by radiologists. Radiologists are able to evaluate imaging findings relatively separate from the clinical impression: i.e., the radiologist is trained to analyze images on their

own merits, not as a means to confirm a diagnosis already supposed by history taking, laboratory findings, or physical examination. Furthermore, no imaging method is perfect, and, when needed, radiologists are better able to correlate the findings obtained with results from other imaging investigations to reach a final diagnostic conclusion. Furthermore, radiologists can assure a full-time dedication to imaging, which is impossible for a clinician who is involved actively in the patient care.

Furthermore, we believe that involvement in US by radiologists is also a way to stay in clinical touch with patients. There are two reasons for this. The first is that US is the primary imaging procedure in a large variety of clinical situations. Thus, for our profession, control of US means that we radiologists are more influential in guiding decisions about the imaging workup of patients. The second is that, in US practice, there is direct patient-physician interaction. In many European countries the whole study is performed directly by the radiologist. When a sonographer performs the examination, it is common practice for the radiologist to discuss and check the case and, usually, at least to obtain limited directed US imaging before the patient leaves the department [25, 26]. There is a lively debate in the literature on the “visibility” of radiology, on how the role of the radiologist is perceived by patients, and on the best way to communicate the results of imaging tests [27]. Direct contact with the patient while performing the US examination makes clear that it is the radiologist, not the machine, making the diagnosis [28].

As regards budget, it has to be stressed that the worldwide financial market of US is thought to be approximately four times higher than that of MR and more than twice that of CT, which illustrates the interest of industry for promoting US in imaging and clinical specialties. The payment for ultrasound examination is relatively variable among countries and in some applications often insufficient (i.e., CEUS). However, an appropriate management of the workflow, including whenever authorized a contribution of sonographers, allows the generation of sufficient income to cover expenses and maintain equipment at a high level. A major limitation would be a lack of medical resources due to a negative demography of radiologists.

In our opinion, it is essential for radiology to celebrate the 60-year anniversary of US, regarding the past contribution of our discipline to the development and maturation of this technique. But, if radiologists want to maintain a key role in US, it is also time to reconsider the following strategic issues and behave accordingly:

1. Radiologists need to have the best specialists in US. The organization of radiological workflow according to organ-oriented subspecialties works well, especially regarding its ability to create dedicated radiologists who understand clinical problems deeply and are able to relate properly with the referring physicians. However, as addressed previously, US is a kind of “art,” highly dependent on the operator’s dedication and ability, and this is commonly regarded as the major drawback of medical US. If radiologists want to keep US within their specialty, a number of dedicated and able operators have to be available in radiology departments to produce high-quality examinations in a timely manner, to cover all the different fields of application of the technique, and to advance research in the field. A study by Hertzberg et al. that assessed the capabilities of a group of radiology residents to perform and interpret US examinations has shown that there seem to be innate individual differences in the ability to understand and assimilate the skills needed for this job [29]. We must detect these talented individuals and suggest that some should pursue their radiological career with an emphasis on US.
2. Radiologists need to invest in US technology. Although there is a wide range of US machines from basic to sophisticated ones, they all continuously undergo technical progress. We need to explore the new technical advances and their diagnostic applications. As radiologists, we are the best suited specialists to evaluate their technical and clinical interest in comparison with other imaging methods.
3. Radiologists need to stay at the forefront of the technique. US imaging has applications in many different fields, and we have to provide the service to all requests. Many new clinical applications of US are continuously introduced (the studies of the musculoskeletal system and of peripheral nerves are just two examples); most have been, and many still are, developed by radiologists. However, this is not the case in all radiology departments. Rheumatologists and orthopedic surgeons are already using US for the study of muscles and tendons, and, after checking the clinical problem with US, they request additional examinations from the radiologist who, in this way, is completely denied a role as a clinician.
4. Radiologists must have higher visibility in the US world. In the beginning of medical US, physicians dedicated to this technique were excluded from medical specialty societies because of the multidisciplinary nature of US [10], and the first presentations of US images at radiological meetings were regarded with skepticism [30]. Societies specifically dealing with US, such as the American Institute of Ultrasound in Medicine and the European Federation of Societies for Ultrasound in Medicine and Biology, were created to allow scientific discussion. Many radiologists have been involved in these multidisciplinary societies and have done a very good job in expressing the voice of radiology. The development of international standards of practice is a challenge for all physicians practicing US, and the CEUS guidelines are an example in which the place of all imaging modalities has been duly respected [15]. But when the present generation of radiological US leaders retire, there is a real danger that the voice of radiological US will be ignored.
5. We must present higher visibility of US in the radiological world. To foster the role of radiology in US, in 1975, American radiologists with special interest in US founded the Society of Radiologists in Ultrasound as a forum to discuss new research in closed sessions at annual meetings [10]. The Society also worked on recommendations for training resident radiologists in US [31] and on development of consensus about the performance of special examinations [32] or the management of common US findings [33]. There is not a society specifically dedicated to radiological US within the European radiological community. We are not sure if an additional society is needed, but this might be discussed within the European Society of Radiology. Specifically, although the efforts of a few enthusiasts can be helpful, they cannot provide solutions to the many challenges we have addressed in this editorial.

The same concepts expressed in this paper have been presented by Mark E. Lockart in the April 2008 issue of the *American Journal of Roentgenology* [34]. This indicates that involvement of radiologists within research and practice of US is decreasing on both sides of the Atlantic, raising global concerns about the future of radiological US.

As US is a strategic issue for radiology, the possible solutions to maintaining a lively role for our specialty within US have to be shared by the whole radiological community, and all radiologists have to deal with them. Leaders have to support increased quality and visibility of

US within the radiological community. Each radiologist has to promote increased quality and visibility of radiological US in his/her environment. We are sure this will provide better diagnosis and management of our patients.

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