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How Often Do Neuroradiologists Perform Sonography of the Carotid Arteries? A Survey of Academic and Nonacademic Radiology Practices, with Implications for Fellowship Training

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BACKGROUND AND PURPOSE: **Debate in the neuroradiology community surrounds the amount of formal training in sonography of the carotid arteries that should be provided to fellows. This study was designed to assess current practice patterns at both academic and nonacademic practices regarding the performance of carotid sonography.**

METHODS: **A neurovascular radiology survey was sent to all 102 program directors of neuroradiology fellowships in the United States and Canada (academic practices). The survey was also sent to 146 randomly selected senior members of the ASNR (three per state, except one each for Alaska and Vermont) who were not affiliated with fellowship programs (nonacademic practices).**

RESULTS: **Fifty-seven surveys from academic practices and 70 surveys from nonacademic practices were returned. Radiologists at academic practices performed approximately 42% of studies (general radiologists or sonography specialists, 36%; neuroradiologists, 5%; cardiovascular radiologists, 1%). Nonradiologists performed approximately 58% of studies (vascular surgeons, 47%; neurologists, 10%; cardiologists, 1%; neurosurgeons, <1%). Neuroradiologists performed carotid sonography at 11% (6/57) of academic practices. On average, radiologists at nonacademic practices performed approximately 62% of studies (general radiologists or sonography specialists, 38%; neuroradiologists, 15%; cardiovascular radiologists, 9%). Nonradiologists performed approximately 38% of studies (vascular surgeons, 25%; neurologists, 6%; cardiologists or internists, 6%). Neuroradiologists performed carotid sonography at 53% (37/70) of nonacademic practices.**

CONCLUSION: **At most academic practices, neuroradiologists do not perform sonography of the carotid arteries. This may explain the reluctance of some fellowships to provide formal training in this technique. In contrast, although neuroradiologists perform carotid sonography at a majority of the nonacademic practices, the percentage of studies that they perform is small; moreover, neuroradiologists perform far fewer studies than do general radiologists or sonography specialists.**

The training requirement for sonography of the carotid arteries in the neuroradiology fellowship has been a source of debate in the North American neuroradiology community for many years. Anecdotally, many programs have not addressed the requirement in a rigorous fashion. Staffing issues, at the fellow and faculty levels, as well as the extent of performance of carotid sonography by neuroradiologists, are important factors. In an effort to evaluate more systematically the issue of sonography training in neuroradiology fellowships, we designed a survey to assess current practice patterns, in both academic and nonacademic practices, regarding the performance of carotid sonography. More specifically, we attempted to answer the following question: how often do neuroradiologists perform sonography of the carotid arteries? It was our intent to provide useful information regarding the requirement for fellowship training in this technique.

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Methods

In September 2001, a cover letter and survey, designed by one of the authors and titled "Neurovascular Radiology Survey," were mailed to the 102 directors of each fellowship program in neuroradiology in the United States and Canada. These practices were designated as "academic practices." In

addition, the survey was mailed to an additional 146 senior members of the American Society of Neuroradiology (ASNR) who were not affiliated with fellowship programs. Three surveys were mailed per state, with the exception of Alaska and Vermont, each of which lists only one senior member. Whenever possible, neuroradiologists practicing in larger population areas, as well as within different cities in each state, were selected; otherwise, the selection was random. This methodology largely precluded multiple neuroradiologists in the same practice from receiving the survey. Moreover, each neuroradiologist identified his or her practice, thereby allowing detection of duplication. We identified one practice (in a less populous state) from which two surveys were completed; one survey was discarded and a replacement was mailed to a different neuroradiologist. These practices were designated as "nonacademic practices." The 2001 *Membership and Resource Directory* of the ASNR was used as a reference for identification of all fellowship programs as well as locations for senior members. In November 2001, the cover letter and survey were faxed to those program directors who had not yet responded. For those states in which three responses had not been received, the cover letter and survey were mailed to additional, similarly selected, senior members of the ASNR in those states; in total, more than 200 surveys were mailed to nonacademic practices. The study was considered closed as of January 2002, and all data were tabulated.

The survey sought responses to 26 questions (www.ajnr.org) pertaining to various aspects of the practice of neurovascular radiology, including equipment, performance of CT angiography, MR angiography, sonography of the carotid arteries, and carotid or vertebral conventional conventional angiography; treatment of aneurysms with Guglielmi detachable coils; carotid or vertebral thrombolysis; and carotid stent placement or angioplasty. The names of the responding institution or practice, approximate number of beds, cities and states, and names of the radiologists (optional) were recorded at the top of the survey. Responses related to the performance of sonography of the carotid arteries form the basis of this study. Respondents were asked to estimate the percent of carotid sonography examinations performed by various specialists at their institution: general radiologists, neuroradiologists, cardiovascular radiologists, cardiologists, vascular surgeons, neurosurgeons, or others (whose specialties they were asked to identify). The number of sonography studies of the carotid arteries performed at each institution or practice was not surveyed. Therefore, for the purposes of this study, it was assumed that each academic practice performed the same number of studies, and each nonacademic practice performed the same number of studies. A χ^2 test was conducted to compare the percentage of neuroradiologists performing carotid sonography at academic and nonacademic practices.

Results

Of the 102 academic practices surveyed, 57 (56%) responded. The mean number of beds at these practices was 733 (range, 250–2,500 beds; SD, 388). Of the 146 possible responses from nonacademic practices, 70 (48%) were obtained. Responses were received from nonacademic practices in 43 states. The mean number of beds at these practices was 388 (range, 34–1000; SD, 204). Nine respondents from academic practices and three respondents from nonacademic practices indicated which specialists performed sonography of the carotid arteries, but they did not provide any percentage information; these practices were excluded from the relevant data analysis.

Radiologists at academic practices performed approximately 42% of sonography studies of the carotid arteries (general radiologists or sonography specialists, 36%; neuroradiologists, 5%; cardiovascular or interventional radiologists, 1%). Neuroradiologists performed carotid sonography at only 11% (6/57) of academic practices; at these six practices, they performed, on average, 51% of studies (range, 10%–100%). General radiologists or sonography specialists participated at 63% (36/57) of practices, cardiovascular or interventional radiologists participated at 7% (4/57) of practices. At 16% (9/57) of academic practices, radiologists performed no more than 20% of studies, and at 32% (18/57) of practices, radiologists did not perform any carotid sonography at all.

On average, nonradiologists at academic practices performed approximately 58% of sonography studies of the carotid arteries (vascular surgeons, 47%; neurologists, 10%; cardiologists, 1%; neurosurgeons, <1%). Vascular surgeons performed carotid sonography at 72% (41/57) of practices; neurologists participated at 25% (14/57) of practices; cardiologists participated at 4% (2/57) of practices; neurosurgeons participated at 2% (1/57) of practices.

Radiologists at nonacademic practices performed approximately 62% of sonography studies of the carotid arteries (general radiologists or sonography specialists, 38%; neuroradiologists, 15%; cardiovascular radiologists, 9%). Neuroradiologists performed carotid sonography at 53% (37/70) of nonacademic practices; at these 37 practices, they performed, on average, 32% of studies (range, 2%–100%). General radiologists or sonography specialists participated at 66% (46/70) of practices; cardiovascular or interventional radiologists participated at 21% (15/70) of practices. At 23% (16/70) of nonacademic practices, radiologists did not perform any carotid sonography at all.

Nonradiologists at nonacademic practices performed approximately 38% of sonography studies of the carotid arteries (vascular surgeons, 25%; neurologists, 6%; cardiologists/internists, 6%). Vascular surgeons performed carotid sonography at 41%(29/70) of nonacademic practices; neurologists participated at 11% (8/70) of practices; cardiologists or internists participated at 17% (12/70) of practices.

Comparing academic and nonacademic practices, there was a statistically significant difference between the percentage of neuroradiologists performing carotid sonography ($P < .001$).

Discussion

Fellowship training in neuroradiology has become increasingly diverse and subspecialized. The Accreditation Council for Graduate Medical Education requires training in cerebral angiography, myelography, CT, MR imaging, sonography of the central nervous system and vessels, and conventional radiology of the brain, head, neck, and spine. Exposure to positron emission tomography, MR spectroscopy, and therapeutic procedures is desirable. Most fellowship programs also provide training in advanced CT and MR imaging techniques, such as CT and MR perfusion and CT angiography. Currently, there is a requirement for 2 weeks of training in vascular sonography.

Nevertheless, a lack of uniformity in many areas of the training experience has been documented (1). Concern has already been expressed regarding the fragmentation of the general diagnostic neuroradiology fellowship (2). Interest in fellowship programs in neuroradiology is declining, and many fellows complete only 1 year of training (1). In the academic year that began in July 2002, only 62% (83/134) of positions were filled through the National Resident Matching Program (NRMP); only 45% of programs filled all of their positions through the NRMP (www.nmrp.org). In the academic year that began July 2001, fewer than half (70/156) of all positions were filled through the NRMP (www.nmrp.org). Of equal concern, a recent survey estimated that approximately 600 faculty vacancies exist in academic radiology departments through the United States (3, 4); approximately 82 represent vacancies in neuroradiology (C. D. Maynard, personal communication, February 13, 2003).

The results of this survey confirm that the overwhelming majority of academic neuroradiologists in North America do not perform sonography of the carotid arteries; they performed just 5% of studies overall, and they participated in just 11% of practices. It can be inferred from these data that most neuroradiology fellows rotate outside of their division to fulfill their requirement for training in sonography; in at least one-third of programs, this training will not even be within the department of radiology. Moreover, clinical demands on faculty in academic radiology are widely perceived to be increasing, and there is the decline in both trainee and faculty levels described above. For all of these reasons, is it surprising that the training requirement in sonography may be met with little enthusiasm by faculty in neuroradiology?

On the other hand, although neuroradiologists at nonacademic practices performed just 15% of carotid sonography studies overall, they participated at 53% of practices. We speculate that the discrepancy in the level of participation by neuroradiologists at academic and nonacademic practices (11% and 53%, respectively) is largely due to the broader range of diagnostic studies interpreted by the typical nonacademic radiologist, irrespective of subspecialty training. Indeed, general radiologists or sonography specialists performed many more carotid sonography procedures than did neuroradiologists, regardless of the practice setting. One can argue, however, that because a majority of nonacademic neuroradiologists are performing these studies it should be an obligation of the subspecialty to provide special expertise to its trainees in this technique (particularly because fellows in neuroradiology already receive additional training in CT angiography, MR angiography, and conventional angiography of the carotid arteries). Is 2 weeks of training adequate to provide this special expertise? For radiology departments that do not perform carotid sonography, how motivated are vascular surgeons, neurologists, and cardiologists to train fellows in neuroradiology?

This survey has several limitations. As stated above, the number of carotid sonography examinations performed by each practice was not recorded; we also assumed that each academic practice performed the same number of studies and that each nonacademic practice performed the same number of studies. Therefore, although we determined the percentage of examinations performed by each specialty, we do not know the actual number of examinations this represents. In addition, because this survey was not directed to cardiologists, vascular surgeons, neurosurgeons, and other nonradiologists who perform carotid sonography, it is almost certain that our results underestimate the number of examinations that are actually performed by these clinical specialists. Our data showed that nonradiologists performed 58% of studies at academic practices and 38% of studies at nonacademic practices; we believe that these figures actually represent lower limits and that the true level of participation is even higher.

What changes can be made in residency and fellowship programs to better serve the subspecialty of neuroradiology and its trainees? As stated above, in this era of increasing complexity of imaging techniques, it is imperative that additional training be made available in neuroradiology without inordinately extending the overall training period (1, 2, 5, 6). In light of the current shortage of radiologists in all practice settings, as well as the fact that fellowship programs in other disciplines of radiology are usually 1 year in length, an 18–24-month fellowship in neuroradiology (after residency) is not a realistic option. We agree with Yousem (2) that, although 18–24-month fellowships are desirable, as much of the training as possible should be shifted into residency. In view of the paucity of academic neuroradiologists who perform carotid sonography, this may be the most effective method to provide comprehensive training in this technique.

Conclusion

Our findings indicate that neuroradiologists do not perform carotid sonography at most academic practices. In the context of decreasing faculty and trainee levels and increasing clinical demand, this may explain the reluctance of some fellowships to provide formal training in this technique. In contrast, although neuroradiologists perform carotid sonography at a most of nonacademic practices, the percentage of studies that they perform is small; moreover, neuroradiologists perform far fewer studies than do general radiologists or sonography specialists.

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