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## The Present Controversy over the Imaging Method of Choice for Evaluating the Soft Tissues of the Neck

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The task is to discuss the controversy that exists as to the best technique for imaging the soft tissues of the neck. However, before entering into such a debate, I believe it is appropriate to first consider the definition of *controversy* so that any discussion might remain focused. Controversy is defined as "a dispute, especially a lengthy and public one, between sides holding opposing views; that is, a disputation as in an academic exercise consisting of a formal debate or an oral defense of a thesis" (1). As defined, there appear to be virtually no restrictions that can limit such a discussion and, as an aside, medicine at times seems to be in constant controversy.

Unfortunately, we physicians no longer have the luxury of debating such problems purely within the confines of academic halls, as the economics of medicine must now be factored into the controversy. What may be philosophically the best choice may not be the practical and affordable one. Thus, any discussion of this topic can no longer exit in the "ivory tower," but must, if you will, be tainted by the mundane reality of everyday life. In effect, there is already a restriction on the debate.

I believe that a discussion of this controversy can be approached in one of two nonexclusive ways. Specifically, one can employ a general discussion of each technique, emphasizing its merits and relative weaknesses, or one can evaluate each anatomic site in the neck and debate the best choice of imaging on a site-by-site basis. In my opinion, the latter approach tends to result in a long and often rambling discussion, which may leave the reader without a clear opinion on the subject. I have chosen the former approach, with some brief site modifiers, in the hope of achieving realistic guidelines to imaging the soft tissues of the neck.

To start the discussion, it should be accepted by the reader that none of these techniques can provide a reliable and precise pathologic diagnosis. To argue that one method has a greater ability to do so, particularly in cases of tumor, is to not recognize the reality of the limitations of all macroimaging techniques. Certainly, the imager can suggest a diagnosis, one that is often correct. However, clinicians who rely solely on imaging for a tumor diagnosis often leave themselves exposed to error, which can lead to incorrect treatment and possible litigation. It is true that imaging can assist the pathologist in arriving at some diagnoses, especially in cases of bone disease. However,

far too often, the pathologist arrives at a different diagnosis than the one suggested by the radiologist (2–5). Thus, philosophically, one must accept that the final arbiter in this arena is the pathologist, and any discussion regarding the superiority of one imaging technique over another in arriving at a final pathologic diagnosis is prone to error, has little basis in reality, and is best left to the zealots.

The mention of litigation also brings to mind the consideration of limiting one's exposure to err by not thoroughly imaging a patient or by incorrectly interpreting the case. That is, each patient must have a thorough examination that gives the radiologist the best opportunity to arrive at a confident diagnosis. Although this concept should remain as a medical ideal, it is also one of the realities of present-day medicine and often dictates an approach to imaging. Thus, in a sense, avoidance of litigation is another restriction to the debate.

Three techniques are worthy of consideration as the primary and sole means by which to image the neck: sonography, computed tomography (CT), and magnetic resonance (MR) imaging. Each has its exponents, who all too often emphasize its strengths while underplaying its weaknesses.

For me, sonography is the easiest method to start with, since to many Americans its benefits are often outweighed by its limitations in the neck. In this regard, the European radiologic community has long been more ready to champion and to use sonography, and in their experience this technique may be used more often. However, in the last decade, as more CT scanners and MR imagers have become available in Europe, the number of articles advocating the strength of sonography over CT and MR imaging has decreased, while those emphasizing the use of CT and MR imaging in the neck has gained popularity (6–8).

The strengths of sonography lie in its relative inexpensiveness, its ready patient compliance, and its excellent application in needle-guided biopsies of superficial structures (9, 10). Its limitations lie in its dependence on operator skill to provide reliable and accurate images and interpretations, and its propensity to be deficient when the soft tissues abut bone or an air column. Since much of neck imaging concerns either the potential deep spread of infection or the evaluation of deep tumor extension, there has been a growing tendency not to use sonography as the initial imaging examination. Invariably in these cases, a

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second study, either CT or MR imaging, must be obtained to verify and map any deep soft-tissue disease. Thus, the initial benefit of low examination cost all too often becomes an additive cost to the complete workup of the patient. This is often the case in children being examined for a superficial mass thought to be a lymphangioma and in adults with palpable nodal disease. The treatment approach hinges not on the superficial disease but on any deep extension, and, overall, this is better mapped anatomically by either CT or MR imaging. Having said this, I believe that sonography clearly has carved out a place in the imaging of the superficial great neck vessels and in the follow-up of patients with thyroid nodules and cysts (11, 12). Its role in evaluating parathyroid adenomas seems recently clouded as articles have suggested that nuclear sestamibi scanning and MR imaging are more accurate studies (13). Thus, when faced with a patient who has a neck mass, sonography is simply not the first imaging technique of choice for most radiologists who desire to obtain all the possible information that will impact on a treatment approach in one study. In addition, many clinicians are uncomfortable interpreting these images and most have difficulty pointing out any neck abnormalities to their patients.

CT has been used as a clinical imaging technique for two decades, and, as such, it often suffers from the notion that something this old must have outlived its usefulness. That might have been true if its technology had remained stagnant. However, the helical/spiral, fast, high-resolution CT scanners of today bear little resemblance to the breakthrough models of two decades ago (14). Today, motion artifacts can be eliminated in almost all cases, meaning that children can often be studied without the need for sedation, and patients with rapid respiration or difficulty in swallowing can be imaged without any concomitant artifacts (15, 16). In a high-resolution mode, the anatomic detail remains superior to that provided by MR imaging, and thin sections can be obtained without sacrificing resolution, which is, in many cases, equal to or superior to that of MR images (17–19). In addition, patient compliance is high. The use of a bolus injector now provides excellent CT contrast delineation, far greater than that available in any previous era. Although the cost is greater than that of sonography, CT is often the only examination needed and it is still less expensive than MR imaging. It also remains the best technique for imaging a bony matrix and it is excellent for identifying small soft-tissue calcifications. Nonetheless, CT has its disadvantages: It uses radiation, which is undesirable in children and pregnant women, it requires an iodine-based contrast agent, which has concomitant allergy-mediated side effects, and in certain areas of the neck CT does not provide soft-tissue definition equivalent to that attainable with MR imaging. Although in the neck, one is limited to axial acquisitions, the reformatting software has improved to the point that multiplanar reconstructions are now of excellent quality (20, 21). Still, they are not equivalent to the direct multiplanar views obtainable with MR imaging.

As with CT, the initial MR units of a decade and a half ago bear little resemblance to the high-technology units of today. Thus, when comparing the role of MR imaging to CT, quotations from the literature should best be limited to the recent 3 to 5 years, when MR imagers have been the most advanced. It appears that MR imaging technology advances by leaps and bounds every few months; in fact, one could argue that present-day MR imagers provide such an abundance of information that we as yet do not thoroughly understand the clinical and pathologic significance of the data buried within these images. It may, in fact, be our limited understanding of what MR images show us that detracts from the more ubiquitous preferential use of this technique for examining the neck. Although we are faced with the task of evaluating the current generation of MR units, it is with the knowledge that any limitation we place on them may be overcome in the near future.

The benefits of MR imaging relative to CT include better imaging of moderate to large vessels; in ideal circumstances, better soft-tissue definition, especially in the brain, spine, and upper neck; the ability to obtain spectroscopic data; and the ability to evaluate bone marrow spaces better (22–26). Greater insight into the internal composition of a mass can be gained with MR imaging than with CT, but to some degree this is operator dependent, since it is the radiologist who must determine the proper sequences by which to delineate a particular problem. Many MR images that I review in consultation are suboptimal not because of the quality of the machine but because the physicians using the units did not optimize the study. Especially for the general radiologist, one has to admit that the plethora of articles on MR technology available each month makes remaining at the “cutting edge” difficult. It may, in fact, be the complexity of modern-day MR technology that can be considered a drawback to its proper use. Other limitations of MR imaging include its often exquisite sensitivity to motion artifacts, which degrade image quality, and other more subtle artifacts that can confound image interpretation. Patient compliance is also limited, either because of claustrophobia or an indwelling electronic or metallic device or foreign body. In addition, MR imaging usually requires more careful monitoring of the examination and more sophisticated technicians than does CT. In general, clinicians feel more comfortable with CT than with MR studies. Other drawbacks relative to CT include the higher cost and longer examination time of MR imaging. This latter point means that often fewer patients can be studied per day than with CT.

Having reviewed these brief technological pros and cons, one arrives at the hard part of such a commentary, the time to offer an opinion as to the method of choice for examining a patient with disease involving the soft tissues of the neck. I have chosen to consider the following criteria in making my decision: What single imaging examination provides sufficient information to allow the clinician to formulate the most informed treatment plan? What imaging study is most easily and accurately interpreted by the majority of radiologists? (This last point impacts on the number of diagnostic errors made and, because of the time

required to study the examination and form an opinion, impacts on the number of cases that can be correctly interpreted by a radiologist in a given period.) What single technique allows the most patients to be studied in a given time period? and What technique is most cost-effective in providing the best diagnostic information as a single study? I believe these are realistic criteria that reflect the problems we all face in the present medical environment.

For me, today, a well-monitored, contrast-enhanced CT study is the clear winner, finishing at the top of these criteria in virtually all instances. When canvassing my colleagues, especially those who almost exclusively interpret head and neck images, they too prefer CT as the primary examination for studying the soft tissues of the neck, especially if only one study can be obtained. There is a shared opinion that although most diagnoses can be made from either a CT or MR examination, the diagnosis seems to be established with less effort from CT scans, and the radiologist often has more confidence in the CT diagnosis. Thus, considering the problem and the restrictions mentioned, CT is a faster and cheaper examination than MR imaging, and the radiologist often arrives at a correct diagnosis more rapidly and with more confidence than is possible on a comparable MR study.

With this said, it is now only fair to reflect on the exceptions I make to use MR imaging in studying the soft tissues of the neck. In my experience, these are sites at which MR imaging not only provides more accurate information than CT but produces images that are more easily interpreted by most radiologists.

In general, my approach to MR imaging of the neck is based on two tenets: 1) the closer the suspected disease is to the skull base, the greater the likelihood that MR imaging will display the disease better than CT will; and 2) a history of a discrete mass in this upper neck region usually means that its boundaries will be seen better on MR than on CT. However when a patient has a history suggestive of inflammatory disease, I prefer CT, as any phlegmon or abscess is depicted as well as it is on MR images, but any clinically important small calcifications present are depicted far better on CT. Thus, I believe that a reasonable argument could be made to image preferentially masses of the parapharyngeal space, masticator space, parotid gland, and tongue by MR imaging (25–30). Although a pharyngeal tumor may be equally well depicted by CT and MR imaging or even better defined on MR images, these tumors pose a second imaging problem in that metastatic nodal disease is an important prognostic factor, and this aspect of the disease is generally believed to be better illustrated by CT (31–34). Thus, overall, most radiologists prefer CT for imaging patients with pharyngeal tumors.

What is clear from the literature is that various radiologists feel passionately about their choice of imaging tool in certain well-defined cases, and that although MR imaging holds the promise of being superior to CT in evaluating the entire neck, present-day MR imaging is limited by its sensitivity to artifacts, its difficulty in interpretation, its examination time, and its cost.

We, as radiologists, no longer have the luxury to ask clinicians to order multiple examinations in order to resolve the imaging problems of a case optimally. We are forced by economics to make a solitary choice. In the final analysis, this choice is based on the technique with which each of us feels most comfortable, and this comfort factor relates to which examination we perceive as minimizing our opportunity to misinterpret the images while assuring us that all the information necessary to make a pertinent contribution to the management of the case is available. Thus, by choosing CT, I believe that we are simultaneously maximizing our overall contribution to the case, minimizing our litigation exposure, and being cost-effective—all worthy goals in today's environment. As with virtually all things in medicine, the future brings change, and the remarks made here will undoubtedly have to be reconsidered in light of these changes. It is with great expectations that I look forward to see how this controversy evolves.

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