Mammographically dense breasts make the exclusion of small tumors difficult. This is particularly worrisome in high-risk patients. The characteristic changes of dynamic MR mammography are capable of discriminating these lesions. Moreover, the characteristic changes are known to apply only to active tumor regions and not to necrotic or fibrotic regions.

Magnetic resonance imaging of the breast in patients with silicone prostheses has proved to be highly accurate in identifying the common complications associated with the implants and in characterizing concurrent disease. A silicone breast implant has a uniform signal intensity that is easily distinguished from pectoralis muscle and breast parenchyma. This permits obvious positioning of the breast implant in relation to adjacent anatomic structures. Ruptured and intact implants are immediately differentiated with a high degree of specificity using MR mammography. Moreover, when implants are found to be ruptured, MR mammography is able to demonstrate whether the silicone material remains within the fibrous surgical capsule or has extravasated into surrounding tissue. In patients with trauma, MR mammography can distinguish a hematoma in the breast parenchyma from silicone that has extravasated into the surrounding tissues.

Although there is a need to identify in which women there is a high risk of breast cancer developing, the widespread use of MR mammography as a screening tool for the disease is not economically feasible because of its high cost. Cost analysis indicates that MR mammography is useful as a diagnostic adjunct to conventional breast imaging modalities that are difficult to interpret due to mammographically dense breasts, surgical scarring, or the presence of silicone implants.

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Radiosurgery

EACH YEAR MORE THAN 100,000 people in the United States are diagnosed with a benign or malignant brain neoplasm. Recent media reports focusing on radiosurgery, a relatively new treatment designed to halt neoplastic growth in the central nervous system, have raised expectations for cure or improved local control over standard treatments. Although not all patients are candidates for radiosurgery, an understanding of its mechanics, indications, selection factors, results, and cost is helpful when responding to patient inquiries or referring patients to radiosurgical facilities.

Radiosurgery, a noninvasive irradiation technique using stereotactic methods, is performed with narrow intersecting beams of one of three types of penetrating radiation: gamma rays produced by the decay of cobalt 60 in a Gamma knife (a specialized apparatus whose sole function is radiosurgery), x-rays produced in standard linear accelerators that have been modified to do radiosurgery, and charged particles such as protons or other ions produced by a cyclotron or synchrotron. No radiosurgical method currently has a clinically demonstrable advantage over another. Although there are a large number of linear accelerators in the United States, most patients are treated on Gamma knife machines. In each case, the intent is to produce cell death or blood vessel thrombosis of targeted tissue within a small, well-defined volume. Accurate targeting is required because the intense radiobiologic effects produced by a single high dose of radiation could result in radionecrosis of normal central nervous system (CNS) tissue. With current technology and commonly used doses, the risk of radionecrosis is often claimed to be less than 5% in many patients, but approaches 20% in patients with malignant gliomas.

The radiosurgical procedure involves a sequence of tasks: temporarily attaching a stereotactic frame to the patient's head, obtaining stereotactic radiologic images of the target and surrounding structures, delineating the target contour on the images, planning treatment by interactively displaying dose contours on computer monitor views of the images, positioning the frame with respect to the radiation beams, and irradiating the target in a single session. The entire process takes a day to do and requires a radiation oncologist, a neurosurgeon, a radiologist, a physicist, and a nurse; in some cases, such as those of children, an anesthesiologist may also be required. Patients are comfortable throughout the procedure, and most return to baseline activity in a day or two.

About 50,000 patients worldwide have been treated with radiosurgery, mostly in the past five years. About a third of these had arteriovenous malformations, a third had benign tumors (such as acoustic neuroma and meningioma), and a third had malignant tumors (glioblastoma, astrocytoma, and metastatic tumors). Clinical reports show that patients selected for treatment should have good neurologic function and a radiologically well-defined target. Most important, the target should be small—usually less than a few centimeters in maximum dimension. For larger targets, it may be impossible to select a dose that provides both a high chance for cure and a low risk for complications. This inverse relationship of dose and volume is supported by clinical experience and radiobiologic theory. Because the target is small, previous irradiation is not a contraindication to radiosurgery.

Numerous retrospective studies have shown that about 35% of arteriovenous malformations selected for radiosurgery are no longer angiographically visible within a year and 85% within two years. Permanent neurologic complications attributable to radiosurgery occur in fewer than 5% of patients treated by experienced teams. These complications may take months or even years to develop, however. Angiographic resolution of the arteriovenous malformation after radiosurgery appears to be equivalent to that of complete surgical resection; in either case, the risk for hemorrhage is virtually zero. The advantage of radiosurgery is that it is noninvasive and requires minimal hospital stay compared with open surgery. On the other hand, protection from hemorrhage is delayed until the malformation is obliterated by radiosurgery, whereas total resection immediately eliminates the risk for hemorrhage. Many physicians think that small arteriovenous malformations in the brain stem or in other hard-to-reach areas are best treated by radiosurgery. For those located in other areas, the immediate surgical risks must be weighed against the risk of delayed hemorrhage during the latent interval after radiosurgery.

The intent of radiosurgery for benign and malignant tumors is to prevent progression of the radiologic abnormality rather than to cause its complete disappearance—which occasionally occurs, but requires a high radiation dose to achieve consistently. Thus, serial scans—at intervals that depend on the tumor type—following radiosurgery are required. About 90% of acoustic neuromas selected for radiosurgery are controlled (do not progress). In the past five years, recommended radiosurgical doses for acoustic neuromas have been reduced, and the risks of facial and trigeminal neuropathy have been greatly decreased. Retrospective data show, however, that patients with useful hearing on the affected side still have a substantial risk for hearing loss. Whether radiosurgery or traditional surgery is the better therapy for acoustic neuroma is a topic of lively debate, especially because at least transient symptoms may occur after radiosurgery. About 95% of meningiomas selected for radiosurgery are controlled.

The standard treatments of glioblastoma and anaplastic astrocytoma include surgical excision, radiotherapy, and chemotherapy, but recent randomized trial results show a survival benefit for those patients who also receive a brachytherapy boost (temporary implantation of highly active radioactive iodine seeds in removable plastic catheters). Because radiosurgery produces a dose distribution similar to that of brachytherapy, it is now offered at many centers, either initially in conjunction with fractionated radiotherapy or as the only radiation procedure at recurrence. Several retrospective studies show that survival following radiosurgery is similar to that following brachytherapy, but this has not been confirmed in a randomized trial.

Brain metastases are usually well defined and noninfiltrative and therefore represent ideal radiosurgical targets. Retrospective studies show that the growth of targeted tumors is halted for six months in about 90% of cases and that patients then are more likely to die of systemic rather than CNS disease. Therefore, patients with CNS metastasis who derive the greatest benefit from radiosurgery are those who have no or minimal non–CNS metastases. Some studies show that radiosurgery may be useful for some patients with multiple CNS metastases, particularly if their primary disease is controlled and they have no evidence of non–CNS metastases. A current randomized trial should determine whether patients who receive radiosurgery at the time of diagnosis should also receive whole-brain radiotherapy.

Radiosurgery is appealing to patients because it is noninvasive and because the results of treatment compare favorably with those of alternative therapies. Although the typical cost per procedure of radiosurgery is greater than that of radiotherapy, it is less than that of an operation. Studies will help determine whether larger targets can be treated effectively and safely and whether radiosurgery results can be improved with radiosensitizers. In the future, we are likely to see radiosurgery techniques used at non–CNS anatomic sites.

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