Early breast cancer detection using Acuson S2000 ABVS and 3D tomosynthesis

The female breast is a fascinating anatomical structure. The mammary gland located in its center is surrounded by dense muscle and adipose tissue. And as if touched by magic, the gland becomes active during pregnancy. It is a complex tissue consisting of diverse cell types – mammary gland cells where the milk collects or myoepithelial cells that press the liquid into extremely fine milk ducts. Fatally enough, malignant tumors, known as mamma carcinoma, occur in this live-sustaining organ. Breast cancer is one of the most frequent cancers in western industrial nations. Every tenth woman in Germany falls victim to this disease. Yet despite these frightening statistics, it is possible to effectively fight breast cancer when detected in time.

The best weapon against breast cancer is early detection. In Germany and many other countries, public health authorities introduced so-called screenings for the female population: in Germany women between the ages of 50 and 69 are invited by a central coordination office to be checked free of charge using a standardized procedure. During the procedure, physicians check women with a mammography system, a special X-ray system, by pressing the breast slightly together and then imaging it in its entirety. In this way, pathological changes in the breast tissue can be diagnosed in the image. The screening program stipulates that women are to be screened every two years over a period of twenty years. The German Federal Joint Committee for Mammography assumes that through regular check-ups one out of 200 women will be saved from dying of breast cancer. However, critics point out that there are no statistics that confirm these findings and that screenings, while very costly, are of little use. One of the main points of attack: mammography indicates too many false positive findings, that is, it claims the presence of cancer although the woman is free from breast cancer. The consequences: in many cases, the woman is subjected to a biopsy, that is, removal of breast tissue. A painful procedure which proves to be completely unnecessary in connection with false positive findings.

But these counter-arguments lose their validity to the degree diagnostics are improving, because improvement also makes for more reliable as well efficient and more cost-effective examinations. For example, the new diagnostic technique of Siemens Healthcare in Erlangen (Germany) introduces for the first time 3D imaging for breast examination. Personnel in Erlangen expanded the proven "Mammomat Inspiration" mammography system by the new “3D tomosynthesis". Different from previous routine examinations, the breast is no longer exposed two-dimensionally in one fixed position only. Instead, the X-ray source swivels now in a 50 degree arch about the breast. At the same time, the system generates 25 extremely short single X-ray images at an extremely low dose. These individual slices of the breast are subsequently automatically combined into a 3D image. As compared to the classic 2D technology, the advantages obtained are considerable because suspect changes in tissue, so-called lesions, are displayed far more clearly in a 3D image. For one, this allows far better estimations regarding the size and type of lesion. For the other, it is easier to localize small micro-calcifications in 3D images that could be interpreted as the first sign of breast cancer. Vice versa, it can also be avoided that unfavorable superpositions of healthy tissue are interpreted incorrectly as malignant changes.
With traditional 2D mammography, the radiologist frequently takes a number of single images as well as a magnified X-ray exposure in case of doubtful initial diagnosis. For example, the lesion is shown blurred or is hidden by the surrounding tissue. If the new detailed images are not conclusive as well, a biopsy is recommended. However, reliable 3D imaging may render this step unnecessary. “Tomosynthesis will make mammography less stressful to both the physician and the patient. According to first impressions, additional examinations and interventions can be omitted in all good conscience. Lesions hiding in the gland tissue are detected earlier”, says Dr. Renate Tewaag of the Radprax group, a networked practice for radiology, nuclear medicine, and radiation therapy in Wuppertal. As one of the first radiologist in Germany, Tewaag has started to work with the new technology. “This 3D technology provides impressive improvements in detail recognition.”

Especially dense breast tissue limits the effectiveness of conventional mammography, for example in women with small breasts. This applies to approximately 40 percent of women where radiation is attenuated to a level that leaves details in the breast barely recognizable. In cases like these, 3D tomosynthesis is especially advantageous because superimposed dense gland tissue can be removed with an algorithm during image generation. An alternative for mammography is ultrasound which provides for better dense tissue sampling. For this reason, physicians have been using this method for a long time when mammography provided non-specific findings. Ultrasound is frequently used to help differentiate between harmless cysts and potentially malignant tumors. A study by the Radiological Society of North America concluded in 2002 that an additional ultrasound examination increases the detection rate of non-palpable breast cancer by 42 percent. However, for a long time the quality of the ultrasound examination depended on the examining physician because the examination was performed with a hand-held transducer. In addition, examinations of this kind were time-consuming. With its new ultrasound system Acuson S2000 ABVS (Automated Breast Volume Scanner), Siemens developed a system that solves these problems in a single sweep. This system also provides three-dimensional images of the breast for the first time.

The clou is automatic breast scanning. For this purpose, a small synthetic box is located on the patient’s breast. The transducer located in the box automatically sweeps the patient’s entire breast two to three times. The software takes the data and computes a 3D volume which is then displayed on the physician’s computer screen. This is just about a paradigm shift, because up to now the physician diagnosed the breast directly at the monitor during the examination while he was guiding the transducer. “The ABVS system is a further development of the previous ultrasound examinations performed with a hand-held transducer. Independent of the examining physician, automatization provides for the same image quality”, explains radiologist Dr. Frank Stoeblen, co-owner of the Essen Diavero Diagnostic Center, one of the first facilities to use this technology. Because of the standardized quality and the possibility of user-independent examinations, it is even possible to have trained personnel performing ultrasound scans. The physician is then able to fully concentrate on the diagnosis. Another advantage: automatization cuts the time required into half, from approximately 30 to 15 minutes. This could be of considerable
advantage and present an enormous savings potential, especially for a screening program that expects a high patient throughput.

For women with dense breast tissue, Stoeblen performs an additional ultrasound after they completed their mammography examination to make sure that he has detected everything. ABVS has shortened this process. What's more: the 3D image makes it possible to display the breast in detail slice-by-slice from the tip of the nipple to the back. Until recently, these displays were not possible. Yet they are extremely helpful for diagnosis or the planning of surgical interventions. In addition, the new 3D technique, continues Stoeblen, is highly suitable for diagnosing women who have a higher risk for breast cancer due to family history.

Currently a little more than half the women follow the request for screening in Germany. The number is higher in other countries, but there are always women who will not heed the request. According to the survey published by the Canadian British Columbia Medical Journal, there are a number of reasons for their refusal. Most patients hesitate because they are either too afraid that it may be painful, or they do not pay too much credence to the risk of breast cancer, or they are afraid of the effect of radiation. Jochen Dick of Siemens Healthcare sees the improved image quality as a solution. "It is not just going to improve the reliability of screening, it will also increase the trust women have in the system. Quick, efficient and safe methods such as 3D tomosynthesis and ABVS could contribute to alleviating their fears. "The work continues: within the framework of the "Medical Valley", a medical engineering excellence cluster in the neighborhood of Erlangen-Nuremberg (Germany), Siemens is currently working on fusing mammography with ultrasound images. A composite image generated with both modalities would provide the physician in record time with an impressive insight of the patient's anatomy. The technology is not yet on the market, but for Dick it is already certain that it will be difficult to find a more reliable technology for cancer care.