Medical Solutions

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Background information: X-rays & Co.

Major achievements in imaging diagnostics and therapy

Increasingly innovative imaging methods have greatly expanded the technical possibilities for diagnosing and treating diseases. In this context, X-ray systems have become more sophisticated. The availability of new methods such as angiography and computed tomography has allowed the continual improvement of diagnostic accuracy at greatly reduced radiation stress. Other recent methods, for example, ultrasound and magnetic resonance tomography and their number of different physical features have further expanded diagnostic possibilities. Both diagnostic and therapeutic methods have been significantly improved by the development of such innovative, hybrid systems. A new, uniform, user-friendly software platform is used to operate these systems. Utilizing IT solutions with increasing efficacy to optimize hospital systems is currently the fastest developing trend in medical technology companies such as Siemens Medical Solutions.

Classic X-Ray Methodologies

Wilhelm Conrad Röntgen's discovery of X-rays in 1895 made it first possible to visualize the interior of the human body without surgical intervention. When passing through the body, X-rays are attenuated differently by bones and organs. The results are displayed on a high-resolution monitor or film as a shadow image of the X-rayed body region. It is necessary to differentiate here between radiography and fluoroscopy. As compared to the short time (milliseconds) X-ray tubes emit radiation, radiation is continual and theoretically emitted for hours during fluoroscopy. Consequently, motion is visualized in addition to static images. Over the years X-ray systems have been improved and ex-

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panded, and new methods such as angiography and computed tomography have been added. Today, the radiation dose is adjustable to the specific clinical situation at hand as well as significantly decreased by a number of technical improvements. Developing film for innovative FD technology (FD = flat detector) in the new systems has numerous advantages: manual activities such as loading and transporting cassettes as well as developing film and inputting patient data more than once are eliminated. The superb image quality signifies diagnostic and therapeutic reliability as well as faster successful treatment. As a result, the patient's radiation exposure is reduced even further.
Practical examples: head, thorax, abdomen, vascular system, skeletal system, joints, chest, foreign bodies

Computed Tomography

For about 25 years, computed tomography (CT) has enabled us to generate detailed images of the body's interior. However, differing from standard X-ray imaging methods, computed tomography provides a cross-sectional view. With CT, the X-ray source as well as a detector system rotate about the patient's body during the examination. In this manner the physician obtains slices and data volumes with a very high spatial resolution in the shortest possible time. Due to advancements in multi-slice technology, even moving organs are able to be visualized today in a matter of seconds and with exact results. Considering the acquisition of up to 32 images per second and slice thicknesses of less than one millimeter, the advantages of 16-slice technology are numerous. This means, in particular for cardiology, new diagnostic methods that display the moving heart including all its vessels in high resolution or that generate a virtual flight through the coronaries.
Practical examples: head, bones, heart, lungs, abdomen, liver, lymph nodes, abdomen/intestines, vascular structures, emergency diagnosis

Ultrasound diagnostics (Sonography)

Sonography enables the visualization of internal organs in realtime. The method uses high-frequency sound waves that are partially reflected by the different tissues. In addition to examining fetuses during pregnancy, this simple, highly patient-friendly method is used primarily for organs whose access is not impaired by air-filled spaces or bones. Lymph nodes are also suitable for sonography. A more extensive method is Doppler

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sonography. Determining the blood flow rate is useful in diagnosing constrictions, blockage, and standard variations of the vascular structures and in the heart. It is necessary to differentiate here between color Doppler methods and spectral Doppler methods. Modern image processing methods have also made it possible to generate large-surface panorama images and 3D images.

Practical examples: throat, throat vessels, abdominal cavity, pelvic cavity, abdominal vessels, leg vessels, heart, chest, extremities, prenatal care

Magnetic Resonance Imaging

Magnetic resonance imaging or tomography (MRI) is a computer-aided medical imaging method that generates whole-body images without using ionizing radiation. Tomography means sectional imaging. In this context, the area examined is displayed as longitudinal or lateral slices. As a result, the physician obtains slice images or three-dimensional images with very high resolution within a short period of time. The human body responds to the strong magnetic field used in MRI. An MR system is a combination including a system that generates a strong magnetic field, a type of antenna that emits or receives RF waves, as well as a computer that calculates images using suitable programs. The excellent soft tissue contrast obtained with MR makes this image modality highly suitable for detecting a number of diseases such as tumors or inflammatory processes in the region of the central nervous system. In MR angiography, blood vessels are visualized either without using any contrast medium or using a significantly reduced amount of contrast medium.

Practical examples: detection of inflammatory processes in the central nervous system, examination of tumors in the entire body, functional representation of heart and vascular structures in realtime, all diagnoses involving organs, vascular structures, spine/bone marrow, joints, and mamma

Nuclear Medicine Diagnostics

Nuclear medicine diagnostics involves the application of low radioactive material using radionuclide imaging and positron emission tomography (PET). This method provides the opportunity to localize and examine physiological as well as biochemical processes and/or their pathological changes. In contrast to other imaging methods, nuclear medical examinations are function-oriented. In this context, metabolic processes are able to be examined using different radioactive substances with a very short half-life and to be

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displayed as functional images. The radioactive substance accumulates in tissue showing an increased metabolism. This allows, for example, visualization of tumors at very early stages. While decaying, the substance emits gamma rays, a very quick X-ray. For example, after a heart attack, the location and degree of the damage to the heart muscles due to lack of blood can be determined quickly and precisely. PET is the most important innovation in the last years in the field of nuclear medicine.
Practical examples: diagnosing cancer and monitoring treatment, diseases of the cardiovascular system, of kidney function, of the brain (epilepsy, dementia, Alzheimer's disease), and of the glands

Radiation Therapy

Next to surgery and chemotherapy, radiation therapy is one of the most important treatment methods for malignant tumors. In radiation therapy, high-energy forms of electromagnetic radiation as well as particle beams are used either alone or in combination with other methods. Today, accelerators are used to accelerate electrons almost exclusively in straight acceleration tubes, hence the name linear accelerator. As the electrons decelerate in the target, they generate bremsstrahlung photons (high-energy X-rays) that are used for treatment. It is also possible to remove the target and use the high-energy electrons directly for treatment. A key factor in the success of radiation therapy involves damaging the cell nucleus to eliminate the cell's ability to divide and to stop the tumor's growth. Radiation therapy is applied locally. This means that radiation is focused on a specific area only, sparing the surrounding healthy tissue. For this purpose, individual treatment schedules are created for every patient. The dose necessary for treating or minimizing a tumor is typically administered in up to approximately 30 individual sessions. The doses administered in this manner reach about 60 gray. Radiation therapy also has several non-oncological uses, e.g. for the treatment of certain joint diseases, support of dilatation (expansion) of blood vessels, and for certain neurological diseases.

Additional Developments

Molecular imaging combines positron emission tomography and computed tomography to produce anatomical and functional imaging in one diagnostic system. By overlaying the information in one image, biopsies are targeted with greater accuracy and treatment

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schedules are more precise as well as patient-friendlier. The system allows very early detection of cancerous tumors. An integrated system comprising a linear accelerator and a computed tomograph on rails was developed to assist exact tumor positioning for radiation using high doses. Virtual simulation expands the operating methods of CT and MR. Today, with the help of innovative software developments and IT solutions, they provide a viable alternative to conventional examination methods.

Siemens Medical Solutions is one of the world's largest suppliers to the healthcare industry. The company is known for bringing together innovative medical technologies, healthcare information systems, management consulting, and support services, to help customers achieve tangible, sustainable, clinical and financial outcomes. From imaging systems for diagnosis, to therapy equipment for treatment, to molecular medicine to hearing instruments and beyond, Siemens innovations contribute to the health and well-being of people across the globe, while improving operational efficiencies and optimizing workflow in hospitals, clinics, home health agencies, and doctors' offices. Recent acquisitions in the area of in-vitro diagnostics – such as Diagnostic Products Corporation – mark a significant milestone for Siemens as it becomes the first full service diagnostics company. Employing approximately 36,000 people worldwide and operating in more than 130 countries, Siemens Medical Solutions reported sales of 8.23 billion EUR, orders of 9.33 billion EUR and group profit of 1,06 billion EUR for fiscal 2006 (preliminary figures). Further information can be found under: http://www.siemens.com/medical

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