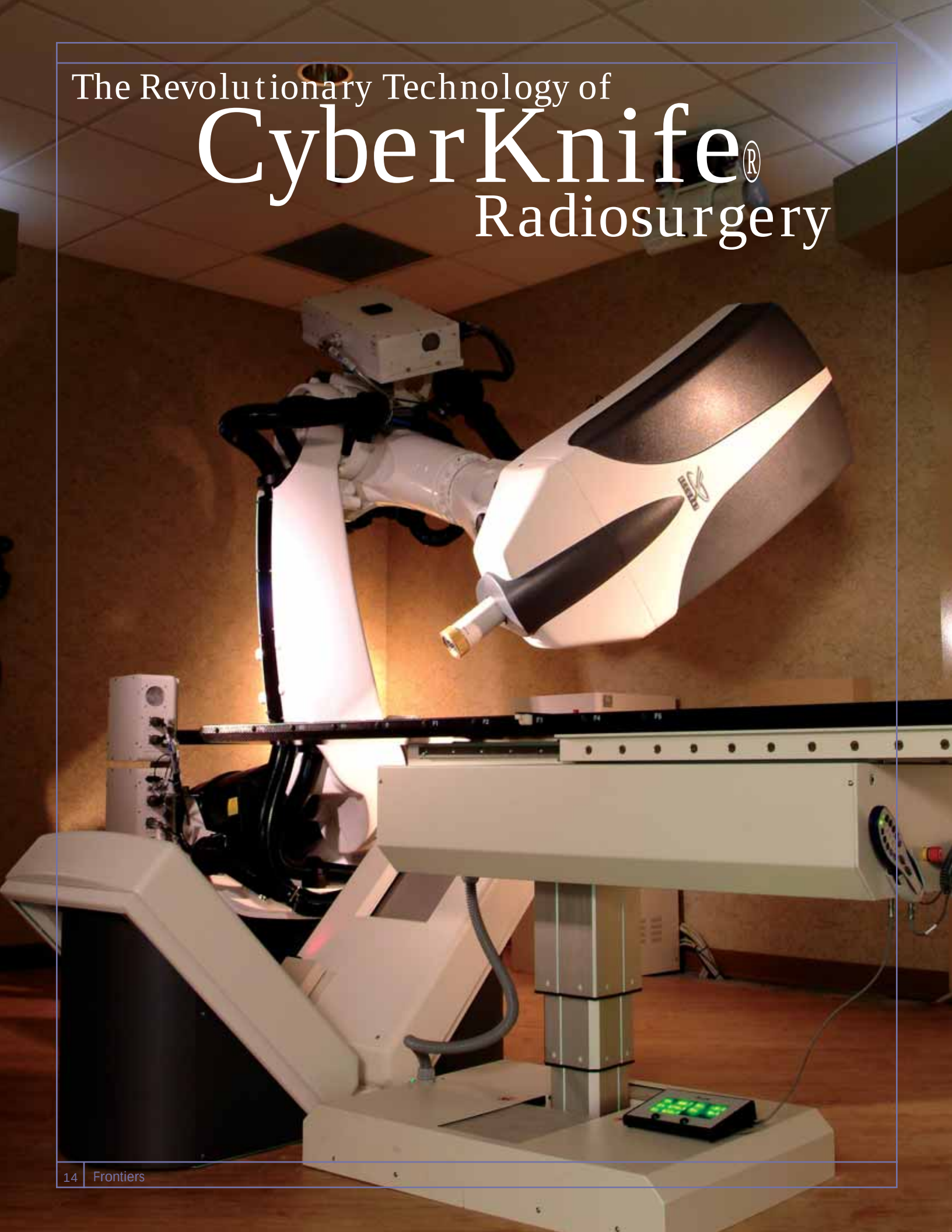
The Revolutionary Technology of CyberKnife® Radiosurgery



While most patients don't understand the meaning of stereotactic, fiducials or linear accelerators, they can relate to the idea of a fast, painless, and non-invasive medical procedure. A revolutionary radiation procedure called CyberKnife now provides an alternative to surgery or conventional radiation for treatment of chronic pain and tumors.

The CyberKnife system consists of three components—a linear accelerator, a robotic arm and an X-ray guidance system. The linear accelerator produces the beams of radiation used to treat diseased areas, while the robotic arm precisely aims the radiation beam directly at the tumor or other problem area. Three-dimensional X-ray cameras compile frequent images of the patient during treatment to guide the radiation beam and adjust for patient movement. University of Tennessee Medical Center Neurosurgeon Dr. William Snyder, Jr. notes that "because of its pinpoint accuracy, the CyberKnife system offers hope to patients who cannot receive further conventional radiation therapy. Patients who are poor surgical candidates or who have inoperable tumors may also be treated with CyberKnife. It also can treat tumors of the spine with the same level of accuracy as in the brain."

Although other systems such as Gamma Knife can deliver stereotactic radiosurgery, they are generally limited to treatments for the head only and require attaching a metal frame to the skull. In contrast, CyberKnife requires no frame and can deliver treatment in other areas of the body.

The CyberKnife procedure consists of three steps that can be completed in one day or spread across five days—all on an outpatient basis. Step one is the set-up. For head treatments, a soft mesh facial mask is custom made, which effectively holds the head steady during the treatment. For spine or body treatments, fiducials (metal markers) are placed near the tumor to guide the beam of radiation. Next, a computed tomography (CT) scan provides detailed information regarding the exact size, shape and location of the area to be treated. From this image, the CyberKnife team—consisting of a neurosurgeon, radiation oncologist and medical physicist—develops a customized radiation delivery plan.

The treatment plan tells the CyberKnife robotic arm the number, direction, and intensity of beams to deliver to the affected area. Dr. Robert Bertoli, a UT Medical Center radiation oncologist, explains, "The physicians outline the tumor or lesion to be irradiated, and mark the surrounding area where radiation should be minimized or avoided. The high-speed CyberKnife computer then performs millions of calculations to generate the optimal radiation delivery plan. Never in my career did I dream I'd be able to use this type of technology."

Physicians and nurses alike praise the CyberKnife technology because it dramatically affects the quality of life for their patients.

Stereotactic Timeline

1951 In Stockholm, Lars Leksell describes radiosurgery

1958 In Uppsala, Sweden, B. Larsson applies a proton beam to neurosurgery

1965 In Moscow, proton irradiation is used by V. Koroshkov

1967 In Stockholm, Lars Leksell develops the first gamma knife procedures

1970 In Stockholm, gamma knife is used for brain arteriovenous (AVM) malformation

1982 Linear accelerator applied to radiosurgery

1992 First commercial radiosurgery linear accelerator installed

1994 Stanford, CA First CyberKnife treatment of a brain lesion

1997 Stanford, CA CyberKnife used for arteriovenous malformation of the brain

2000 CyberKnife used for lung diseases

Step three is treatment. The patient lies on a table while the robotic arm moves the linear accelerator around him, stopping at preset positions to fire a small beam of radiation at the offending area or tumor. The room is surprisingly quiet, with only the hum of the equipment and the buzzing noise of the invisible radiation beam. The patient feels nothing.

The radiation beams are delivered from different angles, but all intersect on the targeted area which receives a very high total radiation dose. The surrounding healthy tissue receives a very low, non-toxic dose. A typical treatment can be composed of 100 to more than 150 beams.

> "The Cyberknife system offers hope to patients who cannot receive further conventional radiation therapy."
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> Dr. William Snyder, Jr.
> Neurosurgeon

Because the treatment is non-invasive, the patient can return home and resume a normal routine, generally with no pain or lengthy recovery process. There is no risk of hemorrhage or infection and there are rarely any side effects.

Physicians and nurses alike praise the CyberKnife technology because it dramatically affects the quality of life for their patients. As Dr. Daniel Green, medical director of Radiation Oncology says, "It is very gratifying to see such immediate pain relief for a patient who had such debilitating pain for 20 years."

With the CyberKnife system in place, the University of Tennessee Medical Center now offers the latest advances in stereotactic radiosurgery. Physicians with the CyberKnife Center at the Brain and Spine Institute include a group of five board-certified neurosurgeons and two board-certified radiation oncologists who are familiar with the newest techniques in stereotactic radiosurgery. In addition, they collaborate with board-certified neurologists, neuropathologists and neuroradiologists, creating a multidisciplinary team that offers the best treatment options for patients throughout the East Tennessee region.

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Dr. Robert Bertoli and members of the CyberKnife team discuss treatment with a patient.

Understanding Tumor Treatments

Stereotactic Techniques:

Computers are used to produce a three-dimensional image of the tumor. This 3-D view offers the physician a precise and accurate view of a tumor as well as its relationship to other vital parts. The 3-D image is obtained with the aid of pins, a compass (or Sextant) system, or C-arm equipment.

Radiosurgery:

Radiosurgery is not really surgery because no incision is required. Focused radiation is used to destroy a tumor. Because the radiation is more tightly focused on the tumor, a smaller dose can be used with far less damage to surrounding tissue.

Minimally Invasive Surgery:

While performed by surgeons, there is no incision, but only a series of small punctures, less than a quarter inch in size. Small cameras, tubes and equipment work through the incisions to reach the tumor. X-ray machines provide the surgeon with a three-dimensional enlarged view of the tumor and surrounding area. Once the appropriate treatment is performed, the incisions are sealed with an adhesive, called Permabond. No stitches needed.

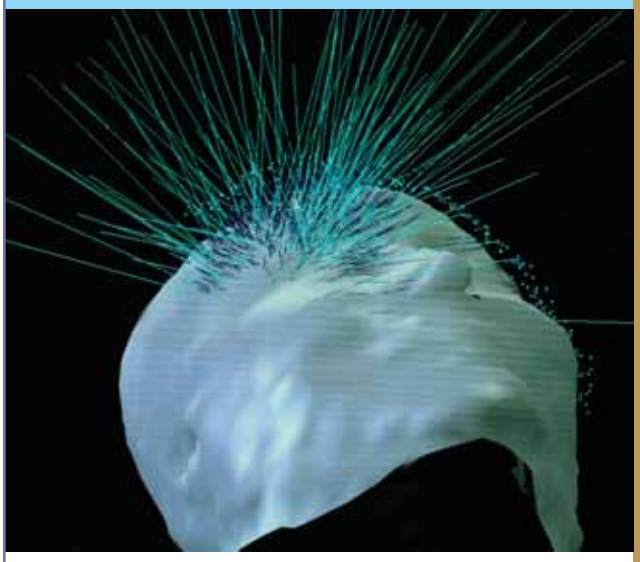

Illustration of radiation beams

Image courtesy of Accuray

"It's a miracle in my life. God has blessed me," she smiles.

Wanda Thrasher sips iced tea with friends after enjoying a full day shopping, walking, and talking. It may seem like an unremarkable scene, but for Thrasher, it's like a dream come true. After living for almost two decades with excruciatingly severe pain in her face, Thrasher has been rescued by the CyberKnife team at UT Medical Center.

In 1986, Thrasher suffered severe injuries throughout her body when she was involved in an automobile accident. The head trauma caused a condition known as trigeminal neuralgia or tic douleureux, a disorder characterized by repeated episodes of severe facial pain. The intense pain she experienced could be triggered by any touch to her face: chewing or swallowing food or drink or even a gentle breeze of cool air could cause the trigeminal nerve in her face to erupt with the speed and severity of lightning.

"I was on several medications and still was in tremendous pain," Thrasher recalls. When the pain hit, she could not eat, drink or talk. Doctors had suggested brain surgery, but that frightened her even more than the pain and medications. Eventually, she found the CyberKnife treatment through her son.

Thrasher's procedure took approximately one hour and 30 minutes, although she says it didn't seem that long. "I felt relief right on the table," she remembers. The first question the team asked her was, "Do you have any pain or numbness?" Astonished, she replied, "I have none." The pain of almost twenty years was gone.

Thrasher's treatment was a success, and she actually could start thinking about a life with no more pain. "Without incisions or blood, I was able to get up and go home," Thrasher states, still amazed. "It's a miracle in my life. God has blessed me."

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