Peter Bremberg’s Web Site has the honest, often-painful quality of an old-fashioned journal that lets you peek into a chapter of someone’s private life. An Internet scrapbook of sorts, its pictures show a strong, young athlete laid low by bone cancer and the treatments to arrest its spread, whose damaged leg is subsequently reconstructed by surgical “builders.”

Bremberg was 20 last spring when surgeons removed an osteosarcoma and a chunk of his left leg in the knee area. The second-year Franciscan University student—a wrestler and member of the rugby team—set out to document, with his priest, Fr. Kevin Gugliotta, his experiences from the time immediately following his diagnosis, through chemotherapy, major orthopaedic surgery, physical therapy, a second round of chemotherapy, prosthesis fitting, then learning once again how to walk, and maybe down the road, to run.
The young athlete’s diagnosis was made on his birthday, November 29, 2002, during his Thanksgiving break from college. Bremberg had assumed that the soreness he felt in his left knee for several months was a rugby injury that would heal on its own. But the discomfort persisted. The diagnosis of cancer was followed by an initial round of chemotherapy. Then, on April 2, 2003, he had a surgical procedure called a “rotation-plasty,” which cut out the cancer, but preserved enough of the patient’s own leg to significantly enhance his chances of regaining full mobility.

Recreating Forms That Function
Eighty percent of osteosarcomas grow in the bones surrounding the knee, and most appear between ages 15 and 25, more often in males than females. In Bremberg’s case, the tumor involved the whole knee. According to University Hospital (UH) orthopaedic oncology surgeon Francis Patterson, MD, there are two kinds of surgeries that can be done for this type of tumor: amputation of the limb or limb salvage surgery (also called limb-sparing surgery). In the majority of cases, amputating an entire limb is no longer necessary.

Limb salvage surgery involves first removing the tumor and
any other diseased tissue, then “filling in” with either an allograft (a bone graft from a tissue bank), endoprosthesis (metal joint replacement) or a composite. Limb salvaging procedures have become more routine since modern chemotherapy boosted cure rates for osteosarcoma and some other bone cancers over 60 percent. New and better implant materials and devices, and major advances in diagnostic capabilities and surgical tools and technique, primed the specialty of orthopaedic oncology surgery to leapfrog into the next century. In 2003, this surgical specialty knows how to save more healthy tissue and so improve function and appearance, while simultaneously arresting cancer’s spread and increasing the odds of halting disease recurrence.

A limb-sparing technique—called van Nes rotationplasty—is an excellent option for some patients, particularly those who are young and athletic, says Patterson, who is also an assistant professor of surgery at New Jersey Medical School (NJMS). In Bremberg’s case, the reasons for using this procedure seemed obvious. The ability to save more healthy tissue enhances the potential to rebuild a stronger limb, better able to withstand the wear and tear of everyday life as well as the more rigorous demands of sports.

According to Patterson, a rotationplasty can be done after surgically removing a sarcoma located above or in the vicinity of the knee. The procedure calls for fusing the residual femur and tibia, and rotating the leg 180 degrees on the femur so the foot is facing backwards. The ankle, in effect, takes over the function of the knee, with the remaining thigh and calf muscles controlling the new knee’s function. After healing from surgery, the patient is fitted with a prosthesis.

The upside, says the surgeon, is not only that it preserves more of the patient’s healthy tissue to reconstruct the limb, but the range of motion is excellent, the limb is strong, only one operation is necessary and there is no internal prosthesis, so there is no risk of infection or need for additional surgeries years down the road to replace an aging implant. Because the patient retains his own foot—even though it no longer functions as such—there is no “phantom foot” pain.

The downside? “This is a great operation for the appropriately selected patient who understands that the alteration of anatomy will provide benefits in terms of function,” explains the surgeon. However different the leg may look, he says that most patients, after adjusting to it, have no problem with cosmetic issues, and when pants are worn, there is no visible difference between the two limbs.

“High amputations are difficult for the patient in terms of regaining function,” he continues. “Rotationplasty turns an above-the-knee amputation into a below-the-knee amputation.” Bremberg recently met someone who had passed the New York City fire department physical exam after recovering from this type of operation; and when Bremberg was called recently to schedule his next appointment, he was out playing golf. “I guess that says something,” his surgeon comments.
Patterson says that when dealing with a tumor of the musculoskeletal system, the top goals of cutting out the entire tumor and preserving the maximum function become ever more reachable as technology advances. High on his current success list are: a 47-year-old man with a large liposarcoma of the thigh whose surgery preserved near normal motion and strength of the extremity, and who has since become a ski instructor; and a 30-year-old woman who had half her pelvis removed, and a composite of allograft and hip replacement used to reconstruct her hip, and is now planning on having a second child.

The orthopaedic surgeon’s practice involves the treatment of benign and malignant bone and soft tissue tumors in children and adults, and is divided equally among primary bone, primary soft tissue and metastatic tumors. “Sometimes patients with metastatic tumors are bedridden with pain and fractures,” says Patterson, “but we can provide pain relief and help the patient get out of bed, walk and maintain independence.”

“What we always try to do is provide the best oncologic treatment first and foremost, but then use all available options to reconstruct the extremity and tailor each reconstruction to the patient’s needs,” he concludes.

**Implants That “Grow”**

Among the newest developments in the world of orthopaedics is a generation of highly sophisticated implants. Joseph Benevenia, MD, vice chair of orthopaedics and an associate professor at NJMS, and director of the division of orthopaedic oncology at UH, puts these devices high on his list of major advances in the field over the last few years. One such new-generation endoprosthesis actually stretches as a child grows up.

The surgeon explains that when bone cancer strikes young children in the growing years, it often appears around the knee, necessitating removal of the knee, including major growth plates. An implant that can be lengthened to keep pace with a child’s growth—without surgically reopening the leg to do so—is often just what this doctor orders. Surgeons remove the tumor and surrounding affected tissue, save the healthy tissue below the knee, and insert this simple internal mechanism that functions as a bone replacement.

The new prosthesis can be lengthened up to a centimeter at a time. It uses a simple computer and a ring that goes over the leg to “melt” an internal plastic piece, allowing the implant to “stretch out slowly like a spring,” according to Benevenia. This is usually done every few months for a couple of years in a procedure lasting just three to five minutes. When the child is finished growing, the expandable prosthesis is replaced with a permanent one.

“This means one additional operation versus four or five,” says the surgeon. Since surgery obviously poses a risk to the child—from infection to pain to a psychological set-back—each procedure not done is a victory of sorts.

In the case of Carissa Kohler of Colts Neck, one limb-salvage procedure also did the trick. Removal of a Ewing’s sarcoma of the wrist and reconstruction by moving a bone in her forearm to recreate the wrist mean the ninth-grader can ride her horse and “flex her muscle” in much the same way as other 14-year-olds. When asked about her ability to hold a pencil, keyboard, and take care of the family’s newest additions—two miniature pinschers—she smiles happily and says there’s really nothing she can’t do. The right arm is a perfect match to the left one, no small feat when you view on the x-ray the metal plate initially used to hold the bones together. “The bone has replenished itself so well since her surgery two years ago,” says Benevenia, “that the plate will probably be removed.”

Benevenia, who graduated from NJMS in 1984 and completed his orthopaedic surgery residency at University Hospital, says he has always appreciated the patient perspective, from
fears about recurrent disease to concerns about disfigurement, disability and how quickly one can resume normal life after surgery. A walk through his home sculpture garden demonstrates that this empathy plus his ability to creatively conceptualize anatomical form is the link between the metal sculptures he creates and his work in the operating room. It is one of the important talents he brings to the table when reconstructing diseased and disfigured limbs.

“His ability to see beyond the disfigured body in front of him to what that leg or arm or hip should look like is at the core of what makes him a really good orthopaedic surgeon,” says Robert Harten, PhD, a biomechanical engineer in the NJMS Department of Orthopaedics.

The orthopaedic surgeon also serves on the board of directors of the Musculoskeletal Transplant Foundation, the largest nonprofit tissue bank in the U.S., located in Edison. He says that while most people are fully aware of the life-saving potential of organ donation, there are few who understand the need for donations of other tissues. In 2002, approximately 220,000 individuals received allografts provided by the Foundation and its members. Sixty percent of the musculoskeletal allografts were for spinal surgery, primarily for spinal fusions, and the other 40 percent for orthopaedic oncology, sports medicine, and other orthopaedic surgeries, mainly of the hip and knee.

According to the Foundation, there are roughly 80,000 people in the U.S. in need of organ transplants and hundreds of thousands in need of tissue transplants. The tissues that can be recovered include bones, tendons, ligaments from the legs, hips, ribs and arms, heart valves, veins from the legs, and skin.

Benevenia points out that as these tissues become safer with ever more reliable tests for pathogens, the use of allografts in orthopaedic surgery is becoming more widespread. Chief among these uses are: long bones to replace bones of the arms and legs riddled by cancer; small sections of bone to strengthen areas of the spine or to replace other injured bone; ligaments and tendons to help rebuild damaged ones; skin as a temporary covering for burn patients during healing; heart valves to replace nonfunctional ones; and veins from the legs for use in cardiac bypass surgery.

The human body is chipped, bruised, broken, sprained, cracked and scarred by disease and trauma, as well as years of encounters with a hard-edged world. But science is pushing forward. New materials such as tissue engineered polymers and growth factors, the use of advanced molecular techniques to better characterize cancers in order to treat them more effectively, advances in imaging abilities and tissue transplantation, and customized modular implants designed jointly by implant engineers and surgeons are making inroads toward fixing the superb engineering feat that is the human body—when it goes awry. But Benevenia points out that to forget the aesthetic, human side is to fail.

“An orthopaedic surgeon needs to go far beyond technical expertise,” he concludes. “It’s not just about being a right knee doctor or a left knee doctor. You have to walk hand-in-hand with the patients, making sure each one understands the process before you both take the next step.”