ADVANCED TREATMENTS FOR KNEE CARTILAGE INJURIES

Wear, Tear *and* Repair

"Joint pain is not normal."

If orthopaedic surgeons were limited to just one diagnostic dictum, this would likely be it.

Pain, they will further assure you, is not a normal part of the aging process; instead, it is a clear sign that treatment should be sought.

Photo by
ERIC FRICK

Story By
S. A. UNGER

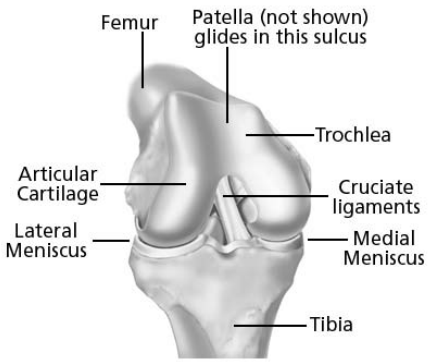
When it comes to the knee joint, the most common source of pain is cartilage injury, which can be due to either trauma or the wear and tear of normal daily activities. Whatever the cause, once an injury occurs, the delicate balance of the knee is upset, which can result in "overload damage."

Over time, what may have started as a small defect in the cartilage can progress, causing a deterioration that leads to osteoarthritis.

In recent years, orthopedic surgeons have developed a number of sophisticated procedures to correct knee problems. Although many of these procedures are relatively new, they are no longer considered experimental. Despite their proven efficacy, however, the procedures are often still only performed in specialized settings. As a result, it's not uncommon for patients to be told by their doctor that nothing short of a total knee replacement can address their symptoms, when in fact other options are available.

It was concern over such limited treatment options that led orthopaedic surgeon William Wind, MD '97, to spearhead the establishment of the Western New York Cartilage Restoration Center at the University at Buffalo in January 2004. The center, located in Farber Hall on the South Campus, is directed by Wind and staffed by UB-affiliated orthopaedic surgeons who offer a comprehensive range of services focused on the treatment of complex knee problems.

NORMAL KNEE ANATOMY



UB TECHNOLOGY AND EXPERTISE

After completing medical school and residency training at UB in 2002, Wind served a one-year fellowship at the Cleveland Clinic Foundation, where he received further training in knee and shoulder arthroscopic surgery, as well as cartilage transplantation. When he returned to Buffalo after the fellowship, he saw that patients with cartilage injuries in Western New York were not being offered the same treatment options as were patients in Cleveland.

"There wasn't a knee cartilage restoration center in western or central New York or Pennsylvania, and there are only a handful of such centers around the country," says Wind. "I was born and raised in Buffalo, and I wanted to offer patients in Western New York the best possible care without them having to travel."

In addition to Buffalo being his hometown, Wind wanted to return to the city because of the positive experience he had at UB, both as a medical student and as a resident. He also knew the university had the technology and expertise necessary to support a cartilage restoration center.

"It's been a perfect fit," says Wind, who explains that surgeons in the center work closely with the UB Center for Advanced Biomedical and Bioengineering Technology (CAT) to access the latest technologies in support of their research projects. This collaboration is facilitated by the fact that William M. Mihalko, MD, PhD, a surgeon in the Cartilage Restoration Center, is the director of the UB CAT.

William Wind, MD '97, pictured on previous page, is founding director of the Western New York Cartilage Restoration Center at the University at Buffalo, clinical assistant professor of orthopaedic surgery at UB and a member of the university's Sports Medicine Institute. He also is head team physician for the UB men's basketball team and assistant team physician for the UB football team.

"There wasn't a knee cartilage restoration center in western or central New York or Pennsylvania, and there are only a handful of such centers around the country," says Wind. "I was born and raised in Buffalo, and I wanted to offer patients in Western New York the best possible care without them having to travel."

THE ARTHRITIS FACTOR

When patients come to the Cartilage Restoration Center, they are first given a thorough evaluation to determine whether conservative treatments will ameliorate their symptoms. These treatments can include physical therapy, anti-inflammatory medication or nutritional supplements. Corticosteroid or joint lubrication ("viscosupplementation") injections may also be appropriate for some patients.

If conservative treatments fail or aren't warranted at the outset, patients are then educated about the surgical options available to them, which can include cartilage restoration, cartilage replacement (arthroplasty) or a variety of other interventions aimed at repairing ligaments or knee malalignments, such as "bow-leg" or "knock-knee" deformities.

A key factor in determining the course of treatment is the presence of arthritis in the knee, or the potential for arthritis to develop.

When talking with patients about how arthritis affects their treatment options, Wind uses the analogy of a road that has been worn down by varying degrees, from mildly "pitted" to severely deteriorated. In general, patients with severely worn tissue are candidates for cartilage replacement procedures, whereas patients with "potholes in the road" are candidates for cartilage restoration procedures. Not surprisingly, the degree of "road wear" more often than not correlates with age.

"We see patients from all age groups at the center," says Wind. "We see younger patients who may have injured ligaments or broken off a piece of cartilage during their athletic activities. We also see middle-aged patients who may have had an injury in the past and are having some symptoms of pain and swelling and are starting to develop early arthritis. Older patients whose cartilage is 'at the end of the road' present with discomfort with activities of daily living."

Once damaged, cartilage is especially prone to arthritis. This is because the cells (chondrocytes) that reside in the tissue do not have a blood and nerve supply and so are unable to replicate, which gives them a poor capacity for healing once they are injured. Typically, the larger the cartilage defect the more likely the progression to arthritis, according to Wind.

One of the primary goals of surgeons at the Cartilage Restoration Center, therefore, is to intervene early in the degeneration of cartilage in order to help the body initiate its own healing process and, in some cases, even delay the progression of arthritis.

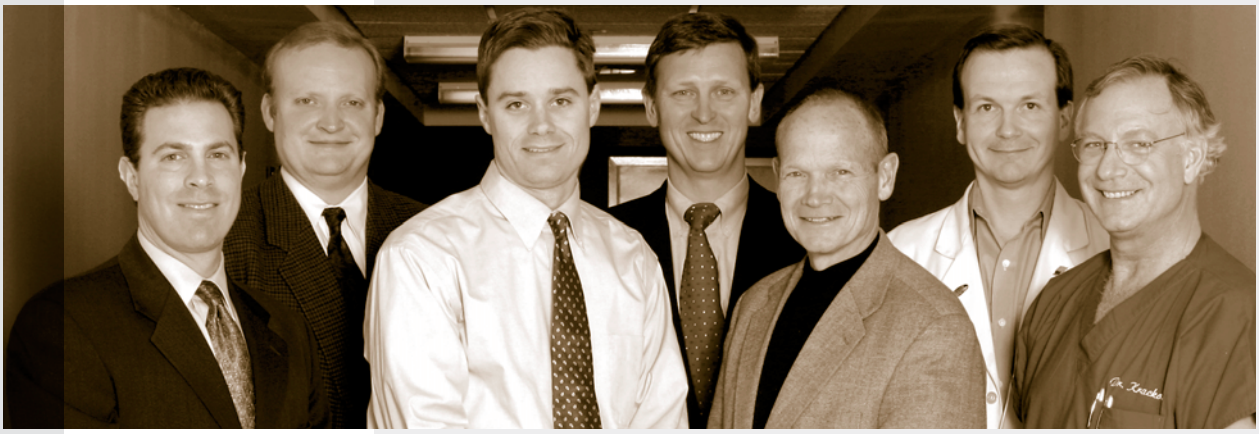


PHOTO BY TIMOTHY PALASZEWSKI

Western New York Cartilage Restoration Center surgeons, *left to right,* are Marc Fineberg, MD; William Mihalko, MD, PhD; William Wind, MD '97; Robert Smolinski, MD '83; Lawrence Bone, MD '73, chair of the UB Department of Orthopaedic Surgery; Matthew Phillips, MD '91; and Kenneth Krackow, MD.

MINIMAL SURGERY, MAXIMUM RECOVERY

Although surgeons in the center perform a wide variety of minimally invasive restorative procedures, three in particular serve to illustrate just how far treatment of knee cartilage injury has come in recent years.

The first is a meniscus transplant. In years past, when a person tore his or her meniscus, it was removed in open surgery. Long-term studies have shown, however, that in addition to compromising the biomechanical function of the knee, removal of the meniscus results in the development of osteoarthritis in many patients. Therefore, surgeons in the center make every effort to repair the tissue arthroscopically, using special sutures or absorbable implants to secure the tear. If a tear is located on the inner edge of the meniscus, where there is minimal blood supply and therefore no capacity to heal, the surgeons perform a partial meniscectomy to remove only the torn meniscus cartilage. "We leave the remainder of the meniscus alone to maintain the shock-absorber properties that the meniscus provides for protection of the articular cartilage," explains Wind.

A Technological Leap in Total Knee Replacement

CONCEPT PIONEERED BY BUFFALO ORTHOPAEDIC SURGEON

BY S. A. UNGER

TOTAL KNEE REPLACEMENT procedures have been performed since the 1960s and significantly restore function and reduce pain in 90 to 95 percent of patients.

Despite this success, surgeons have been dissatisfied with the prosthetics' variable life span, which primarily depends on two factors: the wear and tear the knee is exposed to, and the precision with which the replacement components are initially fitted by surgeons, who, in years past, have had no option but to rely on the "naked eye" to make these fits.

In the mid-1990s Buffalo orthopaedic surgeon Kenneth Krackow, MD, an internationally renowned expert in lower-joint reconstruction and replacement, decided to focus his attention on developing a technology that would circumvent this reliance.

"In the past, many surgeons, myself included, were making judgments that were not as precise as they could be because we had no specific data on which to base those decisions," says Krackow, a UB professor of orthopaedic surgery and head of orthopaedic surgery at Kaleida Health.

To accomplish his goal, Krackow had the idea to take existing motion-analysis equipment, such as that being used in the aircraft and motion picture industries, and adapt it to improve the then-standard total-knee replacement procedure. A similar approach had been successfully taken by physician-researchers developing navigational guidance systems in neurosurgery and several other medical fields.

Working with Krackow at the time was William Mihalko, MD, PhD, a biomedical engineer and recent medical school graduate who was completing a one-year research fellowship with Krackow prior to beginning residency training in orthopaedic surgery at UB.

"We became aware of equipment that uses a camera to look at and triangulate the position of infrared light sources in front of you," explains Krackow. "And we knew that by developing mathematics that allowed us to locate parts of the knee that are not readily accessible to the naked eye, we could adapt this equipment to follow the entire knee replacement operation and implement standards of precision that previously had not been possible."

Mihalko, who today is director of the UB Center for Advanced Biomedical and Bioengineering Technology, was charged with locating the motion-analysis equipment Krakow wanted to adapt for use in knee replacement surgery. Eventually, his efforts were rewarded when he found a company

Young, symptomatic patients who have had all or most of the meniscus removed during a prior surgery and who have not yet developed significant arthritis are eligible for a meniscal transplant, which involves implanting a donated cadaveric meniscus under arthroscopic guidance.

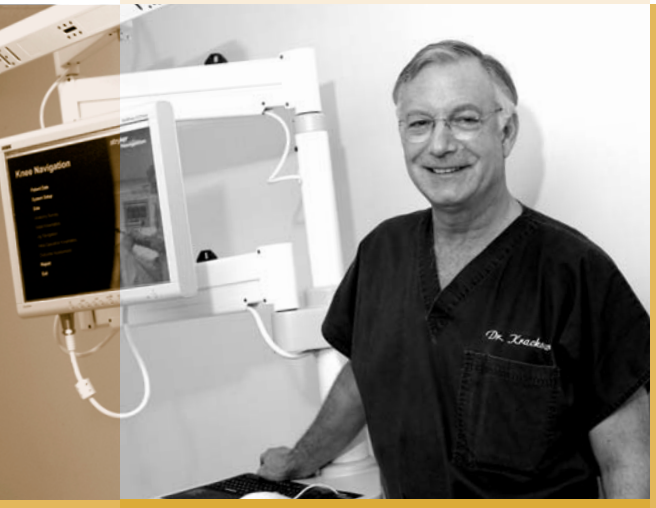
Unlike other transplant surgeries, patients who have undergone this procedure do not need to take immunosuppressive drugs to prevent rejection of the tissue.

The transplanted meniscus, in addition to restoring biomechanical properties, helps delay the progression of arthritis.

"Many middle-aged patients who in the past have had a partial meniscectomy and are now developing arthritis in the knee joint inquire about a meniscus transplant," says Wind. "Unfortunately, studies have shown that this type of patient doesn't do as well following this procedure. Instead, it's the younger patients who have had a traumatic injury to the knee resulting in a near-total meniscectomy whom we're able to help in the long term."

The second procedure of note is called an osteochondral autograft transplantation, which surgeons in the

Continued on Page 8



Kenneth Krackow, MD, professor of orthopaedic surgery at UB and a member of the surgical staff in the Western New York Cartilage Restoration Center, is internationally renowned for his research and development of surgical procedures, devices and instrumentation that have evolved total knee replacement. In the mid-1990s, Krackow, who also is chief of orthopaedic surgery at Kaleida Health, pioneered computer-assisted total knee replacement, now in use worldwide.

only 100 miles away in Ontario that could supply the hardware.

Mihalko then began residency training at UB and his successor, Louis Serpe, set to work developing prototype hardware and software as envisioned by Krackow.

By 1997 the prototype was ready for the operating room and Krackow performed the first computer-assisted total knee replacement operation. That same year, he and his group published a paper on the procedure in the journal *Orthopaedics**. In the paper, they described how the new system enables surgeons to make precise decisions on the alignment and orientation of instruments, the location and depth of bone cuts and the placement of knee implant components.

Over the next few years, Krackow worked to find an industry partner to commercialize his idea. Eventually the medical products manufacturer Stryker Company took up the project and further refined the equipment, which they now market as the Stryker Navigation System: Knee Module.

In October 2001, Krackow performed the first Stryker Navigation System computer-assisted total knee replacement procedure in the United States at Kaleida's Buffalo General Hospital.

Since then, he has introduced the procedure to orthopaedic surgeons worldwide, both in person and via satellite broadcast from Buffalo General Hospital.

"Once the Stryker system was released, other companies jumped on board and got their own systems going," says Mihalko. "However, to Dr. Krackow's credit, although these other manufacturers tried to go their own, unique route, today they all have come back around to the same way he implemented the system from the beginning."

"Many people don't realize that back in the '80s Dr. Krackow was also involved in developing the modern instruments used for total knee replacements, prior to developing the computer-assisted system," Mihalko adds. "He really is an unbelievable asset to Buffalo." BP

**A New Technique for Determining Proper Mechanical Axis Alignment During Total Knee Arthroplasty: Progress Toward Computer Assisted TKA,* Orthopaedics *22:7:698-702, 1999.*

Continued from Page 7

center offer to patients who have had extensive cartilage damage that results in defects about one to two square centimeters in size (see illustration, opposite).

Analogous to a hair-plug transfer, this procedure involves removing a small cylindrical section of the patient's own cartilage along with the underlying bone plug obtained from a nonweight-bearing area in the knee (typically the femoral trochlea, where the patella glides, or the outer aspect of the knee).

The harvested bone and cartilage plug is then placed in the previously prepared defect, thereby transferring normal, mature cartilage to the area of injury.

A third procedure that illustrates the advanced treatment available at the center is called an autologous cartilage cell implantation (ACI), which is used to treat articular cartilage defects larger than two square centimeters. The procedure, which was first developed in Sweden a decade ago, was approved by the U.S. Food and Drug Administration in 1997 and since that time has been offered to patients in cartilage restoration centers across the country.

The ACI procedure is performed in two stages. The first stage—which can be done when the knee joint is initially assessed arthroscopically by the surgeon—involves harvesting a small amount of the patient's own articular cartilage from a nonweight-bearing area. The cartilage is then sent to a lab where cell-culturing and growth techniques are used to increase their numbers from a few hundred thousand to over 10 million.

The cells are then returned to the Cartilage Restoration Center, where, in a second surgical procedure, they are implanted under a patch that is sewn to the surrounding cartilage. Over several months, the implanted cells create a matrix to reestablish the articular surface.

According to Wind, studies have shown that the ACI procedure, just like the osteochondral autograft transplant, can replicate the function of normal cartilage in the knee joint.

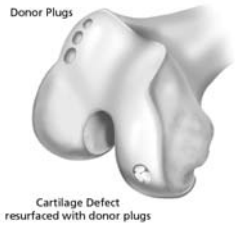
Recovery from all three of these procedures requires that patients do not place any weight on their knee for about six weeks. In addition to being on crutches, patients spend a prescribed amount of time on a continuous-passive-motion machine, which moves the knee for the patient, stimulating the cartilage cells to grow.

"In general, most patients take a good six months to a year to fully recover from these procedures, depending on the size of the defect," says Wind. "But the long-term results have been very promising."

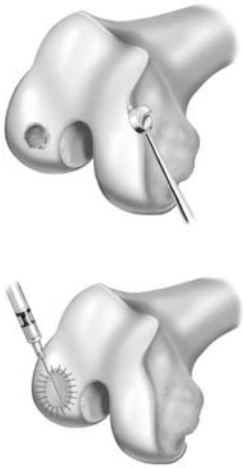
The "take-home" message, Wind stresses, is that there are a wide variety of treatment options available for patients other than a total knee replacement.

"Unfortunately, many people are not aware of these cartilage restoration procedures," he says. "We typically see the middle-aged patient with mild arthritis who is told they have to wait five to ten years in pain until they will

OSTEOCHONDRAL AUTOGRAPH TRANSPLANTATION



AUTOLOGOUS CARTILAGE CELL IMPLANTATION (ACI)



One of the primary goals of surgeons at the Cartilage Restoration Center, therefore, is to intervene early in the degeneration of cartilage in order to help the body initiate its own healing process and, in some cases, even delay the progression of arthritis.

become candidates for a total knee replacement. Some of these patients may be candidates for cartilage restoration, which may not only relieve their pain, but also prevent them from ever needing a total knee replacement. The life span of a knee replacement is limited and it's not uncommon for us to see patients in their 60s who have already worn out one. So, if we can buy someone even five to 10 years with a cartilage transplant, that's a huge service."

TOTAL KNEE REPLACEMENT

Despite the variety of minimally invasive surgical options available today, there still are patients for whom a total knee replacement is the only option due to their having developed what Wind calls "severe bone-on-bone arthritis."

The good news for these patients is that the total knee replacement procedure has been enhanced in recent years by the development of a computerized navigational system that enables surgeons to use infrared beams to more precisely shape and place replacement components.

This concept and the software behind this new technology were pioneered in Buffalo by Kenneth Krackow, MD, clinical professor of orthopaedic surgery at UB and a member of the surgical staff at the Cartilage Restoration Center (see article on page 6).

Wind explains that in order for a knee-joint prosthetic to wear well over time, it's essential that it be precisely aligned with a person's hip and ankle, just as the correct alignment of a car's wheels affects how tires wear. Orthopaedic surgeons know that to obtain the best outcomes for total knee replacement, they must make cuts that are accurate to within one to two degrees.

Using the computer-assisted navigational system, surgeons at the center can achieve this accuracy with a "smart camera" that uses minimally invasive wireless "pointers" and "trackers" to send data about knee anatomy and movement to the system's computer. The data are then translated into two-dimensional real-time images that give surgeons a picture of the knee's mechanics prior to making the bone cuts.

"The navigational system enables us to make adjustments to accommodate the patient's individual anatomy and to make extremely precise bone resections prior to inserting the prosthesis," says Wind. "By utilizing this

Continued on Page 11

Mouse Calls

Knees and Knee Disorders

For a guide to Knees and Knee Disorders, visit the UB Health Sciences Library web site at (http://ublib.buffalo.edu/hsl/resources/guides/knees.html), where you will find listed select audiovisuals, books, and journals available in the Health Sciences Library, as well as a guide to Internet resources.

The Internet Section includes links to six U.S. cartilage restoration and repair center web sites, including the Western New York Cartilage Restoration Center (http://www.wnycrc.buffalo.edu/), located in the University Sports Medicine facilities in Farber Hall on the South Campus.

Of notable interest, in the Journal Section are links to 30 full-text electronic journals in the subject areas of orthopaedics, sports medicine and surgery. Three journal titles are particularly relevant to the knee: *Arthroscopy: The Journal of Arthroscopic and Related Surgery, Minimally Invasive Therapy and Allied Technologies,* and *Sports Medicine and Arthroscopy Review* (available online to UB-affiliated users only if accessed off-campus).

The Digital Media Resources Center in the Health Sciences Library offers five programs listed in the Audiovisual Section, including Daniel's knee injuries: ligament and cartilage: structure, function, injury, and repair CD-ROM, accompanied by a textbook, edited by Robert A. Pedowitz, published by Lippincott Williams & Wilkins in 2003.

The Book Section includes more than a dozen titles covering everything from basic knee anatomy to physical therapy, including a recent book on minimally invasive surgery, MIS of the hip and the knee: a clinical perspective, edited by Giles R. Scuderi.

All resources listed on the page can be used within the library by anyone in the community.

Compiled by Pamela M. Rose, MLS, Health Sciences Library, University at Buffalo, Abbott Hall Room 102, 3435 Main St. Building 28, Buffalo, NY 14214. (716) 829-3900 x129. pmrose@buffalo.edu. BP

Special Needs for Athletes' Knees

BY S. A. UNGER

RUNNER DENNIS MIKE IS BACK ON THE TRAIL

WHILE THE PAIN AND SWELLING associated with cartilage damage can be frustrating for patients whose goal is to restore the functionality of their knee, other patients are further discouraged by how such damage can impair their ability to return to highly active lifestyles, including athletic competition.

For all of his adult life, 53-year-old Dennis Mike has relied on trail running to provide a foundation for good health and an essential outlet for stress.

"I just love to be out of doors," says Mike, a professor of reading education at Buffalo State College. "Running not only is a large part of staying fit for me, it's a large part of my mental regime—something I really realized when I hurt myself and couldn't do it."

Tools used for microfracture procedure.

In April 2003, Mike fell down stairs at home and injured his knee. Being an experienced competitive athlete, he felt confident he could rehabilitate the knee himself and over the course of the summer worked toward this goal.

One morning in September, however, Mike woke up and could barely move his leg.

"I went to see an orthopaedic specialist, who determined that I had a torn meniscus," he recalls. "I asked specifically for a referral to a sports medicine clinic because I knew the physicians there would understand about someone who wanted to bring their knee back to where they could engage in athletic activities again."

Mike was referred to orthopaedic surgeon William Wind, MD '97, founding director of the Western New York Cartilage Restoration Center (see article on page 2) and a member of the University at Buffalo's Sports Medicine Institute.

After seeing Wind, Mike decided to undergo surgery to evaluate the torn meniscus. In addition, he asked Wind to further assess his knee during surgery and make other repairs he felt were necessary.

As it turned out, Wind did find other damage: a "pothole" lesion in Mike's articular cartilage. To address it, he performed a microfracture procedure, which is used to treat small cartilage defects (about a square centimeter in size) that are well contained.

"At the time of surgery, we take a very sharp instrument and pick at the bone underneath the cartilage," says Wind, describing the microfracture procedure. "This supplies blood to the injured area and stimulates a scar cartilage to form."

Although the scar cartilage is inferior to normal cartilage, the technique successfully eliminates symptoms for most patients.

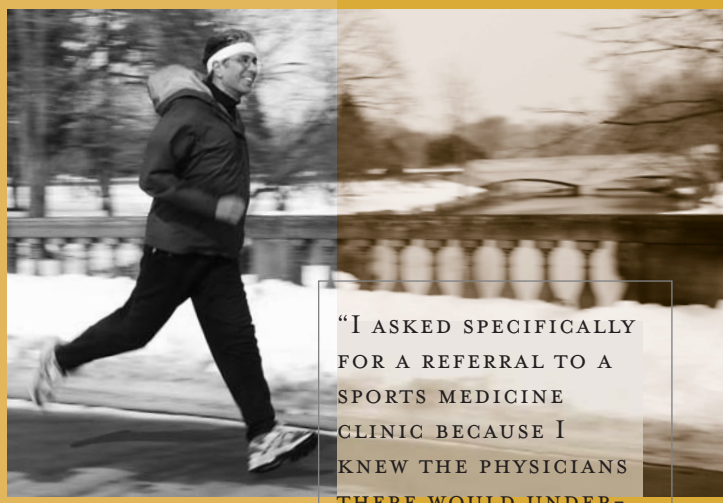
While Mike's recovery was "long and arduous," involving six weeks on crutches and months of special exercises, he says Wind was with him every step of the way.

"It was the best experience I've ever had with any sort of healer," says Mike. "He involved me in the entire recovery process to the point where—and I find this extraordinary—I would ask for articles from medical journals and he would provide them for me."

In addition, Wind invited Mike to e-mail him any questions he had.

"Normally in this type of situation I would be worried that I was making a pest of myself, but I never got that sense from him," says Mike. "And it wasn't just the quantity of communication that I appreciated, but the quality; he was so open and accommodating."

PHOTO BY KC KRATT



Dennis Mike

"I ASKED SPECIFICALLY FOR A REFERRAL TO A SPORTS MEDICINE CLINIC BECAUSE I KNEW THE PHYSICIANS THERE WOULD UNDERSTAND ABOUT SOMEONE WHO WANTED TO BRING THEIR KNEE BACK TO WHERE THEY COULD ENGAGE IN ATHLETIC ACTIVITIES AGAIN."

Today Mike is back on his favorite trails, steadily recovering his former strength and stamina. "As I've gotten back into shape and built up the running to where I was before, what I'm finding is that when I have any discomfort at all, it's not in the knee that was operated on," he says. "It's in the other knee!" BP

Continued from Page 9

technology, we can better restore a patient's natural knee alignment. Also, we are now beginning to apply this same technology to research computer-assisted anterior cruciate ligament (ACL) reconstruction."

Wind and his colleagues are conducting long-term studies comparing the new procedure to the standard total knee replacement procedure. Results to date have shown that patients who have undergone the computer-assisted total knee replacement procedure have a less variable lower-extremity alignment, which is associated with better outcomes.

Due to the training and instrumentation required to perform the new procedure, however, only a small number of facilities in the country currently offer it to patients.

"The life span of a knee replacement is limited and it's not uncommon for us to see patients in their 60s who have already worn out one. So, if we can buy someone even five to 10 years with a cartilage transplant, that's a huge service."

"It's just these types of complex cases that the Cartilage Restoration Center was established to treat," Wind emphasizes. "With our university affiliation, we are confident that we have the technologies and expertise needed to not only provide the most advanced care possible, but also assist in the development of new treatments."

For more information on the comprehensive services provided by the Western New York Cartilage Restoration Center, visit the center's Web site at www.wnycrc.buffalo.edu.