

# JOINT JOURNAL

VOLUME 12

DECEMBER 2007

## The Quest Continues

Despite the great patient satisfaction derived from knee and hip replacements, many orthopaedic surgeons want to see the longevity of artificial joints improve. Much of our research at Anderson Orthopaedic Research Institute (AORI) focuses on two primary areas of vulnerability in joint replacements: component wear and the linked issue of bone loss, or osteolysis, that can occur around an implant. It is believed that osteolysis is caused by minute particles of polyethylene debris that result when implants in the hip or knee joints wear against each other.

This issue of the *Joint Journal* includes several articles about AORI research projects that are related to the quest for greater longevity of joint replacements. The adjacent article describes new equipment being used by our knee research team to assess the relationships among knee implant design, patient gait, and implant durability.

On page 2, Dr. William Hamilton discusses findings from a 20-year follow-up study on the revision of femoral components in total hip replacements, as well as changes that have occurred since this treatment was first championed by Dr. Charles Engh.

Page 6 features the discoveries of our visiting Research Fellow, who has continued AORI's leading research into the use of computed tomography (CT) scans for assessing osteolysis and cup stability in a clinical setting.

## New Research Equipment to Answer Questions About Knee Replacements

By Rebecca Wolf

Doctors always want to know how their patients are walking, climbing, and doing their daily activities after a knee replacement. AORI's knee research team needs this same information to study the performance of different implants and surgical techniques. Typically, patient follow-up — and most knee research — has been based on patients' responses to questions and measurements taken while they are inactive. This works well for patient care, but researchers would like more precise measurements that show how different implants affect a patient's regular activities. This fall, AORI purchased two new pieces of equipment that make it possible to obtain such data.

"Patients' answers and doctors' observations are subjective, so we're trying to get something we can actually measure," says Nancy Parks, one of AORI's knee project directors. "Our new equipment is going to help us quantify how people are moving while doing activities relevant to their daily lives. We want to be able to measure how much better they're doing than before surgery, and, again, a year

after surgery, when they have gotten back to using muscles that may not have been used for years."

Until recently, researchers could only gather measurements of a person's walking pattern and stance at specially built centers. The miniaturization of technology has made it possible to collect rather complex data from a lightweight device that is worn like a belt. Dime-sized sensors on this "portable gait lab" are attached to a patient's feet, thighs, and chest.

"Accelerometers measure where each sensor is in time and space and record it on a computer chip on the belt. The sensors gather tons of data every third of a second," says Parks enthusiastically. "One could think of it like a

global positioning system (GPS) tracking the placement of individual body parts and then drawing conclusions about the person's movements."

The data will enable Parks to compare how different types of knee implants affect walk, stance, and daily activities.

The second piece of equipment is much larger and has a 5-foot-long force



Kate Whitney, Director of Physical Therapy at Anderson Clinic, shows off the portable gait lab that participants in AORI knee studies will wear during follow-up evaluations.

See *Knee Studies*, page 3

## A Hip Replacement That Lasts and Lasts

By Rebecca Wolf

In the early 1980s, orthopaedic journals and conferences were filled with studies and discussions about a growing problem. Surgeons had been witnessing a rising need for revision total hip arthroplasties due to the loosening of early implants. The hip revision procedures of the day did not provide a satisfactory, long-term solution for these challenging cases, which frequently involved the deterioration of the hip bone (femur) or socket (acetabulum). Dr. Charles Engh — convinced that bone could grow into a porous-coated implant — championed the use of fully coated stems for femoral revision surgeries. AORI's subsequent studies of these revision surgeries influenced others to adopt the procedure, and by 1990, it had become the unequivocal gold standard for femoral revisions. The latest clinical review, published this past spring, examined the results of 905 Anderson Clinic patients, ranging from the earliest cases done 26 years ago to ones done as recently as 2006. The findings, described by lead author Dr. William Hamilton in the following interview, show why this has become the preferred treatment for femoral revisions.

**Q.** How would you describe the predicament presented by femoral revisions in the 1980s?

**Hamilton:** Many revision patients had very poor bone quality from multiple previous surgeries. The gold standard for fixing implants to bone was bone cement. It worked reasonably well in first-time hip replacements, but it did quite poorly in most re-do surgeries.

**Q.** Why was cement so unreliable for revision surgery?

**Hamilton:** It has to do with the structure of the bone. The inside of a healthy bone — the cancellous bone — is rather spongy and has little pores, almost like a beehive. Cement can form a bond with this porous surface, but when an implant fails, the cancellous bone interface is lost. The remaining interior bone is smoother, and the cement cannot form a good bond with it. Consequently, the stem comes loose much more quickly than on a first-time hip replacement.

**Q.** Why are most femoral hip revisions now done with extensively porous-coated stems?

**Hamilton:** Probably 90% - 95% of the orthopaedic surgeons in North America use extensively porous-coated femoral implants for revision hip surgery. These stems, designed to bypass the defective bone that typically occurs on the higher part of the femur, are placed in healthier

bone lower on the femur. The porous-coating that covers at least two-thirds of the stem provides a rough surface into which bone can grow. It has been shown repeatedly that this ingrowth provides durable fixation.

**Q.** What was the reason for your latest study on the clinic's femoral revision cases?

**Hamilton:** We were asked for long-term data for a meeting of orthopaedic surgeons. The point was to see how our femoral revision patients were doing in the long run. The take-home message from the review is that once a stem becomes bone ingrown, it does not come loose.

**Q.** Are you saying that if a patient's femoral implant has become bone ingrown, it can be expected to last indefinitely?

**Hamilton:** That is right. All of the failed stems in the study occurred within the first 10 years. The survival rate of about 96% remained stable after that.

**Q.** Does this mean that implants that become loose were never bone ingrown?



Dr. William Hamilton says the take-home message from their study is that once bone grows into an artificial femur, the implant will not come loose.

**Hamilton:** Yes, a small percentage of patients have implants that fail because the bone doesn't grow into the implant. It is not entirely clear why this happens. Some of it may have to do with poor bone quality or surgical technique, but there also are the wild-card cases where everything goes perfectly, and the implant still doesn't become bone ingrown.

This is the subject of another paper I recently wrote. We wanted to learn the success rates for patients who had failed a re-revision and then were revised again. We found that with these challenging re-do surgeries, there is still about a 90%

Continued on next page

## Patient Follow-up: It's Indispensable

**W**hy is it important that patients make follow-up appointments in the years after a joint replacement, even when everything seems fine? The foremost reason is so the doctor can assess the condition of the joint and the implant. Doctors are particularly concerned about how an implant is wearing and if osteolysis, or bone loss, has occurred around the joint. Wear and osteolysis rarely cause symptoms, but over time both can necessitate corrective surgery. How fast an implant wears is an individual matter, depending on many patient factors. The rate of wear and progression of osteolysis can be estimated for each patient from regular X-rays.

Another way regular appointments ensure patient well-being is that our doctors and researchers use follow-up information to assess the performance of newer components or treatments. Not only does this research affect the treatment received by Anderson Clinic patients, it also influences the treatment received by patients around the world. The clinical studies described in this newsletter are possible because of the



A patient's phone rings. It could be Shivi Kamalanathan, calling to remind them of a follow-up appointment. Recently graduated in Human Kinetics from Ontario's University of Guelph, Shivi handles patient surveys and the paperwork required for AORI's research studies.

extensive patient database available to AORI. We applaud Anderson Clinic patients for caring for their own health and for contributing to progress in hip and knee arthroplasty.

### Hamilton interview continued



**LEFT:** The light area near the top of this revised femur is an area of bone loss. The stem is stabilized by placement into healthy femoral bone below the deteriorated area. The porous-coated stem provides a surface into which bone can grow, and thus, provide long-term fixation.

chance that the component will become bone ingrown, and that once it does, it will remain stable.

**Q.** I understand that sometimes a patient's femur can be so deteriorated that an extensively porous-coated stem isn't the best solution. How has research helped define the treatments for rebuilding a hip?

**Hamilton:** One of the benefits of Dr. Charles Engh's 30 years of practice is that he used the same stem for all of his patients. This has enabled us to assess which types of cases in our database are most successful and which are less suc-

cessful. The success rate is lower among patients with extremely poor bone stock, perhaps from extreme osteoporosis or multiple surgeries. While the vast majority of femoral revisions can be treated with this procedure, it has become clear that in extreme cases, a different reconstruction method is needed.

The research paper referred to in this article is *Extensively Porous-Coated Stems for Femoral Revision: A Choice for all Seasons* by W. Hamilton, D. Cashen, H. Ho, R. Hopper, C. Engh, published in the *Journal of Arthroplasty*, Vol. 22, No. 4, Suppl. 1, 2007.

### Knee Studies from page 1

much larger and has a 5-foot-long force plate on which patients do activities, such as walking, sitting, or turning around. The plate can measure balance and stability and determine whether one leg is being favored or if a person sways when walking — all factors that may vary with different implants.

“Most knee patients are thrilled with their results, because they are in so much less pain, but right now, there is a lot of interest in the orthopaedic community in trying to get people back to normal physiology,” says Parks. “The force plate enables AORI to quantify and compare aspects of that.”

Initially, AORI's new equipment will be used for prospective research studies. In the future, they may become valuable tools for evaluating clinical outcomes and distinguishing the performance of a wider variety of implants.

## Water Exercise: Good for the Body, Good for the Soul

By Rebecca Wolf

It is Monday morning, and the atmosphere inside the Pocomoke City, Maryland, YMCA locker room is filled with energy, as women getting ready for their water exercise class catch up on the latest news. They come 3 mornings a week, year-round, from rural and coastal villages on the Eastern Shore of Maryland and Virginia — 20 or more women, the youngest, 44, the oldest, 91. What began as an exercise class 6 years ago has become a community of women who share lots of laughter, celebrate each other's birthdays, and lend a shoulder or hot dish when needed.

But as they enter the pool at 9 AM, their talking is cut short by instructor Linda Hartsock, who reminds them it is time to work. Hartsock started the class in 2001 as a means of getting some REAL exercise before her first hip surgery. She and some neighbors had been exercising daily at an outdoor community pool, but as Linda says, "Some people would talk, and some would exercise." When the new YMCA opened, they asked if a water exercise class could be offered. The only hitch was finding a qualified instructor. Hartsock, who had retired from an association management career in Washington, D.C., is not one to let that small hurdle stop her.

"I have a degree in physical education, but it's 40 years old, and I hadn't used it for the last 39 years," Hartsock says laughing. "Long story short, I dusted off my old books and talked to some friends who are in the business."

With a doctoral degree in education and access to the internet, Hartsock had no problem putting together a class plan. Incorporating recommendations of the American College of Sports Medicine, she included 30 minutes of aerobics and 30 minutes of stretching, strengthening and toning of the major muscle groups. To increase the effectiveness of their workout, the women use Styrofoam noodles, webbed gloves, or 1- or 2-pound weights that add resistance to their moves.

Although Hartsock seems to have boundless energy, that was not the case 6 years ago. Since then, she has had two total hip replacements and a total knee replacement.



Those Styrofoam noodles may look funny, but they add resistance to the women's workout.

"The surgeries gave me my life back. Before the replacements, I was a crotchety old woman. I'm sure I wasn't any fun to be around," Hartsock says. "Given the choice between going into the grocery store or sitting in the car, I'd sit in the car. I was old before my time, because every time I moved, I was in excruciating pain."

Advised that exercising before the surgery could help her recovery, Hartsock started doing water exercises regularly and even did physical therapy before her first hip replacement. By the time she had her second hip surgery — with a knee replacement in between — she had been exercising regularly for almost 4 years. She was amazed at the difference in her recoveries.

"The harder you work on the exercises in the Anderson Clinic book, the quicker the recovery and the better the pain management. The day after my second surgery, I was able to walk on crutches, and I was out of the hospital



Linda Hartsock, left, and Betty Tyler share several things in common. They both had three joint replacements at Anderson Clinic, and they both love being able to do water exercises with the other women in their class.

in three days," Linda says.

Linda seems somewhat surprised — and definitely pleased — by the life her water exercise class has taken on. When the YMCA celebrated its 5th anniversary, the class members were interviewed on the local radio station. Linda says that when the interviewer asked

## Norm's 66th Birthday: A Time to Celebrate Good Health

By Rebecca Wolf

As a young man, Norm Braveman played semiprofessional baseball; during his middle years he competed in squash, played a mean game of racquetball, and worked out daily; but by his early 60's, Braveman could barely walk from the pain of osteoarthritis. In 2005, after three years of limited activity, he chose to have a hip replacement.

Surgery can be daunting, and Braveman had a unique approach in selecting a surgeon. He asked each prospective doctor the same thing – would a hip replacement give him a 70% chance of getting back to an active life? The answer he received from Dr. Charles Engb was surprising.

“He was the only surgeon I visited who would not give me that promise. He said it would help me, but what happened to me after surgery was up to me,” said Braveman.

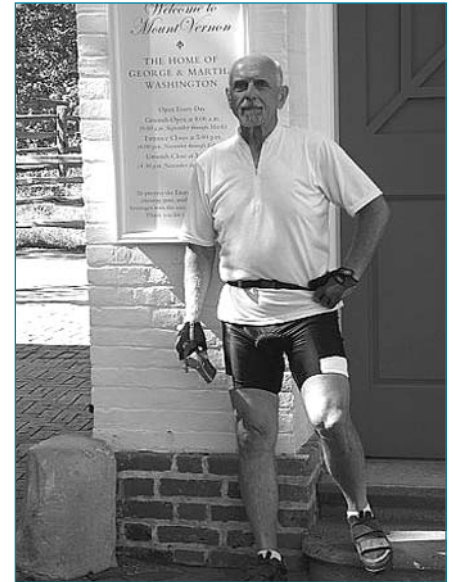
That message stuck with Braveman. While doing physical therapy after surgery, he set a goal of losing the 75 pounds he had gained during his years of inactivity.

“Now, I feel like a different person physically,” Braveman says. “It was like I had a different life before and after surgery. I had started to think of myself as an old man, but I discovered I could change my lifestyle and the way I look.”

When Braveman's 66th birthday approached this past September, he wanted to celebrate by bicycling with friends.

“While I was figuring out how to get other people to spend the day biking, it occurred to me that they would do it, if they thought it would cost me money,” Braveman says.

Being a supporter of the Children's House at the National Institutes of Health (NIH), where he works, Braveman proposed to donate a dollar to the facility for every mile ridden by the birthday group. Going from NIH, north of Washington, D.C., to Mt. Vernon, Virginia (near Anderson Clinic), the riders totaled 381 miles. When other coworkers heard about Braveman's challenge, they chipped in more donations – bringing the total in honor of his big day to nearly \$700.



Because of the changes a total hip replacement made in his life, Norm Braveman wants others to know that the surgery can make it possible for people with debilitating arthritis to get back to their lives. “Not everybody is going to be like me and want to go bicycling for 50 to 60 miles every weekend, but they can go for a walk, enjoy nature and other people, and get away from the T.V. set. After surgery, the limits for doing those things are gone.”

### Water exercise continued

one woman why she keeps taking the class, the woman answered, ‘My cholesterol's down, my blood sugar's down, and my bone density's up. What else would you want?’

“We have a 91-year-old in the class,” Linda continues, “who joined two years ago because she could not pick up her 1-year-old great-great grandchild. She felt terrible about it. She's a little bit of a thing, and sometimes when she pushes the exercise buoys down during class, she pops right up. But now she can pick up the child.”

The participants come for a variety of reasons. Two women had suffered the loss of loved ones. “They were having real trouble dealing with the grief, but they got out of bed, pulled up their socks, and came to the water exercise class. The exercise group encompassed them,” Linda says. “Everybody knows everybody's challenges and successes and is concerned.”

Interestingly, the YMCA water exercise class also has attracted a number of other people with joint replacements. “We have at least 8 joint replacements, 6 done at Anderson Clinic, in the class now and at least 4 more joint replacement

candidates, who will soon be deciding where to get it done. You know my recommendation,” says Hartsock.

### Rich Rewards After Retirement

Linda Hartsock and her friend Martie Burns have embraced life after retirement. As newcomers to the Eastern Shore, they were fascinated by the stories they heard from locals about the oyster boom towns of Greenbackville and Franklin City on Chincoteague Bay. “The stories were too rich to lose,” says Hartsock. Together they interviewed long-time residents until a picture of life in those communities emerged. As first-time authors, the women are thrilled that *Voices of the Chincoteague: Memories of Greenbackville and Franklin City*, (Arcadia Publishing) is soon to go into its third printing.

## Improving Diagnostic Capabilities

By Rebecca Wolf

Over the past 16 years as an orthopedic surgeon and instructor at Japanese university hospitals, Dr. Hiroshi Egawa developed several research ideas about some of the leading issues in hip replacement surgery. Like other orthopaedic surgeons, he had to rely upon an imprecise diagnostic method to quantify the amount of bone loss (known as osteolysis) around an acetabular implant. His assessment could mean the difference between leaving a cup in place or revising it.

Although radiographs, or X-rays, are the standard method for assessing osteolysis, recent research at AORI and elsewhere has shown that interpretation of X-ray images can be highly variable. When Egawa learned about AORI's investigations into the use of computed tomography (CT) as a diagnostic tool, his interest was sparked. In 2005, he took a sabbatical from his position at the University of Tokushima Medical School to dedicate 2 years to research at AORI.

Once here, Egawa picked up where previous research fellows had left off. Their research with Drs. Charles and Andy Engh had led to the use of CTs at Anderson Clinic. One of Egawa's goals was to develop a graphical presentation that would help other doctors interpret these 3-dimensional images. He also wanted to find a way to address his pet concern — quantifying bone ingrowth around a cup. Neither task was easy.

"I'm not a graphic designer. But because I had no patients, I had time to spend on the issue and to develop a way to show the area," Egawa says. "I created the picture (graphics) based on the eyes and needs of a surgeon."

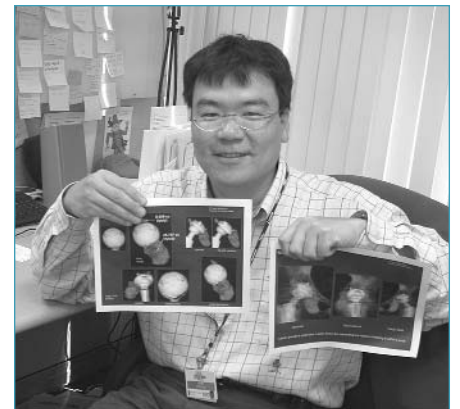
By combining several mathematical methods he also found a way to quantify the area of bone contact. The method requires time-consuming calculations, but Egawa feels a programmer could use his methodology to write a program.

Before coming to AORI, Egawa had another research goal. He was interested

in learning what happens after a bone substitute has been used to fill an area of bone loss during a hip replacement.

### A Link Between Research and Care

AORI research has shown that large osteolytic lesions, or areas of bone loss, can be detected reliably on X-rays, but that X-rays do not reveal the full extent of bone loss. Over the past 6 years, our investigations into computed tomography (CT) — 3-dimensional X-rays — have shown that CTs can be used to assess osteolysis more accurately. CT images can be manipulated on a computer, making it possible for a physician to view the bone all around an implant and to measure the volume of a lesion. This is critical in predicting implant stability and the progression of osteolysis. Due to these findings, all Anderson Clinic patients with total hip replacements receive X-rays at their follow-up appointments, but if osteolysis is found, CTs are taken for a more accurate assessment. Because the twin problems of wear and osteolysis can increase over time, CTs are now recommended for hip patients at 5- and 10-year follow-up.



The graphics technique developed by Research Fellow Dr. Hiroshi Egawa makes it easier for physicians to interpret CT scans around a hip implant.

His question — does new bone grow around the synthetic substitute — has been asked by many surgeons and is particularly relevant to revision surgeries in which bone deterioration is common.

"We haven't known what happens after grafting with a bone substitute, because we cannot see that on radiographs," says Egawa.

Reviewing CTs of such cases, Egawa saw evidence that new bone had replaced the bone substitute at one year after surgery. Additionally, the bone around the substitute had grown denser. The amount of new bone growth varied among patients with new bone filling up to 50% of a defect at one year after surgery.

This December, Egawa, his wife and 6-year-old daughter return to Japan. He and his wife, both physicians, return to busy practices, while at AORI research in this area continues. Before CTs can be used on a widespread basis, the protocol and techniques must be further refined — one task for our next research fellow.

AORI thanks Dr. Egawa for his many hours of dedication. Our best wishes go with him and his family.

## The Life and Legacy of David Kruckenberg

By Robert Hopper, Jr.

**D**avid Kruckenberg's wife Judy fondly recalls that the parking lot was packed to capacity, and the church overflowed with friends and family who attended his memorial service. In the process of building a family-owned construction business, he had also developed deep relationships in his community. Although his own life was cut short by a tragic accident at work, he had touched the lives of many other people as a husband, father, friend and business partner.

David was born on January 31, 1940. He began his career in construction at the age of 16, building houses in Illinois. It was there that he met his wife and future business partner, Judy. They later moved to New York and eventually settled in Virginia. After a year in the city of Alexandria, the family sought a more rural home and invested in 8 acres in Stafford, Virginia.

In 1983, David bought his first tractor to do some gardening on his own land. To help pay for the tractor, he planned to use it to do a little work on the side. What began as a small residential service with a single tractor grew to become a business with 9 full-time employees, who used heavy excavation equipment for commercial development projects.

When most of us think of construction, we imagine the structures visible above the ground. David's business specializes in the work that must be done before the foundation is laid --clearing lots and boring lines for water and sewer to subdivisions and commercial pump stations.

As they built a business, David did the field work; Judy ran the office and helped in the field whenever necessary. The business flourished, because David had uncompromising standards and thrived on challenges. Where other people saw insurmountable obstacles, David found unique opportunities. His wife recalls that he was always able to find a solution, visualizing it in his head before implementing it. He did not delegate the tough jobs but did the work himself and stuck with a task until it was done. During a typical day, he would be on the phone by 5:30 AM and out on the job until 9:00 or 10:00 P.M. Of course, main-



David Kruckenberg (right) returned to his commercial construction business and the demanding physical labor that he loved after a hip replacement.

taining that level of activity eventually took a toll on his body.

David's hip pain began when he slipped and fell while climbing into a big loader in 1998. Not one to let a little pain slow him down, David continued working as long as he could. When it finally came time to have his hip replaced, he visited the Anderson Orthopaedic Clinic on the recommendation of several friends. With the prospect of a hip replacement that could restore pain-free mobility and enable him to return to an active lifestyle, David decided to have the surgery.

Afterwards, David was up and around quickly. The pain relief was remarkable. He went from living on a steady diet of aspirin before surgery to no pain afterwards. Although he could not drive immediately, he yearned to get out of the house. While convalescing, he hung sheet rock on the new home he and Judy were building. He never used a walker to get around, but, instead, went right to crutches. When cleared to drive, he was out on the job 10 hours that same day and every

day for the next 6 weeks.

Judy recalls that when David first contemplated hip replacement, he imagined that he might retire after his operation. But after his surgery, David felt so good that he went back to work full-time, climbing 20 feet up and down ladders many times in the course of a workday.

Although deeply grieved by his passing, David's family took consolation in the fact that he had found passion in his life's work and that he had left an enduring legacy. Because David's own life was so profoundly affected by his hip replacement, his family asked that memorial contributions be made to the Anderson Orthopaedic Research Institute (AORI) to help improve the quality of life for all joint replacement patients. Collectively, David's family, friends, and business colleagues have contributed more than \$8,000 to support the joint replacement research done by the AORI. It is with our deepest gratitude that we extend our best wishes to David's family and friends for their generosity on his behalf.

*Joint Journal* is published by Drs. Charles, Gerard, C. Anderson Engh, K. Fricka, and W. Hamilton for the friends of the Anderson Orthopaedic Research Institute (AORI). Its contents are not intended as a substitute for medical advice.

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## Research Making an Impact

In 2007 AORI made the following contributions to progress in hip and knee arthroplasty.

**12 research papers** appeared in orthopaedic peer-reviewed journals.

**4 textbook chapters** on surgical techniques were published in orthopaedic text books.

**59 presentations** were given by our doctors and researchers at orthopaedic conferences and seminars in the United States, Spain, the Czech Republic, and Japan.

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