Research offers Pa. woman new arm, 14 years after amputation

December 24 2012, by Scott Dance

Over the 14 years since losing her right arm to a hollow-point bullet, Dana Burke was convinced she could feel herself pointing, pinching or waving as she motioned with the 5-inch-long limb the attack left behind.

Still, she had to relearn how to pull her hair back in a ponytail and tie her shoes. It's a struggle to play horsie with her three children using only one arm for support, and she had to start off with a child's fat crayon to learn to write left-handed.

But now, she has proof of what she knew all along. A team of researchers watched in awe this month in her Central Pennsylvania home as she controlled a virtual arm depicted on a laptop through 11 distinct hand, wrist and elbow movements using just her brain and a set of sensors on her arm.

Burke soon will be one of the world's first amputees to replace her lost limb with a high-tech, thought-controlled prosthetic capable of nearly matching the dexterity of flesh and bone. It's the fruit of a federally funded project at Johns Hopkins Applied Physics Laboratory six years in the making, intended to aid wounded war veterans. But Burke's case is a medical marvel, her doctor said, that could change amputation surgery and recovery for all patients.

"It shouldn't really be possible with a typical above-elbow amputation," said Army Capt. Michael A. Powell, a Hopkins graduate student researcher who developed the software that translates nerve impulses at

the end of arms like Burke's into virtual motion on a laptop screen - a small step away from controlling a robotic prosthetic.

For most patients today, prosthetic options use a tension cord or simple mechanics to control basic movements - at most, opening and closing a pincers and extending an elbow.

"Wow," whispered Burke's brother, Chris Griffith, as he watched his sister demonstrate not only pointing, pinching and waving, but flexing, rotating and extending in all directions.

While Burke isn't surprised to have maintained the capacity she took for granted for the first 26 years of her life, the prospect of returning to normal made her giddy.

"I feel like a kid on a bike," said Burke, looking the part as she bounced in her chair at her dining room table, flexing brainpower that had been lying dormant since she lost her arm. "I feel special."

—-

Dr. Albert Chi, a trauma surgeon at Johns Hopkins Hospital, said Burke is indeed special.

Chi has been working for the past year with researchers at the Johns Hopkins Applied Physics Lab and patients who could benefit from the prosthetic technology.

To make it work, Chi figured patients would require surgery to replant nerve endings detached during amputation into muscle at the arm's end. That would restore muscle stimulation at the amputation site, enabling detection of intended movements for the missing limb.

Burke stumbled across Chi by way of a blurb in Popular Mechanics her father saw that highlighted the physics lab's work developing the most lifelike prosthetic arm ever assembled. The device, only six of which exist, is considered the most advanced ever created, with nearly all the dexterity and precision of a real arm. After an Internet search and a phone call, she was on the line with Michael McLoughlin, program manager for the modular prosthetic limb project at the applied physics lab.

McLoughlin referred Burke to Chi, who met with her to prepare for the surgery, known as targeted muscle reinnervation. But it turned out she didn't need the surgery. When she later visited the lab this spring and was connected to the arm, she almost immediately was able to control it.

"It was amazing," Chi said. "My jaw almost hit the floor."

Chi found that after Burke's amputation, the surgeon reattached loose nerves to the muscle that remained above where her elbow once was. That meant that when her brain sent signals down toward the hand, instead of disappearing into her tissue, they were transferred to muscle in the rounded end of her arm.

"It was a progressive thinker, whoever did that surgery," Chi said. "It was against the norm."

The researchers are in the midst of 10 straight days of visiting Burke at her home and fine-tuning her control of the virtual device. They plan to outfit her with the real thing - a slightly simpler version of the lab's modular prosthetic limb - by Feb. 1.

The scientists' efforts began in 2006, under a program of the U.S. military's Defense Advanced Research Projects Agency known as Revolutionizing Prosthetics. The government hired the Hopkins applied

physics lab in 2010 for the $35 million job of managing development of the arm, as more and more soldiers returned from Iraq and Afghanistan with amputations.

"What's available commercially is woefully inadequate," Col. Geoffrey S.F. Ling, a physician and war veteran who manages the military program, told The Baltimore Sun that year. "We also set the bar really high. We want to give them back their lives."

Since then, McLoughlin and researchers have tallied up 3,000 hours of experience with the device, fine-tuning the technology that directs its movement. Sensors placed around an amputated arm detect patterns in firing muscles when subjects are told to imagine making particular movements. Once a pattern is established, it can be assigned to an action; the more complex the pattern data collected, the more lifelike the movement.

"It's almost more important than coloring it right," said Bobby Armiger, one of the physics lab researchers, of amputees' need for prosthetics that mimic human motion as much as possible.

Such thought-controlled robotic motion has been achieved in the past. Under an earlier project sponsored by the military research agency, Duke University researchers taught monkeys to operate a robotic arm by thought alone, but that was through wires implanted in their brains. In another venture, a patient at the Rehabilitation Institute of Chicago was able to operate an arm using sensors attached to his chest muscles, to which arm nerves had been grafted.

But the modular prosthetic limb project goes beyond both, the Hopkins researchers said, because it doesn't require any sensors to be implanted, and, as in Burke's case, doesn't even require surgery.

Elsewhere, projects include efforts to build a thought-controlled, whole-body exoskeleton for paralyzed patients and to create a substance that would fuse severed nerves with robotic limbs.

—-

After six years of development, the researchers say they are ready to put the technology to use. Along with Burke, a second patient will also soon be outfitted with a thought-controlled device - a West Virginia man who, along with Chi, will be featured in an upcoming segment devoted to the breakthrough on CBS' "60 Minutes."

But there are hurdles to giving more amputees such an opportunity.

For one, the technology is relatively unknown and the pool of potential patients with amputations above the elbow is small enough that few realize it's an option. Burke had no idea until last January, when her father spotted the magazine feature. But just over a year later, she'll have her own version.

Chi said he hears from interested patients every few months, gaining a handful each year. Recent calls have come from California and Arizona, but hopping on a plane to spend weeks working with Chi, McLoughlin and their colleagues isn't so simple. Testing of the prosthetic technology with patients has been going on at the University of Pittsburgh and Walter Reed National Military Medical Center, and more patients will be recruited soon at the California Institute of Technology in Pasadena, McLoughlin said.

Most amputees would need to go through the nerve surgery that Burke didn't require, Chi said, but that could change if her case is any lesson.

"This is a game-changer for all trauma surgeons," Chi said.

If more doctors took the extra few minutes to reattach nerves to muscle during amputation surgeries, it could make the later surgery unnecessary, Chi said. It also would help patients avoid the phantom limb pain that can occur when nerves remain detached. The fact that Burke didn't need it means she will get her prosthetic at least six months earlier than she might have otherwise.

Still, the prosthetic itself remains cost-prohibitive for commercial production. The goal is to reduce the cost per arm to less than $30,000, but it's nowhere near that now. The researchers are exploring whether production could be paid for by a philanthropic organization or nonprofit - "something not looking for a return on investment but for the good of our soldiers and others who need limbs," McLoughlin said.

While they continue to refine the device, the researchers say they are finally getting to the point where the goal of their work is being realized.

"We will always continue to develop the technology, but now we're able to focus on the really important part of this," McLoughlin said.

Burke's long journey began 14 years ago when an estranged friend confronted her and her future husband outside a Central Pennsylvania bar one August night. The man shot her and her companion, then himself.

As she waited for paramedics, she didn't even feel the pain in her arm, but could smell the blood and the gunpowder. Her side, near where her elbow met her abdomen, was blown open, she said.

When she awoke in a hospital, she didn't understand the severity of her injuries at first. Immobilized, she couldn't see that her arm was missing, nor could she feel it.

"You should be on 'Oprah,' " Burke recalled a hospital worker telling her. "I said, 'Why?' And she said, 'Because you lost your arm.' "

Now she talks about visiting the doctors who saved her life to share her opportunity for a new limb. And despite the tragedy in her past, she doesn't see herself as a victim. She said she is only looking to the possibility ahead.

"It's the closest to two-handed I've been in 14 years," Burke said. "Put a price tag on that. I can't."