

New Hope for Amputees

Story by Janice Arenofsky

VA photo



▲ With a prosthetic right foot, CPT David Rozelle makes his way down a mountain at Snowmass Village, Colo. New types of prostheses allow amputees to perform a wide range of activities.

WHEN Darth Vader chops off Luke Skywalker's hand in the movie "The Empire Strikes Back," Star Wars' favorite hero helps himself to a robotic prosthesis and proceeds on his merry way.

Thanks to technology, this sci-fi scenario is closer to reality than many people realize, said Dr. Roy Aaron, an orthopedic surgeon and director of the Center for Restorative and Regenerative Medicine at the Veterans Affairs Medical Center in Providence, R.I.

Aaron predicts that bio-hybrid limbs will be commercially available within three years, and that lifelike prostheses with a neural interface will soon follow.

Aaron's confidence in innovative technology stems from two sources: healthy competition within the biomedical field itself, and the creativity and genius of researchers at the VA center in Providence.

"It's our hope and intention to transfer our discoveries into clinical settings to benefit war amputees," he said.

Aaron said the Providence center is "an intimately integrated program" employing 20 major investigators from a mix of disciplines, including psychology, engineering, robotics and medicine. The "discoveries" encompass limb lengthening, tissue engineering, osseointegration (for example, attaching a titanium bolt to a residual limb) and implantable sensors that allow the recipient's nerves and brain to move the prosthesis.

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▼ Before energizing former SFC Michael McNaughton's gait, Barri Miller of the Walter Reed Orthopedic Amputee Center raises McNaughton's C-Leg to ensure motion-sensing digital cameras can see reflectors placed on it.



Michael E. Duker

☰ New Amputees

Brent Bretz knows how arduous recovery can be. The 23-year-old former sergeant from Mesa, Ariz., lost both legs when his truck hit a land mine near Mosul, Iraq, last year. Since then he has had 40 surgeries and awaits more before he can be fitted for prostheses.

“The surgeries are painful,” he said. Not yet ready to discuss walking again, Bretz said most of his fellow amputees are “satisfied” with their prostheses.

Mike McNaughton is one of those satisfied former Soldiers. Wounded by a land mine in Afghanistan in January 2003, he endured 11 operations to clear up infections, remove bone spurs and reshape bone on his above-the-knee leg amputation.

McNaughton was one of the first amputee-vets to receive a computerized C-leg. With its microprocessor and sensors, the leg can adjust for flexibility and speed as many as 50 times a second.

Like many amputees in rehab, McNaughton enjoyed athletics before his injury and quickly outgrew his C-leg because, he said, “The C-leg couldn’t keep up with me.”

He now wears the “Rheo Knee,” invented by Dr. Hugh Herr, professor of biomechanics at the Massachusetts Institute of Technology, a staff member at the VA center in Providence and an amputee himself. Herr’s device is the first artificial-intelligence knee system.

► McNaughton, seen here with a different type of prosthesis, was one of five Army amputees to run the Bataan Death March Memorial Race at White Sands Missile Range, N.M.

Ted Gaskins





SGT Lorrie Jewell

▲ Walter Reed research prosthetist Joe Miller cleans up a foam mold for a prosthetic socket after it was machine carved.

Its microprocessor can respond to sensory data as many as 1,000 times a second, and the system uses magnetic forces to make movement more natural.

It took just five minutes for McNaughton to adjust to the Rheo. “It adjusts to any speed and prevents a stiff-legged free stance and the fear of falling. I’m actually more active now than before the amputation.” He runs marathons and hopes to compete in a triathlon. Today, he works for the Department of Homeland Security’s Emergency Preparedness division in Baton Rouge, La.

≡ Testing New Devices

Advances in body armor have affected the types of injuries Soldiers suffer, and spurred changes to the medical industry and rehabilitative process.

“It’s a whole new paradigm,” said Dr. Michael Ehrlich, a 30-year veteran of limb-lengthening research and head of orthopedics at Brown University Medical School. “These are young men with devastating wounds. We’re forced to learn quickly — to go from basically barbaric to high-tech devices.”

McNaughton is now interested in Herr’s ankle-foot device, which is currently in development and will use artificial muscle made of electroactive polymers to help amputees climb stairs.

Herr plans to develop a new generation of robotic knees and ankles that are powered by artificial muscles and controlled by the brain and nerve signals. To do this, he will inject a wireless microchip into the residual leg muscle. The chip will pick up nerve

▶ A Soldier demonstrates how the advent of advanced technology in prosthetics makes it possible for amputees to perform a range of once-impossible activities.

signals instructing the prosthesis to move.

Not everyone, however, will want or qualify for these high-tech devices. Every veteran’s personality and needs are unique, Aaron said.

Take former SPC Kevin Pannell, transformed in seconds into a double amputee after two hand grenades exploded in front of him in Baghdad in June 2004. Pannell has kept a positive attitude since day one. “I have yet to find anything I can’t do now,” said Pannell.

And the “crazier-looking” the prosthesis is, the happier he is. In fact, he rarely uses his C-leg, favoring a hydraulic system for kayaking, hunting, snowboarding and other sports.

≡ Changing the World

Though he tries not to paint an unrealistic picture of prosthetic innovations,

Aaron said robotic devices and neural interfaces are “a lot closer to reality than people think.”

Recently, Brown University neuroscientist Dr. John Donoghue achieved a significant goal with “BrainGate,” which in 2003 was named by MIT Technology Review as one of the top 10 emerging technologies that will change the world.

The Food and Drug Administration authorized Donoghue to implant a small sensor with 100 microelectrodes into the brains of two quadriplegics. The sensor sends signals through the brain, via cable, to a computer that transmits data into movement commands.

“We just completed a year’s trial with one patient and we’re very pleased,” Donoghue said. The patient uses his





▲ SPC Sean Lewis and his wife, Jessica, watch as Walter Reed prosthetist Dennis Clark adjusts the socket of Lewis' new prosthetic leg. It was the first time Lewis had donned the new limb.

personal computer to pick up e-mail, turn off lights, answer the phone and do other routine tasks.

Donoghue hopes to eventually use the same system, but in wireless form, with amputees. He's also closely watching the ongoing development of lifelike prosthetics with sensory capabilities.

"So far, our artificial arms are not that impressive," Donoghue said. "Muscle is a strong material and replicating it is a complex engineering task."

"The most advanced technology will take the longest to perfect," he added. The first clinical trials using a neural interface, about three years away, will focus on upper-body control and will target prosthetic hands.

≡ Increased Demand

Neither McNaughton nor Pannell are completely sold on brain implants, due to the devices' invasiveness, but both amputees want to benefit from the newest medical technologies.

"The last 10 years have seen amazing things," Pannell said. "Cosmetic coverage is so realistic, it's spooky."

But next-generation prostheses will not be cheap. A current prosthesis can cost as much as \$80,000. According



▲ Filled with a variety of innovative electrical components, the myoelectric arm gives wearers a greater range of movement and more comfort.

to the O&P Edge, a prosthetics publication, the number of patients seeking VA prosthetic services has increased by about 30 percent in the last four years.

Will the VA be able to keep up with rising costs? Last year, it provided 176 veterans with state-of-the-art C-Legs. The department also operates 63 prosthetic labs staffed by 97 board-certified prosthetists.

VA's proposed 2006 budget for prostheses is \$100 million more than last year's. The new Providence VA Medical Center will use some of those dollars to ensure "no one is left behind," said Ehrlich. 🇺🇸