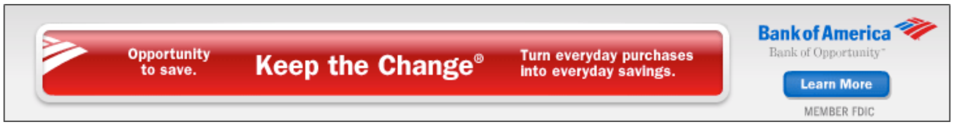

In New Procedure, Artificial Arm Listens to Brain

Shawn Poynter for The New York Times

Amanda Kitts was fitted with a bionic arm after she lost her arm in an automobile accident in 2006.

By PAM BELLUCK
Published: February 10, 2009

Amanda Kitts lost her left arm in a car accident three years ago, but these days she plays football with her 12-year-old son, and changes diapers and bearhugs children at the three Kiddie Cottage day care centers she owns in Knoxville, Tenn.

Ms. Kitts, 40, does this all with a new kind of artificial arm that moves more easily than other devices and that she can control by using only her thoughts.

"I'm able to move my hand, wrist and elbow all at the same time," she said. "You think, and then your muscles move."

Her turnaround is the result of a new procedure that is attracting increasing attention because it allows people to move prosthetic arms more automatically than ever before, simply by using rewired nerves and their brains.

The technique, called targeted muscle reinnervation, involves taking the nerves that remain after an arm is amputated and connecting them to another muscle in the body, often in the chest. Electrodes are placed over the chest muscles, acting as antennae. When the person wants to move the arm, the brain sends signals that first contract the chest muscles, which send an electrical signal to the

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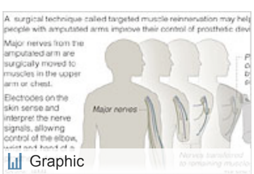

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Shawn Poynter for The New York Times

Amanda Kitts lost her arm in a car accident in 2006, but a new kind of prosthetic allows her to tie shoes at her day care center.

prosthetic arm, instructing it to move. The process requires no more conscious effort than it would for a person who has a natural arm.

Researchers reported Tuesday in the online edition of The Journal of the American Medical Association that they had taken the technique further, making it possible to perform 10 hand, wrist and elbow movements, a big improvement over the typical prosthetic repertoire of bending the elbow, turning the wrist, and opening and closing the hand.

"It's dramatically impacted the field," said Stuart Harshbarger, a biomedical engineer at Johns Hopkins University who is the program manager for a military-financed prosthetics study that includes research on the technique. "It's already being used by practicing clinicians and surgeons across the country. The ability to control a pretty robust prosthetic limb has surprised everyone with how good it is."

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HEALTH

New Artificial Arm Technology

Amanda Kitts, 40, of Lenoir City, Tenn., uses an experimental prosthetic arm in a series of motion studies at the Rehabilitation Institute of Chicago. (Video courtesy of the Rehabilitation Institute of Chicago and DEKA Research)

Typically, a person with a prosthetic arm can make only a few motions, often so slowly that many people use the arms only for limited activities. There is a separate motor for each movement, said Gerald E. Loeb, a professor of biomedical engineering at the University of Southern California, "and that motor has to be explicitly controlled," usually by the person consciously contracting muscles in the back or biceps.

"Essentially up until now," Dr. Loeb said, "subjects have controlled one motor at a time and had to think very carefully about what motor they wanted to control and how to move it instead of just thinking about moving it and being able to do it."

Before Ms. Kitts had the reinnervation procedure in October 2007, for example, she had to move her back muscles a certain way to make the wrist rotate, and flex her triceps and biceps to move the elbow up and down. "It was a lot of work," she said. "It wasn't useful to me at all."

The reinnervation method is part of a recent explosion of new ideas and techniques being explored as scientists try to help people better compensate for missing limbs or paralysis. The drive is being fueled by increasing amputations from diabetes and military injuries and by advances in technology.

Arms have become a particular focus. Science has long had success with prosthetic legs, but it is harder to mimic the complexity and dexterity of hands and arms. Efforts under way include more flexible and sensitive skin and arm designs, and wireless devices implanted in prosthetic arms to allow more natural movement. Researchers have also used sensors implanted in the brain to enable two monkeys to control a mechanical arm, and a paralyzed man to move a cursor on a computer screen.

Some of these methods, if perfected and if approved by regulatory agencies, may eventually become more viable for amputees. And while the reinnervation technique does not require regulatory approval because it is done with surgery and existing devices, it has limitations that even its creator acknowledges, including that it is not possible for every patient, is costly, and takes months for the rewired nerves to grow and become effective.

Still, experts say it is the most advanced system being used in actual patients that allows the nervous system to directly control movement of an artificial arm. Since it was pioneered in 2001 by Todd Kuiken, a physiatrist and biomedical engineer at the Rehabilitation Institute of Chicago, it has been performed on about 30 people in the United States, Canada and Europe, including eight soldiers injured in Iraq or Afghanistan.

Many patients, including the first, Jesse Sullivan, an electrical worker from Tennessee who lost both arms when he was electrocuted by a wire, can not only manipulate their prosthetic arms, but feel sensations of their missing hand when their chest is touched, Dr. Kuiken said.

Mr. Sullivan, 62, and Ms. Kitts were among five patients who participated in the study. Along with five nonamputees, they were fitted with electrodes and told to use thoughts to make a virtual arm on a screen mimic 10 movements, including three hand grasps. The patients performed quite respectably, only a little slower and less accurate than the able-bodied subjects. "The movement speeds that we found in our patients were really encouraging," Dr. Kuiken said. "They were able to complete the task. Clearly they were not as good as the able-bodied people, but good enough."

A virtual arm was used because most existing prostheses cannot accommodate all those movements yet, although Mr. Sullivan, Ms. Kitts and a third patient, Claudia Mitchell, tried out two more versatile prototype arms, performing complex tasks with tennis balls and other props.

Performing reinnervation on soldiers presents additional challenges, Dr. Kuiken said, because military injuries often “cause very extensive damage” to nerves, muscle or bone.

Daniel Acosta, 25, an airman injured by a roadside explosive in Iraq in 2005, had the procedure last year, and said his prosthetic left arm now moved “a lot faster” and more naturally. “The difference is I’m not really thinking about it,” said Mr. Acosta, of San Antonio said. “I kind of just do it.”

Still he said, “it’s been a long process,” and the electrodes have to be adjusted to pick up the signals as nerves grow or shift.

Even as they praised the reinnervation method, experts said the science of prosthetic arms had a long way to go.

“This is a crucial part, but it’s only one part of many things that comprise normal arm function,” said Dr. Loeb, who wrote an editorial accompanying the article in The Journal of the American Medical Association. “Right now we’re somewhere between the arm in ‘Dr. Strangelove,’ ” which involuntarily jerked into a Nazi salute, “and the Luke Skywalker arm in ‘Star Wars’ where he turns it on and it’s fully naturally functional. I think it’s still going to be many years before all the pieces come together to make a normal functioning arm.”

A version of this article appeared in print on February 11, 2009, on page A1 of the New York edition.

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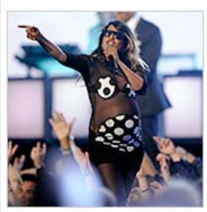

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