Jerry Fisher, 36, from Jackson, Michigan, became the nation’s second hand transplant recipient following a 13-hour procedure on February 16-17, 2001.

The procedure, which was performed at Jewish Hospital in Louisville by Kleinert, Kutz and Associates and University of Louisville surgeons, involved an 18-member hand surgical team and five-member anesthesiology associate’s team. The group of surgeons performing the experimental procedure also performed the nation’s first single-hand transplant on Matthew Scott two years earlier.

Dr. Warren C. Breidenbach, MD, FRCS, at Kleinert, Kutz and Associates, says because hand transplantation is still an experimental procedure, more research needs to be done. “Transplant research is performed on pigs because their skin is much closer to that of a human,” he says. “We also analyze research done by others around the world on various animal models. Hand replants [in which a person’s own hand, arm or finger is reattached] have been performed at the Center for 30 years. This is where the experience of the hand surgeon plays a major role. Because both replant and hand transplant procedures require many hours, a large team of surgeons may be necessary. The experience of world-renowned hand transplant surgeons at Jewish Hospital prepared us to bring these two disciplines together to seek out the feasibility of a hand transplant.”

The History of Hand Transplant Surgery

To date, only a few hand transplant surgeries have been performed around the world. They include:

1964: Ecuador Hand Transplant

The patient was given what, by today’s standards, are considered primitive immunosuppressive agents, and the hand was rejected within two weeks. Little was learned from the experience because of the lack of immunologic testing and follow-up.

1998: France Hand Transplant

Clint Hallam, a Perth, Australia, businessman, underwent a hand transplant in Lyons, France, on September 23, 1998. Jean-Michel Dubernard, MD, led a group of doctors from around the world to perform the 13-hour procedure.

At the patient’s request, surgeons in Britain amputated the hand on February 2, 2001, in a London hospital. Dr. Earl Owen, the British microsurgeon who performed the amputation procedure, was among the international team that transplanted the hand. He reported that Hallam fell out of touch with his doctors and refused to stick with the necessary treatment. “We know he voluntarily went without drugs for two weeks at a time over the two years, and he failed to follow the plan he willingly agreed to before the transplant was performed,” Dr. Owen reports. “It was inevitable that his body would reject the hand and require eventual amputation in the interests of his own health.”

Hallam reported that he regretted not conferring with his transplant team, but denies being negligent. “I thought it wouldn’t matter if I stopped taking the medication for a week or 10 days,” he says. “Clearly, it did.”

1998: United States Hand Transplant

The Louisville team that operated on Jerry Fisher also performed the first U.S. hand transplant on January 25, 1999, on Matthew Scott, an Absecon, New Jersey, man. Scott continues to do well and is gaining strength, control and range of motion in his new left hand. One year following the transplant surgery, Scott could use the hand to throw a ball, tie his shoes and turn the pages of a newspaper.

Three episodes of moderate acute cellular rejection of the skin occurred at 6, 20 and 27 weeks after transplantation. Each episode was manifested as a skin rash, and each was resolved after treatment with intravenous steroids and topical tacrolimus and clobetasol.

Doctors say Scott’s success
Passing Through the Threshold of Limb Transplantation

indicates that hand transplantation can be successfully achieved with the use of currently available immunosuppressive drugs.

1999: Peoples Republic of China Hand Transplant
Two single-hand transplants were performed simultaneously in China on September 21, 1999, on two males, ages 39 and 27.

2000: Lyons, France, Double-Hand Transplant
A team of surgeons led by Professor Jean-Michel Dubernard performed the world’s first double-hand transplant. The 50-member surgical team performed the 17-hour operation on January 12, 2000, at Hospital Edouard in Lyons, France. The patient, Denis Chatelier, was a 33-year-old house painter at the time of his accident. The father of two children, his hands were severed when a homemade model rocket exploded prematurely. Chatelier’s operation is the first in a series of five double-hand transplants that French surgeons will use as models to decide whether the transplantation of limbs and other external multis- tissue organs will become commonplace in that country.

2000: Malaysian Hand and Arm Transplant
A team of physicians at Selayang Hospital performed the world’s first arm and hand transplant on a month-old baby girl on May 18, 2000. Chong Lih Ying was born with a severely deformed left arm. Her donor was her identical twin sister, who died at birth. Since Chong received the limb from her identical sister, there was no need to take anti-rejection drugs. Malaysia’s Health Minister expects the transplanted arm to function fully by the end of 2001.

2000: Italian Hand Transplant
Professor Marco Lanzetta, a member of the world’s first hand transplant team in Lyons, France, led a team of surgeons to perform a 15-hour single-hand transplant, in Monza, Italy. Valter Visigolli, a 35-year-old hand transplant team in Lyons, France, led a team of surgeons to perform a 15-hour single-hand transplant, in Monza, Italy. Valter Visigolli, a 35-year-old man, was severely injured in an accident. The donor was his 27-year-old identical twin sister. After the operation, Visigolli was able to move his fingers and perform a simple self-help gesture.

Patient Selection Criteria
Donor selection (in the U.S.) is similar to selection in solid organ donations. The primary criteria for hand transplantation are that a person be between ages 18 and 65 and have had his or her arm amputated below the elbow.

The transplant procedure is for individuals who have experienced hand or forearm loss due to trauma and lifesaving interventions that caused permanent injury. At this time hand transplant procedures are not considered for congenital anomalies, loss of a limb due to cancer or for leg amputations because more research is needed in these areas. In addition, the procedure is not being considered for individuals whose injury is limited to fingers.

The goal of the procedure is to restore functional recovery to the patient with a transplanted hand. The patient will undergo several clinical evaluations, including a history and physical, x-ray evaluation, psychosocial evaluation, nerve conduction studies, tissue studies and laboratory studies.

Prospective patient should be otherwise healthy. Tests required for further evaluation include, but are not limited to:
• X-rays
• Extensive blood work
• Physical measurements of the affected limb
• Psychiatric evaluation and psychological projective testing
• Consults with transplant surgeon, hand and microsurgeon, social worker, physical therapist, orthotist, primary care physician and other physician disciplines as appropriate
• Other tests as indicated such as gastrointestinal tests, etc.

Before undergoing such surgery, patients must clearly understand the advantages and risks involved in this experimental surgical technique.

Post-Transplant Drug Therapy
With the 1980 introduction of the drug cyclosporine (which prevents rejection of transplanted organs by suppressing the body’s immune system), survival rates of transplanted organs have climbed. All hand transplant patients will be on immunosuppressive therapy, which includes drugs that must be taken every day for the life of the hand transplant. The immunosuppressant drug therapy is similar to the drugs that are taken by kidney transplant patients. Side effects of these drugs include, but are not limited to:
• Hypertension (high blood pressure)
• Acne
• Hand tremors
• Gastrointestinal discomfort
• Increased risk of infection
• Increased hair growth
• Weight gain
• Liver and kidney dysfunction
• Increased risk of developing skin cancers, lymph node tumors and other cancers
• Diabetes requiring insulin

Risk of Infection
Risk of infection caused by the immunosuppressive drugs may make it necessary for recipients to alter their daily activities particularly in the first six months.
Activities to consider include:
• Avoiding children with
Passing Through the Threshold of Limb Transplantation

U.S. Donors are screened and matched for gender, skin tone, race, age, viral status and blood type. Size and blood type are the only mandatory donor requirements; the other criteria are more of an individual preference than a mandatory requirement.

Following the hand transplant procedure, intensive physical therapy is required to regain hand and arm function. The patient also is required to have biopsies and lab evaluations as needed. U.S. transplants are currently offered only at the Louisville transplant facility, so individuals will need to stay in that area for three months following surgery.

Surgeons progress with tissue repair in the following order: bone fixation, tendon repair, artery repair, nerve repair and vein repair. The surgery generally lasts from eight to 12 hours. In comparison, a typical heart transplant takes six to eight hours, and a liver transplant, eight to 12 hours. Typical postoperative complications include blockage of the blood supply, infections and rejection.

The U.S. Transplant Patients
Since his hand transplant in February, Jerry Fisher, who previously used a cable hook prosthesis, has become independent in his daily living activities and describes his level of function as good. Fisher is married, has three children, and is self-employed as an installer of seamless gutters. He entered the organ donor network in November 2000 and underwent amputation of his nondominant left hand at the wrist - the result of a fireworks accident on July 6, 1996.

Matthew Scott, 37, was the nation’s first successful hand transplant recipient. He works as clinical coordinator for Virtua Health System in Gibbsboro, New Jersey, and also as the assistant director for the School of Paramedic Science at Camden County College, Blackwood, New Jersey. Scott is married and has two sons.

Scott originally lost his dominant left hand in 1985 in a blast from an M80 firecracker and he entered the organ donor network in December 1998. Since his transplant, he is independent in his daily living activities, though he admits he had to relearn everything necessary with a prosthetic device to achieve independence. Before the hand transplant, Scott used a myoelectric prosthetic device.

The idea of hand transplants may not be to everyone’s liking. But many people will lead richer lives as a result of the breakthroughs in medical research and the technological strides being made. And the research has only just begun.

Alternatives to Transplants Offer Hope

On September 18, 2000, 3-year-old Parker Sebens mysteriously slipped from his father’s watchful eye while his father operated a grain auger on the family’s Milnor, North Dakota, farm. “One minute he was playing with toys in the tractor’s pickup box, the next I heard a funny noise,” Mitch Sebens says. “I looked back and realized he was caught in the auger. The worst part was trying to decide what to do. I didn’t want to leave him, but I decided to run to the shop and call for help on a portable phone. When I got back he’d already gotten out of the auger on his own.” Both of Parker’s arms were severed.

Parker spent the next 54 days in the hospital where he underwent more than 50 hours of surgeries in attempts to save his arms. Doctors reattached them, but complications from the injuries required them to amputate most of his right arm and his left arm below the elbow.

Dr. Jennifer Harrington, a member of the surgical team that worked on Parker, says everyone tried their best to put his arms back on and make them function. “As surgeons, we were extremely discouraged to have to remove these parts after they were on for weeks,” she says.

“We were forced to eventually remove his right arm below the shoulder and his left hand just above the wrist,” she continues. “He knows he was in a bad accident and no longer has any fingers. He seems to be taking it very well, and just kept asking if he could go home to be with his sisters and brothers.”

Finally, on November 10, Parker went home with his parents. Now in recovery, Parker is able to walk and loves to kick the stuffed animals that
Alternatives to Transplants Offer Hope

crowded his hospital room. He talks and uses facial expressions and points to things with the stump of his right arm. His left arm has been immobilized to protect it. Harrington says youngsters tend to adapt to their disabilities and prosthetics much better and more quickly than adults. “He uses his feet more than I can tell you,” Dr. Harrington says. “I’m sure he’d like to kick me. I’m not his favorite person. White coats are not a good thing for him.”

**Prosthetic Hand Breakthroughs at Rutgers**

“For the first time we have people able to move multiple fingers by their own command,” says Dr. William Craelius, Rutgers University’s biomedical professor and research team leader. “Since we began this research in 1997 we’ve worked with numerous amputee subjects. We now have a prototype with five-finger movement. Our primary and initial interest is to provide users with a hand that can perform light office work including holding pencils and paper and using a mouse and keyboard. The prototypes are currently being tested in our laboratory. Our latest work, the development of the hand microcontroller, is now ready for testing on our subjects.”

Researchers at the university recently unveiled a prosthetic hand prototype that allows for independent control of three fingers. Production and marketing of a hand with five-finger capabilities is projected to begin next year.

Dr. Craelius says three amputees have tested the new hand - all with remarkable results. “The system comprises the hand, a silicone sleeve and three sensors inside the sleeve connected to wiring that links to a computer,” he says. “Amputees use their own tendons that would control a specific finger to trigger the sensor, which relays the information to the computer. The computer then controls the movement of that particular prosthetic finger.”

Rutgers’ research team is also considering the possibility of a new prosthesis for controlling wrist, elbow and shoulder motion. But Dr. Craelius says these are more complex joints and require unique procedures. They plan to ultimately create a hand-held computer, allowing better mobility and convenience.

If the research continues to be successful, the metal “claw,” or a hand with limited movement, may become a thing of the past. Researchers plan to proceed with measuring the effectiveness of the prototype, hoping for continued success in their results.

**Severed Hand Reattached**

Brenda Pahl, a 37-year-old Defiance, Ohio, woman, suffered a severed left hand amputation in October 2000 when her vehicle collided with the edge of an 18-foot farming disk being pulled by a tractor.

The disk’s blade reportedly sliced through the car and caught her arm.

The volunteer rescue team found the hand, and it was flown by helicopter with the patient to Medical College Hospital of Ohio. Dr. Martin Skie, assistant professor of orthopedic surgery and chief of hand and microsurgery at the hospital, saw Pahl about an hour after the accident. “As a trauma center team, we always attempt a reattachment with a whole portion of an extremity,” Dr. Skie says. “Our optimism, however, is much higher when it’s a clean injury - such as what a table saw, for example, would result in. In Brenda’s case, and besides a bad shoulder fracture of the same arm, the injury had suffered a fair amount of bone loss and soft tissue injury. Her therapy is more difficult because of the way she was injured, and it will likely take longer for her to rehabilitate. In cases like hers, we generally see more tendon damage and scarring - and this too slows down the healing process.”

Dr. Skie says the surgical procedure took approximately eight hours and was performed by himself and Dr. Nabil Ebraheim, a chairman of the hospital and professor of orthopedic surgery. “We’ve been doing reattachment surgery for about six years,” Dr. Skie says. “It’s still a relatively new procedure - so progress is sort of hit or miss.”

Although there has been discussion in the hospital about performing transplant procedures in the future, no definite steps have been taken to date. “It takes a large and highly educated and trained staff to perform transplants,” Dr. Skie continues. “While we do perform all major organ transplants, when you’re dealing with bone and bone marrow, there’s an entirely different - and highly sophisticated - rejection rate. Rather than the body trying to reject the hand, as with organs, the hand actually attempts to reject the body. The intense amount of postoperative care required for these patients is completely different from that for those with organ transplants. If we have patients who we consider good candidates for hand transplantation, we refer them to the group in Kentucky.”