

Update on Hand Transplantation

A Potential Option

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A number of options are available to individuals who must deal with the loss of a hand or limb. These include reconstructive surgery using their own tissue to repair the damage, or the use of prosthetic devices. We would like to present an update on the most recent addition to the list of options, namely composite tissue allotransplantation (CTA). In this procedure, tissue to repair the loss is taken from deceased donors who are giving hearts, kidneys or other types of organs and tissue for transplantation.

In 1964, the first hand transplant was attempted in Ecuador. The new hand was rejected by the patient's immune system and was amputated within 2 weeks. Since that time, all component tissues of the hand including skin, muscle, tendons, nerve, vessel and bone and joint, have been individually transplanted with success in humans. Worldwide, there have been 38 hand transplants (18 one-hand transplants, and 10 patients had both hands transplanted) and two digits, for a total of 30 patients with a follow-up period ranging from 6 months to 9 years. There were 28 males and two females, median age of 34 years. Currently, our center, based at Kleinert, Kutz and Associates in Louisville, Kentucky, is the only program in the United States that offers clinical trials of hand transplantation. Here we report an update on the four hand transplants done at our center. We feel that



the outcome of hand transplantation in these four patients gives a good representation of what someone could expect from hand transplantation with respect to function, cosmetic appearance and adverse events, or what can go wrong after hand transplantation.

Patient #1

This 37-year-old man lost his dominant left hand in December 1985 in a M-80 firecracker accident. He is a paramedic instructor and wore a myoelectric prosthesis for 13 years. The patient was diagnosed with type 2 diabetes in 1988 but was in otherwise excellent health. The level of amputation was in the front third of the left forearm. He underwent the hand transplant procedure in January 1999; he has had his new hand for 9 years.

Immunosuppression: People who get a transplant from another person almost always have to take drugs the rest of their life to control their immune system. These are called immunosuppressive drugs. This patient has been maintained on three types of immunosuppressive drugs for most of the time he has

had his hand. At 8 years after the transplant, we weaned him off the steroids (prednisone) and now he is taking only two kinds of immunosuppressive drugs: Prograf and MMF.

Clinical course: The patient underwent surgery in the third month after transplant for excision of a scar on the forearm with skin grafting. He also had some minor surgery to release some contraction in the new hand. This patient did have three episodes of rejection in the first year after the transplant, but they were easily controlled with medication. The patient developed a virus infection common to transplant patients (cytomegalovirus, or CMV) at 3 months and this also responded to medication. Since this event, the patient has had no problems with his health related to the transplant.

Function of transplanted hand: Motor function improved from the end of the first year to 6 years and has remained stable. The range of motion includes full passive finger extension and flexion. At 5 and 6 years post-transplant he gained intrinsic function



This complication and the resulting hip replacements were almost certainly related to the steroids he took. This is important to remember. At the current time, there are significant risks associated with the drugs needed to keep your body from rejecting the hand.

Function of transplanted hand: This patient also received a level of fair

function in the transplanted hand. Sensory return has returned to normal range in all finger tips. Touch localization (to tips of thumb, long, ring and small finger), temperature and vibration sensation have returned.

Patient #2

This 36-year-old Caucasian man lost his non-dominant left hand in a fireworks accident in 1996. He wore a cable-hook prosthesis and worked full time. He had no health issues and successfully underwent hand transplantation in February 2001.

Immunosuppression: The types of medication were the same as those used for patient #1. However, this patient developed poorly controlled diabetes related to the high Prograf levels and the multiple steroid bolus regimens to treat rejection in the weeks following the transplant. To improve sugar control, we tried a different type of immunosuppression. With proper medication, the patient does not require insulin. We have also weaned this patient off steroids (prednisone) and he is maintained on only two types of immunosuppressive drugs.

Clinical course: This patient had five episodes of acute rejection in the first year, and one episode was treated with a strong anti-rejection medication (ATG). In the fifth year of follow-up he had another episode of rejection related to noncompliance with medications. The rejection responded to treatment and resuming compliance with his medication. In the 2 years since then, he has remained in good health. Of note, this patient developed osteonecrosis of both hips (year 2 and 6 after the transplant), which was treated with total hip replacement on both sides.

function by one year, but in contrast to patient #1, he has not improved as much over the years. The range of motion was good in the forearm and wrist but only 40 percent of normal in the wrist. There is persistence of tightness in the hand ligaments even at 7 years. Sensory return has been significantly less, with diminished protective function at finger tips at 6 years. Touch localization (to tips of thumb, long, ring and small finger) are poorly developed but temperature and vibration sensation (256 cps) have returned.

Patient #3

This 54-year-old Caucasian man lost his dominant right hand 34 years prior in an industrial press accident. He functioned well with a cable-hook prosthesis. No health issues were present. The transplant was performed in November 2006.

Immunosuppression: This patient received a new type of immunosuppression treatment that was designed to need only two types of immunosuppression from the beginning. We never started this patient on steroids (prednisone) He has been on the steroid-free regimen for the past 12 months.

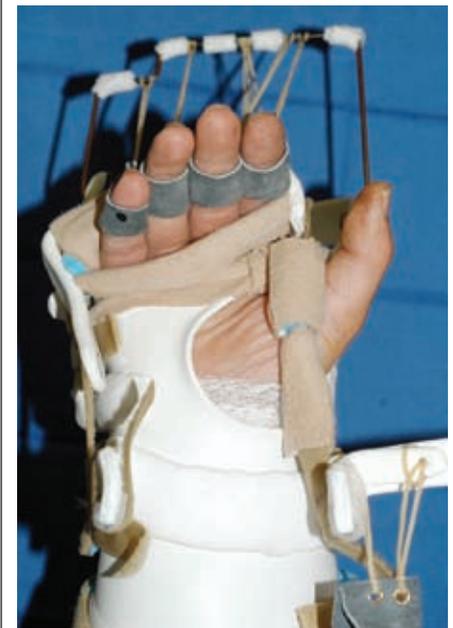
Clinical course: The only significant health problem this patient has had was a period of combined rejection and infection (CMV) about 2 months after the transplant. He had to be put in the hospital for 3 days for the infection, but he responded to treatment. The rejection he had at the time of infection also responded to treatment. The patient also had an episode of swelling that responded to a transient increase in immunosuppression at approximately 18 months post-transplant. Since resolution of this episode, the patient

has had no further problems. We did notice an increase in his cholesterol, which has responded to medication.

Function of transplanted hand: At this patient's first annual checkup, function in the transplanted hand was measured as fair using the Carroll test (he scored 57 of a possible 99). The range of motion was improved with active digit motion, reaching approximately 45 percent of normal. Sensory evaluation showed advancement of sensation, with diminished protective function and light touch localization in the index, ring and small fingers only. He could feel cold and heat at 1 year post-transplant.

Patient #4

This 32-year-old Caucasian man lost his dominant right hand 6 years prior in a firearms accident. He functioned well with a cable-hook prosthesis. No health issues were present. The transplant was performed in July 2008.



Immunosuppression: This patient also received the new steroids sparing type of immunosuppression treatment that was designed to need only two types of drugs from the beginning. We never started this patient on steroids (prednisone). He has been on the steroid-free regimen for 2 months.

Clinical course: This patient is very early in his course, but everything has gone smoothly. His incisions have healed well, and

he is receiving physical therapy 5 to 6 days a week. The function of the hand is as good or better than we have observed for the first three patients. We are very pleased with his progress to date.

Summary

All four patients use their new hands in daily activities. These are some of the activities they can now perform:

- Open regular door knobs
- Pick up smaller objects (checkers, washers, nuts, bolts, etc.)
- Lift gallon of milk from refrigerator
- Hold steering wheel with transplanted hand only
- Use wrench and other tools
- Use rake and other garden tools
- Take change in palm
- Use knife and fork
- Swing golf club or bat
- Catch balls
- Tie shoes
- Assist in holding dishes and food items in buffet line.

For patient #1, transplantation enabled an important sense of reparation to occur, allowing relief from guilt about the accident that had led to amputation and was “repaired” by the transplant. He was delighted with his new hand; his body image improved significantly, and he reported increased confidence, feeling “whole” and “balanced.” In the early post-transplant phase, patient #2 experienced some mild mood and sleep symptoms secondary to steroids that were treated. One year post-transplant, he experienced situational depressive symptoms that also responded to treatment. Two years post-transplant, he remained glad he had the transplant and felt it had met his goals. He reported feeling increased personal confidence. Two and a half years post-transplant, in the context of hip osteonecrosis and psychosocial stresses, the patient experienced a return of depressive symptoms and some associated decrease in medical compliance, but mood and medical compliance improved as the stress decreased. Following his second hip replacement in May 2007, patient #2 is back at work and has been demonstrating good compliance with respect to immunosuppression. He has been weaned from prednisone, and continues to function well and reports an excellent quality of life at 7

years post-transplant. Patient #3 is doing very well at 1 year post-transplant. He is satisfied with the hand function, with the exception of the thumb, which does not have pinch function yet. In addition, he does not care for the hair pattern on the transplanted hand, but he has come to terms with it. All four patients have accepted the hands as their own.

We report here the world’s longest follow-up on a patient who received a hand transplant, as well as the American experience. In addition, there have been great strides in hand transplantation worldwide, including



transplantation of both hands. A patient in Innsbruck, Austria, received a bilateral transplant and is doing very well more than 5 years post-transplant. In fact, he regularly takes long motorcycle trips, traveling thousands of miles.

Our experience, and that of the world, has demonstrated several points.

- It is possible to achieve prolonged survival of a transplanted hand using the same kind of drugs that are used on kidney transplant recipients.
- Reasonable function *does* return. We were worried that our patients might injure their hands while they were waiting for protective sensation to return. That has not been the case, and none of our patients developed ulcers or chronic injuries during sensory recovery. As demonstrated by our first patient, the return of good intrinsic muscle function can occur – this type of

function allows you to pinch your fingers and thumb. The first two patients have demonstrated hand function superior to that obtained with a prosthesis, and we have every indication the same will be true for our third patient. All of our patients were discharged to home and work in an anti-claw splint 3 months after surgery. The first three patients returned to full-time work. Every indication suggests the fourth patient will do the same. The second patient has returned to a position that involves manual labor, and his new hand is allowing him to function well.

- As in solid organ transplants, the rejection that did occur was managed with medication. To date, we have not seen evidence of chronic rejection, although it is too early to rule this complication out completely.
- There were no imminent life-threatening complications in our patients. However, we have observed potentially life-shortening complications such as hypercholesterolemia (excess cholesterol), diabetes and hypertension in our patients. We noted quality of life complications like avascular necrosis of the hips in patient #2. We have acted upon this information and aggressively reduced the maintenance immunosuppression, and have successfully eliminated maintenance steroid use in all four of our patients.

Our intermediate long-term results of hand transplants have demonstrated functional return similar to that of replants. Graft survival and quality of life after hand transplantation has far exceeded initial expectations. We conclude that allogeneic hand transplant is feasible and is an option for very select patients and highly specialized centers with the infrastructure and experience in CTA and organ transplantation. ■

For more information regarding hand transplantation, you may contact Brenda Blair, RN, at bblair@cmki.org or 502/562-0313.

Photos courtesy of Christine M. Kleinert Institute for Hand and Microsurgery

