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Current Topics in Upper Limb Loss and Difference Virtual Conference

Guest Editor: Debra Latour, OTD, MEd, OTR/L

Current Topics in Upper Limb Loss and Difference: Electronic Multi-Articulating Hands and Digits,Toe-to-Hand Transfers, and Hand Transplantations

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Baylor College of Medicine
Houston, Texas
Learning Outcomes

1. After this course, participants will be able to describe the current advances and outcomes in multi-articulating hands and their functional abilities.

2. After this course, participants will be able to describe the history of hand transplantation, when they are considered, and what to expect.

3. After this course, participants will be able to list some of the reasons the perception of disability is less in prosthetic users vs. hand transplant recipients.
Background of Study

To date there has never been a national or international effort designed to compare the dexterous abilities, functional outcomes and “disability experience” of individuals who have been fit with advanced electric multi-articulating hands and digits, toe-to-hand transfers, and hand transplantations.

Quick review of terms and acronyms…….

- Autotransplantation?
  - A transplant in same body (as in hand replantation)

- Allotransplantation?
  - A transplant between 2 different individuals (as in hand transplantation)

- What types of drugs are required in order to prevent rejection from an allotransplantation?
  - Immunosuppressive drugs

- What are some of the side effects of taking Immunosuppressive drugs?
  - Infections, metabolic disorders, disease, malignancies, renal insufficiency, diabetes, avascular necrosis of bilateral hips treated with hip replacements
Quick review of terms and acronyms……..

- Autoimmune response to a transplanted hand?
  - Improbable
- Alloimmune response to a transplanted hand?
  - Probable (but complications are manageable)
- VCA?
  - Vascularized Composite Allograft (hands & face)
- CTA?
  - Composite Tissue Allograft (composite refers to skin muscle, bone, and nerve tissue)

Historical Overview of Hand Transplantations

The first hand transplantation was performed in Lyon, France in September, 1998.
- Operation technically successful
- Patient proved to be noncompliant with immunosuppression and therapy
- Left the care of the Lyon group and required an amputation in 2001
Lesson learned… one of the many to come….

- The psychological “screen” that is done prior to a hand transplantation is critically important
- Patient compliance with immunosuppression drugs is essential (up to 50 pills/day)
- Patient compliance with therapy for up to 2 years and 6 hours a day/7 days/week
- “The survival of an allograft, and the physiological ramifications surrounding transplantation of a visible, sensate and functional part differ greatly from a solid organ transplant.”


Since 2000, 110 hand transplantations have been performed on 73 patients worldwide

The primary transplantation teams *abroad* are located in:

- Austria
- France
- Turkey
- Spain
- Poland
- Germany

United States teams include:

- University of Kentucky/Louisville
- Johns Hopkins University
- University of Pittsburgh
- UCLA
- Walter Reed Army Medical Center
- University of Pennsylvania
- Cleveland Clinic
- Brigham and Women’s Hospital
- Mass General
The most current state-of-the-art facts shared at the last American Society of Surgery for the Hand conference (September 2014)

- The bilateral transradial amputee is considered to be the most appropriate transplant candidate.
- Prostheses must be trialed for at least 6 months before an individual is considered for a transplant.
- A comprehensive team approach to screen candidates is required which includes rehabilitation medicine, OT, and social work among many other surgical specialties.
- Additionally 3 psychiatric specialties (Transplant, PTSD, and Depression) make certain candidate is acceptable.

from ASSH conference 2014…

- At least 10 cadaver rehearsals are required for anyone to be on the transplant team.
- The procedure for the bilateral upper limb patient averages 18 hours with 32 surgeons per donor/recipient procedure.
- Immunosuppression is one of the most challenging aspects of the transplantation experience. Gerald Brandacher, MD, from Johns Hopkins is currently working on a new protocol that is bone marrow based, utilizing stem cells which could result in a single “agent” to deal with immunosuppression.
- A committed compliance from the patient to the transplant program and protocol is critical.
Quality of Life vs Quantity of Life

A Debate

Because the hand transplantation procedure is considered life-enhancing as opposed to life-saving, ethical issues are balancing the risks and benefits, and remain a foremost consideration.

“The goal of Composite Tissue Allograft (CTA), therefore, is not to save lives, but rather to restore function and improve quality of life.”

Goal of study with Neil Jones MD:

- To define a “Functional Baseline Index” (FBI) score or “standard” that defines a measure of functionality of individuals fit with electric multi-articulating hands and digits, toe-to-hand transfers, and hand transplantations.

- The study is preliminary, and will require additional subjects; however, it sets the stage for future investigation and research into the dramatic advances that have occurred in the fields of reconstructive hand surgery and the emerging technological advances in electric prosthetic hands.
Subject Population

- 5 individuals with unilateral and bilateral hand transplants
- 14 unilateral and bilateral users of electric multi-articulating hands and digits
- 6 individuals with unilateral and bilateral toe-to-hand transfers

4 Validated and Standardized Tests include:

- **Box and Blocks Test (BBT):** Measure of manual dexterity that requires repeatedly moving 1 inch blocks from one side of a box to another in 60 seconds.

- **Nine Hole Peg (NHP):** A timed measure of fine dexterity that involves placing and removing nine pegs in a pegboard.

- **Disabilities of the Arm, Shoulder and Hand (DASH):** A 30 item, self-report questionnaire designed to help describe the disability experience by people with upper limb disorders.

- **Southampton Hand Assessment Procedure (SHAP):** A timed test with 8 abstract objects and 14 Activities of Daily Living designed to study 8 different prehensile patterns of grasp.

An independent and experienced occupational therapist performed all of the assessments of the study subjects.
Also included in testing regarding Sensation:

Semmes Weinstein monofilament test

Sensation questionnaire (subjective measure regarding the importance of sensation as it relates to function)

Examples of Results:

Unilateral transradial amputee utilizing an electric wrist rotator and i-limb Ultra prosthesis

Unilateral transradial hand transplant subject
Examples of Results:

Toe-to-hand transfer subject
Bilateral Participants in this Study

- 3 Bilateral amputees fit with electric multi-articulating hands

- 4 Bilateral amputees with hand transplants (2 from US, 2 from Austria)

- 1 Bilateral toe-to-hand transfer (6 toes transferred, 3 toes to each hand)

Disabilities of Arm, Shoulder and Hand (DASH)

Subjective - “Perception of Disability”
The lower the score, the Lesser Perception of Disability
Bilateral Prostheses
Bilateral Transplants
Bilateral Toe-to-Hand

Southampton Hand Assessment Procedure (SHAP)
Index of Function (IOF)

Objective – Timed test with 8 abstract objects and 14 Activities of Daily Living designed to study 8 different prehensile patterns of grasp

n = 3 4 1

Jason

- 3/08- 7200 V
  Electrocution injury
- Totally independent with BP prostheses
- One of the first bilateral transradial amputees to wear i-limb hands
- Recently fit with i-limb revolution hands
Sheila

- 7/03- Bacterial Meningitis (bilateral transradial/bilateral transtibial amputations performed)
- Initially fit with bilateral BP prostheses and became independent and returned to work
- Tried bilateral myoelectric prostheses and did not like (“too heavy”)
- 12/09- Heard about hand transplants/ Approached Andrew Lee, MD, at University of Pittsburgh
- 10/10- 12 hour hand transplant surgery performed
- Totally independent, drives and has returned to work as administrative assistant
Bilateral Hand Transplant

Surgeons: W.P. Andrew Lee, MD
Jaimie Shores, MD

Marius

- 5/08- Severe burn injury while caught in family’s burning home in Romania
- Lost all fingers from both hands/ Severe facial and lower limb burns
- Treated at LA Shriners Hospital/ Neil Jones, MD, performed 6 toe-to-hand transfers
- Walks, runs, plays football and basketball
- Totally independent
Bilateral Toe-to-Hand Transfer

What are the Key Differences of each Subject Group as it relates to the Rehabilitation Experience

<table>
<thead>
<tr>
<th></th>
<th>Prosthetic Users</th>
<th>Hand Transplants</th>
<th>Toe-to-Hand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time from procedure to “function”</td>
<td>3-6 mos.</td>
<td>18 mos-2 yrs.</td>
<td>2-3 mos.</td>
</tr>
<tr>
<td>Amount of therapy</td>
<td>3x/wk. 1-2 hrs/day</td>
<td>7 days/wk. 5-6 hrs/day</td>
<td>Minimal if any</td>
</tr>
<tr>
<td>Medications</td>
<td>None</td>
<td>Up to 50 pills a day</td>
<td>Minimal</td>
</tr>
<tr>
<td>Potential complications</td>
<td>None</td>
<td>Yes</td>
<td>Minimal if any</td>
</tr>
<tr>
<td>Sensation</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Appearance</td>
<td>Good</td>
<td>Good</td>
<td>Good in single digit transfer</td>
</tr>
</tbody>
</table>

Surgeon: Neil Jones, MD
A Closer Look at Results……

- Early results reveal that the outcomes of hand transplants, 2 years or more post-procedure, demonstrate similar outcomes of prosthetic users of advanced hand technology, as it relates to activities of daily living, fine motor, and manual dexterity.

- What is interesting, however, and requires further investigation, is that subjects who utilize electric multi-articulating hand and digits perceived themselves as “less disabled” when compared to hand transplant subjects.

What are some of the Possible Reasons the Perception of Disability is Less in Prosthetic Users vs. Hand transplants?

- 1. The time from onset of upper limb loss to being fit and functional with an upper limb prosthesis is considerably less than the duration of time required for hand transplantation.

3-6 months ----------- versus----------- 18 months - 2 years

Prosthetic users become independent sooner and therefore see themselves as “less disabled.”
What are some of the Possible Reasons the Perception of Disability is Less in Prosthetic Users vs. Hand transplants?

2. The fine motor abilities of those who have been fit with advanced multi-articulating hands is the one area of dexterity that appear to be superior to those with hand transplantations.

Tip pinch is one of the last fine motor abilities that is possible with hand transplants, and even then, it is not always achieved.

Some of the prehension patterns possible with multi-articulating hands
“Recovery of the *intrinsic muscles* of a transplanted hand is observed on average at 9-15 months following transplantation. Different degrees of intrinsic return are based upon the skills and experience of the transplant team, and the frequency and duration of occupational therapy.”


What are some of the Possible Reasons the Perception of Disability is Less in Prosthetic Users vs. Hand transplants?

3. Once the amputation is performed and an upper limb prosthetic fitting/training has been accomplished, the upper limb amputee is essentially finished with his rehabilitation program.

Ongoing medical treatment, frequent follow-up, and numerous immunosuppressant drugs are required in the hand transplant patient for the remainder of their lives. They continue to see themselves as a “patient” versus an independent, “back to work/society” individual.
Future Goals and Direction of this Study

Add additional prosthetic users and hand transplant subjects.

Continue to build bridges of understanding between rehabilitation, surgery and 3rd party payers.

Define “Success” in a way that is universally understood.

Enable the individual who has lost one or both hands to make an informed decision.
Questions?

- Email: djatkind@yahoo.com
Current Topics in Upper Limb Loss and Difference Virtual Conference

Mon 11/11  Unlimbited Wellness and Secondary Conditions  Debra Latour, OTD, MEd, OTR/L

Tues 11/12  Problem Solving Complex Issues with Pediatric Upper Limb Loss Difference  Vivian Yip, OTD, MA, OTR/L

Wed 11/13  OT for Targeted Muscle Reinnervation and Pattern Recognition Control  Kristi Turner, DHSc, OTR/L

Thurs 11/14  Bilateral Upper Limb Loss  Shawn Swanson Johnson, OTR/L

Fri 11/15  Electronic Multi-Articulating Hands and Digits, Toe-to-Hand Transfers, and Hand Transplantations  Diane J. Atkins, OTR/L, FISPO