ASPN/ASRM Combined Scientific Paper Presentations
(ASRM Abstracts Only)
Sunday, January 14, 2018, 9:45am – 10:15am

10:00 AM - 10:04 AM
RM 304. **Closed-Loop Control of Robotic Hand Prosthetics in Partial Hand Amputees**
University of Texas Southwestern Medical Center, Dallas
Presenter: Jonathan Cheng, MD, FACS
Jonathan Cheng, MD, FACS(1), Cynthia K Overstreet, PhD(2) and Edward W. Keefer, PhD(2)
(1)Plastic Surgery, Division of Hand Surgery, University of Texas Southwestern Medical Center, Dallas, TX, (2)Nerves Incorporated, Dallas, TX

Background As part of the DARPA HAPTIX program, we are developing a peripheral nerve interface system for closed-loop control of robotic hand prosthetics in partial hand amputees. This is the first system intended to benefit patients with partial hand amputations, who constitute the dominant population among upper limb amputees. Our goal is to provide dexterous control of individual prosthetic fingers using data obtained directly from peripheral nerves. We also seek to restore both tactile and proprioceptive sensation through electrical stimulation. **Methods** Two thin-film longitudinal intrafascicular electrode (LIFE) arrays were surgically targeted to the ulnar sensory and motor fascicular groups in the forearms of partial hand amputees. Electrode leads were passed percutaneously to a connector block and interfaced with a Ripple Grapevine electrophysiology system. Weekly experimental sessions were conducted over the course of a 90 day period, to investigate sensory stimulation and motor recording signal parameters over the duration of the implantation period. At the conclusion of the experiments, all implants were surgically removed. **Results** Sensory maps and characterization were obtained at each lab session. Sensory stimulation produced a range of percepts, including light pressure, pulsing, squeezing, individual finger movements, and multi-digit grasp sensations. Modulation of sensory stimulation could elicit changes in the quality and location of percepts. Stimulation on multiple electrodes could produce discrete or fused percepts with the appropriate choice of parameters. Subjects could reliably discriminate between pulse amplitudes as small as 5 μA, and could detect stimulus trains as short as two pulses. Motor recordings could be decoded to identify imagined movement of specific amputated fingers with high accuracy. When mapped to subject's prosthetic hands, percepts could be used by subjects to identify contact events on multiple digits and joint motion during grasping. **Conclusion** The decode algorithms and sensory restoration protocols we are developing hold promise to provide dexterous control of prosthetic hands with restoration of both tactile and proprioceptive sensations. Ultimately, the system we are exploring will include custom electrode arrays, specific surgical techniques to target individual nerve fascicles, low-noise implantable electronics for recording the very small signals of the peripheral nerve, sensorized prosthetics to trigger and control delivery of sensory stimuli, wireless transmission of data and power, and software-mediated calibration of stimulus configurations to restore real-world useable hand sensibility.

10:04 AM - 10:08 AM

RM 305. **Free Functioning Gracilis Muscle Transfer for Elbow Flexion Reconstruction after Traumatic Adult Brachial Pan-Plexus Injury: Where Is the Optimal Distal Tendon Attachment for Elbow Flexion?**

Mayo Clinic, Rochester

Presenter: Andrés A. Maldonado, MD, PhD

Andrés A. Maldonado, MD, PhD(1,2), Santiago Romero-Brufau, MD(2), Robert J Spinner, MD(3), Allen Bishop, MD(4) and Alex Shin, MD(5)

(1)BG Unfallklinik, Frankfurt, Germany, (2)Mayo Clinic, Rochester, MN, (3)Department of Neurological Surgery, Mayo Clinic, Rochester, MN, (4)Department of Orthopedic Surgery, Mayo Clinic, Rochester, MN, (5)Orthopedics, Mayo Clinic, Rochester, MN

Background: Reconstruction after pan-plexus root avulsions often includes microsurgical reconstruction using a gracilis free functional muscle transfer (FFMT). For elbow flexion reconstruction, the FFMT distal tendon is inserted into the biceps tendon or more distally (i.e. flexor digitorum profundus [FDP]/flexor pollicis longus [FPL] tendons) for combined elbow and finger flexion; the theoretical drawback of the latter approach is weaker elbow flexion. We sought to critically compare elbow flexion strength with a biceps tendon versus a FDP/FPL tendon attachment to determine which insertion point resulted in better elbow flexion.

Methods: Thirty-nine patients underwent FFMT with either a biceps tendon or distal attachment. The groups were compared with respect to postoperative elbow flexion strength, as well as preoperative and postoperative DASH scores, range of motion, and other surgical and demographic characteristics. A biomechanical analysis was performed simulating different tendon attachments to determine which reconstruction resulted in optimal elbow flexion mechanics.

Results: Distal tendon attachment was associated with M3 or M4 elbow flexion and greater range of motion compared to the biceps tendon attachment (p-value < 0.05). There were no statistically significant improvements in DASH scores. Biomechanical analysis demonstrated a 15-30% greater torque with the distal tendon attachment and with a 10 cm and 15 cm from the elbow axis of rotation in the radius attachment compared to the biceps tendon.

Conclusion: The FDP/FPL tendon attachment of the gracilis FFMT distal tendon was superior in achieving elbow flexion strength. Patients with only elbow flexion reconstruction may also benefit from a FDP/FPL tendon attachment or from a more distal attachment to the radius.

10:08 AM - 10:12 AM
RM 306. **Long-Term Outcomes of Smile Reconstruction in Möbius Syndrome**
The Hospital For Sick Children and University of Toronto, Toronto
Presenter: Irina Domantovsky, MD, MS
Irina Domantovsky, MD, MS(1), Jocelyne Copeland, OT Reg (Ont), BA, BHSc OT(1), Rachel M. Clancy, MBChB, MA, MRCS, MEd(1), Ronald M. Zuker, MD, FRCSC, FACS, FAAP(1) and Gregory H. Borschel, MD, FAAP, FACS(2)
(1)The Hospital for Sick Children and University of Toronto, Toronto, ON, Canada, (2)The Hospital for Sick Children, Toronto, ON, Canada

Background

Gracilis muscle transplant is the standard of care for smile reconstruction in children with Möbius syndrome. However, the long-term clinical efficacy, durability, and psychosocial impact of the transplant remain unknown. We describe the function and psychosocial impact of gracilis transplant after a mean follow-up of 20 years following surgery.

Methods

Patients with Möbius syndrome who underwent gracilis muscle transfer between 1985-2005 were included in the study. We compared pre- and postoperative oral commissure excursion using photographic measurements, administered the patient-reported FaCE outcome measure, and used semi-structured interviews to assess long-term outcomes.

Results Twelve patients completed the study. The mean age at surgery was 13.2 ±10.6 years and the mean follow-up was 20.4 ± 4.4 years postoperatively. Twenty-two gracilis muscle transplants were performed, all innervated by the motor nerve to the masseter. Photographic analysis using SMILE software demonstrated that movement of the muscle was unchanged twenty years after surgery. Smile symmetry was stable long-term. The overall mean FaCE score of the cohort was 62.3 ± 12.0. Facial comfort (86.4 ± 21.2) and social function (69.9 ± 18.5) subdomains were the highest. Although the facial movement subdomain score was 35.6 ± 12.4, the score related to smiling alone was 84.1 ± 20.2, indicating satisfaction with the reconstruction. Interview responses indicated high satisfaction with surgery, fulfilled expectations of social acceptance, improved communication, enhanced self-confidence, and a sense of increased facial symmetry, spontaneity and smile excursion.

Conclusion

Segmental gracilis muscle transplantation provides long-lasting improvements in objective and patient-reported measures of facial function.