

## CURRICULUM VITAE

Name: **Michael Warren Keith, M.D.**  
Address: 2500 MetroHealth Drive  
Cleveland, Ohio 44109-1998  
Telephone: 216-778-4399  
FAX: 216-778-4690

### EDUCATION

Case Western Reserve University, Bachelor of Arts/1969  
Ohio State University, Doctor of Medicine/1973

### POST GRADUATE TRAINING

Internship and General Surgery-Yale University, 1973-1975  
Residency: Orthopaedic Surgery-Case Western Reserve University, 1975-1978  
Fellowship: Hand Surgery-Thomas Jefferson University, Dr. James Hunter, 1978-1979

### ACADEMIC APPOINTMENTS

Instructor-Orthopaedics, Case Western Reserve University, July, 1979-July, 1980  
Senior Instructor-Orthopaedics, Case Western Reserve University, July, 1980-July, 1981  
Assistant Professor-Orthopaedics, Case Western Reserve University, July, 1981-July, 1990  
Assistant Professor-Biomedical Engineering, Case-Western Reserve University, July, 1980-July, 1990  
Associate Professor-Orthopaedics, Case Western Reserve University, July, 1990-July, 1996  
Associate Professor-Biomedical Engineering, Case-Western Reserve University, July, 1990-July, 1996  
Professor-Orthopaedics, Case Western Reserve University, July, 1996 - current  
Professor-Biomedical Engineering, Case Western Reserve University, July, 1996 - current

### HOSPITAL APPOINTMENTS

MetroHealth Medical Center, Cleveland OH, Active Staff, 1979-current  
Dept. of Veterans Affairs Medical Center, Cleveland OH, Consultant, 1979-current  
Dept. of Veterans Affairs Medical Center, Palo Alto CA, Consultant, 1994-current  
Southwest General Health Center, Middleburg Heights OH, Provisional Staff, 1994-1995, Active Staff, 1995-current.  
University Hospitals of Cleveland, Cleveland OH, Active Staff, 1979-June, 2002.  
St. Luke's Medical Center, Shaker Heights OH, Active Staff, 1990-; Courtesy Staff 1983-April, 1994  
**Revised 11/30/2012**

### BOARD CERTIFICATION

American Board of Orthopaedic Surgery, 1981  
American Board of Orthopaedic Surgery, Certificate of Added Qualifications in Hand Surgery, August 31, 1992.  
American Board of Orthopaedic Surgery, Re-certification of Added Qualifications in Hand Surgery, August, 2002, EXPIRES 12/31/2012

### SURGICAL SPECIALTY SOCIETIES

American Society for Surgery of the Hand  
Associate Member, 1983  
Active Member, 1987  
Fellow-American College of Surgeons, 1983

### **LICENSURE TO PRACTICE**

Ohio, 1973 (036187) active through October 1, 2012  
Pennsylvania, 1978 (020699E) active through December 31, 2004  
Connecticut, 1974 (16757) inactive  
Indiana, 2000 (01052531A) inactive

### **HONORS**

Ohio State University, 1973, Elected to Landacre Research Honorary, Effects of Phenformin on Active Transport of Amino Acids in Intestinal Epithelial Cells

Elected to Alpha Omega Alpha, 1973, Medical School Honorary, Ohio State University

Departmental Honors, Department of Surgery, 1973, Robert M. Zollinger, M.D. Award

Fellowship: Department of Health, Education & Welfare for Department of Physical Medicine and Rehabilitation, Stroke Rehabilitation 1970

Case Western Reserve University, Resident Research Prize, 1978, Analysis of Length-Tension Properties of the Muscle Tendon Unit by Electrical Stimulation

Departmental Honors, Department of Orthopaedics, 1993, John R. Carter, M.D. Orthopaedic Teaching Award

2004 Maurice Saltzman Award, The Mt. Sinai Health Care Foundation, June 7, 2004

### **MEMBERSHIP IN HONORARY AND PROFESSIONAL SOCIETIES**

Ohio State Medical Association, 1982  
Cleveland Orthopaedic Club, 1979  
Jefferson Hand Club, 1979  
Rehabilitation Engineering Society of North America, 1981  
Society for Neuroscience, 1981  
Ohio Orthopaedic Society, 1982  
European Brain and Behavior Society, 1981 (Honorary)  
British Brain Research Association, 1981 (Honorary)  
American Society for Surgery of the Hand, 1983  
American College of Surgeons, 1983  
Orthopaedic Research Society, 1983  
American Academy of Orthopaedic Surgeons, 1984  
American Spinal Cord Injury Association, 1985  
American Orthopaedic Association, 1993

### **COMMITTEE APPOINTMENTS**

MetroHealth Medical Center  
Acute Care Subcommittee, 1979-1980  
Emergency Room Committee, 1979-1980  
Surgical Clinics Committee, 1979-1987

Laser Committee, 1985-1987  
Operating Room Committee, (ad hoc), 1979-1990  
Medical Staff Health Committee, 1988-1991  
Surgical Risk Management Committee, 1988-1991  
Human Investigation Committee, 1989-1991  
Information Systems Steering Committee, 1990-1991  
Hospital Quality Assurance Committee, 1989-1991 (President, Medical Staff)  
Medical Executive Committee, 1989-1991 (President, Medical Staff)  
Steering and Credentials Subcommittee, 1989-1991 (President, Medical Staff)  
Joint Conference Committee, 1989-1991 (President, Medical Staff)  
Program and Agenda/Nominating Subcommittee, 1989-1991 (President, Medical Staff)  
Senior Vice-President-Medical Affairs Search Committee, 1990-November, 1990 (President, Medical Staff)  
MHC/Saint Luke's Hospital Physician Planning Committee, 1990-1991  
MHC/Saint Luke's Hospital Clinical Practice Committee, 1990-1991  
Orthopaedic Quality Assurance Committee, Chairman, 1988-1994  
Faculty Business Office Management Board, MetroHealth Medical Center, 1992-1997  
Faculty Business Office Operations Subcommittee, MetroHealth Medical Center, 1994-1998  
Information Services Committee (ISC), MetroHealth Medical Center, 1994-1998  
Medical Records Committee, 9/2009-9/2012

University Hospitals of Cleveland

Medical Records Committee, 1979-1985  
Department of Orthopaedics, Credential Committee, 1991-2001

Case Western Reserve University, College of Medicine

Committee on Continuing Medical Education, 1983-1984  
Committee on Curriculum and Content Monitoring, 1983-1984  
Ad Hoc Committee on Ambulatory Training of CME, 1987-1988  
Orthopaedic Research Committee, 1990-1997

MetroHealth Center for Rehabilitation

Peer Review and Utilization Review, 1979-present

Wright Surgery Center

Patient Care, Tissue and Utilization Committee, 1984-1986  
Task Force Committee, 1985-1986

University Suburban Health Center

Peer Review and Utilization Review Committee, 1985-1986  
Computer Committee, 1984-1985  
Marketing and Communications Committee, 1985-1986

Academy of Medicine of Cleveland

Sports Medicine Committee, 1984-1988

American Society for Surgery of the Hand

Outcome Studies, 1993-present; chairperson 2000-2003  
Research Committee - 1996-1999  
Research Group, Chairperson – 10/2003- 10/2004  
Evidence Based Practice committee, chairperson, Aug 2004; co-chair Aug 2006- Sep 2008  
Multicenter Clinical Trials Task Force, 2004-2006

American Academy of Orthopaedic Surgery

Evidence Based Practice Committee 2001-current, chairman 2007-2011

Guidelines Oversight Committee, appointed 2006 - 2011  
Carpal Tunnel Diagnosis Clinical Practice Guideline Committee, appointed 2006, chairperson  
2007-2011  
Carpal Tunnel Treatment Clinical Practice Guideline Committee, chairperson 2007-2008  
Council on Research, Quality Assurance and Technology, appointed 2008-2011  
RAND  
Appropriate Use Criteria Committee, 2/2011-3/2013

American Spinal Injury Association

Ad Hoc Committee on Functional Assessment, 1993-1995

Administrative Positions Held

Acting Director, Department of Orthopaedics, MetroHealth Medical Center, 11/87-9/88

President, Medical Staff, MetroHealth Medical Center, 7/89-6/91

Associate Chairperson, Department of Orthopaedics, 1988-2001

Chief Orthopaedic Hand Service, MetroHealth Medical Center, 8/01-present

Medical Advisor, Industrial Commission of Ohio, Rehabilitation Division

## BIBLIOGRAPHY

### PUBLISHED PAPERS (Reviewed Journals)

1. Waylonis GW, **Keith** MW, Aseff JN.: Stroke Rehabilitation in a Midwestern County. *Arch Phys Med Rehabil*, Vol 54, April, 1973.
2. Freehafer AA, Peckham PH, and **Keith** MW: Determination of Muscle Tendon Unit Properties During Tendon Transfers. *The Journal of Hand Surgery*, 4:331, July, 1979.
3. Barre P, **Keith** MW, Sobel M, Rashad FA, Shields RW Jr.: Vascular Insufficiency in Okiihiro's Syndrome Secondary to Hypothenar Hammer Syndrome. *The Journal of Hand Surgery*, 12A(3):401-405, May, 1987.
4. Smith B, Peckham PH, Roscoe DD, **Keith** MW, Marsolais EB: An Externally Powered, Multichannel Implantable Stimulator for Versatile Control of Paralyzed Muscle. *IEEE Transactions on Biomedical Engineering*, BME-37(7):499-508, July, 1987.
5. Rashad, F, **Keith** MW, Shields RW Jr., Barre, PS, Sobel M: Congenital Vascular Abnormalities in Okiihiro's Syndrome. *Angiology*, August, 1987.
6. Peckham PH, **Keith** MW, Freehafer AA: Current Concepts Review: Restoration of Functional Control in the Tetraplegic Upper Extremity by Electrical Stimulation. *Journal of Bone and Joint Surgery*, 70A(1):144-148, January, 1988.
7. Bellon EM, **Keith** MW, Coleman PE, Shah ZR: Magnetic Resonance Imaging of Internal Derangement of the Knee, *Radiographics*, 8(1):95-118, January, 1988.
8. Freehafer AA, Peckham PH, **Keith** MW, Mendelson LS: The Brachioradialis: Anatomy, Properties, and Value for Tendon Transfers in the Tetraplegic, *Journal of Hand Surgery*, 13A(1):99-104, January, 1988.
9. **Keith** MW, Peckham PH, Buckett JR, Thrope GB, Stroh K, Menger V: Functional Neuromuscular Stimulation Neuroprosthesis for the Tetraplegic. *Clinical Orthopaedics and Related Research*, 233:25-33, August 1988.
10. Buckett JR, Peckham PH, Thrope GB, Braswell SD, **Keith** MW: A Flexible, Portable Functional Neuromuscular Stimulation Neuroprosthetic System. *IEEE Transactions on Biomedical Engineering*, 35(11):897-904, November 1988.
- \*\*Freehafer AA, Peckham PH, **Keith** MW: New Concepts on Treatment of the Upper Limb in the Tetraplegia. Surgical Restoration and Functional Neuromuscular Stimulation. *Hand Clinics* 4(4):563-574, November 1988.
11. Mendelson LS, Peckham PH, Freehafer AA, **Keith**, MW: Intraoperative Assessment of Wrist Extensor Muscle Force. *The Journal of Hand Surgery*, 13(6):832-836, November, 1988.
12. Mendelson LS, Peckham PH, Freehafer AA, **Keith** MW: Assessment of Tendon Transfer Surgery in the Tetraplegic Upper Extremity. *Innov. Tech Biol. Med.* 9:281-293, 1988.
13. **Keith** MW, Peckham PH, Thrope GB, Stroh, KC, Smith B, Buckett JR, Kilgore KL, Jatich JW: Implantable Functional Neuromuscular Stimulation in the Tetraplegic Hand: A Case Report. *The Journal of Hand Surgery*, 14A(3):524-530, May, 1989.

14. Kilgore KL, Peckham PH, Thrope GB, **Keith** MW, Gallagher-Stone KA: Synthesis of Hand Movement Using Functional Neuromuscular Stimulation. *IEEE Transactions on Biomedical Engineering, Special Issue on Functional Electrical Stimulation*, 36(7):761:770, July 1989.
15. Miller LJ, Peckham PH, **Keith** MW: Elbow Extension in the C5 Quadriplegic Using Functional Neuromuscular Stimulation. *IEEE Transactions on Biomedical Engineering, Special Issue on Functional Electrical Stimulation*, 36(7):771-780, July, 1989.
16. Riso R, Ignagni AR, **Keith** MW.: Electrocutaneous sensations elicited using subdermally located electrodes. *Automedica*, 11:25-42, 1989.
17. Kilgore KL, Peckham PH, **Keith** MW, Thrope GB: Electrode Characterization for Functional Application to Upper Extremity FNS, *IEEE Transactions on Biomedical Engineering*, 37(1):12-21, January, 1990.
18. Carter RR, Crago PE, **Keith** MW.: Stiffness Regulation by Reflex Action in the Normal Human Hand. *Journal of Neurophysiology*, 64(1):105-118, July, 1990.
19. Wijman CA, Stroh KC, Van Doren CL, Thrope GB, Peckham PH, **Keith** MW.: Functional Evaluation of Quadriplegic Patients Using a Hand Neuroprosthesis. *Archives of Physical Medicine and Rehabilitation*, 71:1053-1057, December 1990.
20. Riso RR, Ignagni AR, **Keith**, MW: Cognitive Feedback for Use with FES Upper Extremity Neuroprostheses. *IEEE Transactions on Biomedical Engineering*, 38(1):29-38, January, 1991.
21. **Keith** MW, Lacey SH: Surgical Rehabilitation of the Tetraplegic Upper Extremity. *Journal of Neurological Rehabilitation*, 5(1&2):75-87, 1991.
22. Betz RR, Mulcahey MJ, Smith BT, Triolo R.J, Weiss AA, Moynahan M, **Keith** MW, Peckham PH.: Bipolar Latissimus Dorsi Transposition and Functional Neuromuscular Stimulation to Restore Elbow Flexion in an Individual with C4 Quadriplegia and Claim: 5 Denervation. *Journal of the American Paraplegia Society*, 15(4):220-228, October, 1992.
23. Peckham PH, **Keith** MW, Stroh KC, Kilgore KL, Hart RL: Restoration of Functional Grasp-Release in Tetraplegia with Implantable Neuromuscular Stimulation and Tendon Transfer. *Electrophysiological Kinesiology*, 5:269-274, 1993.
24. Memberg WD, Peckham PH, Thrope GB, **Keith** MW, Kicher TP: An Analysis of the Reliability of Percutaneous Intramuscular Electrodes in Upper Extremity FNS Applications. *IEEE Transactions on Rehabilitation Engineering*, 1(2):126-132, June, 1993.
25. Stroh-Wuolle KC, Van Doren CL., Thrope GB, Peckham PH, **Keith** MW: Development of a Quantitative Hand Grasp and Release Test for Patients with Tetraplegia Using a Hand Neuroprosthesis, *Journal of Hand Surgery*, 19A(2):209-218, 1994.
26. Memberg WD, Peckham PH, **Keith** MW: A Surgically-Implanted Intramuscular Electrode for An Implantable Neuromuscular Stimulation System, *IEEE Transactions on Rehabilitation Engineering*, 2(2):80-91, June, 1994.
27. Vasen AP, Lacey SH, **Keith** MW, Shaffer JW: Functional Range of Motion of the Elbow, *Journal of Hand Surgery*, 20A(2):288-292, March, 1995.
28. Scott TR, Peckham PH, **Keith** MW: Upper Extremity Neuroprostheses Using Functional Electrical Stimulation. *Baillieres Clin Neurol* 4(1):57-75, April 1995.

29. **Keith MW**, Kilgore KL, Peckham PH, Wuolle KS, Creasey G, Lemay M: Tendon Transfers and Functional Electrical Stimulation for Reconstruction of Hand Function in Spinal Cord Injury. *J Hand Surg* 21A(1):89-99, 1996.
30. Triolo JR, Nathan R, Handa Y, **Keith MW**, Betz R, Kantor K.: Challenges to Clinical Deployment of Upper Extremity Neuroprostheses. *J Rehab R&D*, 33:111-122, April 1996.
31. Amadio PC, Higgs P, Keith MW: Prospective Comparative Clinical Trials in the Journal of Hand Surgery (American). *Journal of Hand Surgery*, 21A: 925-929, 1996.
32. Lemay MA, Crago PE, **Keith MW**: Restoration of Pronosupination Control by FNS in Tetraplegia: Experimental and Biomechanical Evaluation of Feasibility. *Journal of Biomechanics*, 29(4):403-409 December 1996.
33. Kirsch RF, Acosta AM, Perreault EJ, **Keith MW**: Measurement of Isometric Elbow and Shoulder Moments: Position-Dependent Strength of Posterior Deltoid to-Triceps Muscle Tendon Transfer in Tetraplegia. *IEEE Trans Rehab Eng*, 4:403-409, 1996.
34. Schroer W, Lacey S, Frost F, **Keith MW**: Carpal Instability in the Weight-Bearing Upper Extremity, *Journal of Bone and Joint Surgery*, 78A(12):1838-1843, December, 1996..
35. Kilgore KL, Peckham PH, **Keith MW**, Thrope GB, Wuolle KS, Bryden AS, Hart R.L.: An Implanted Upper Extremity Neuroprosthesis: Follow-up of Five Patients: *Journal of Bone and Joint Surgery*, 79A(4):533-541, April 1997.
36. Akers JM, Peckham PH, **Keith MW**, Merritt K: Tissue Response to Chronically Stimulated Implanted Epimysial and Intramuscular Electrodes. *IEEE Trans Rehab Eng* 5(2):207-220, 1997.
37. Crago PE, Memberg WD, Usey MK, **Keith MW**, Kirsch RF, Chapman GJ, Katorgi MA, Perreault EJ: An Elbow Extension Neuroprosthesis for Individuals with Tetraplegia. *IEEE Trans Rehab Eng* 6(1):1-6, March, 1998
38. Wuolle KS, Van Doren CL, Bryden A, Peckham PH, **Keith MW**, Kilgore KL, Grill J: Satisfaction With and Usage of a Hand Neuroprosthesis. *Arch Phys Med Rehabil* 80:206-13, 1999
39. Johnson, MW, Peckham, PH, Bhadra N, Kilgore KL, **Keith**, MW, Strojnik, P: An Implantable Transducer for Two-degree-of-freedom Joint Angle Sensing. *IEEE Transactions on Rehabilitation Engineering*, 7(3):359-359, September 1999.
40. Lauer RT, Kilgore KL, Peckham PH, Bhadra N, **Keith MW**: The Function of the Finger Intrinsic Muscles in Response to Electrical Stimulation. *IEEE Trans Rehab Eng* 7(1):19-26, March 1999.
41. Bhadra N, Peckham PH, **Keith MW**: Variations in Innervation of the Flexor digitorum Profundus Muscle. *Journal of Hand Surgery* 24A(4):700-703, July 1999.
42. Ejeskar A, Hentz VR, Holst-Nielsen F, **Keith MW**, Rothwell AG: Clinical Case of the Month- Reconstructive hand surgery. *Spinal Cord* 37(7):475-479, July 1999.
43. Ziran BH, Scheel M, **KEITH MW**: Pin Reduction and Fixation of Volar Frcture Fragments of Distal Radius Fractures via the Flexor Carpi Radialis Tendon. *The Journal of TRAUMA Injury, Infection and Critical Care* 49(3), 433-439, September 2000.
44. Creasey GH, Kilgore KL, Brown-Triolo DL, Dahlberg JE, Peckham PH, **KEITH MW**: Reduction of Costs of Disability Using Neuroprostheses, *Assistive Technology*, 12(1), 67-75, 2000.

45. Creasey GH, Brown-Triolo DL, Kilgore KL, Dahlberg JE, Peckham PH, **KEITH MW**: Reduction in costs of disability using neural prostheses. *Assistive Technology* 12(1):67-75, 2000.
46. **KEITH MW**: Neuroprostheses for the Upper Extremity, *Microsurgery* 21(6):256-263, 2001.
47. Peckham PH, **KEITH MW**, Kilgore, KL, Grill JH, Wuolle KS, Thrope GB, Gorman P, Hobby J, Mulcahey MJ, Carroll S, Hentz, VR, Wiegner A: Efficacy of an Implanted Neuroprosthesis for Restoring Hand Grasp in Tetraplegia: A Multicenter Study. *Arch Phys Med Rehabil* 82:1380-1388, October 2001.
48. Peckham PH, Kilgore KL, **KEITH MW**, Bryden AM, Crago PE, Bhadra N, Buckett JR, Montague FW, Gazdik MM, Smith B: An Advanced Neuroprosthesis for Restoration of Hand and Upper Arm Control Employing an Implantable Controller. *The Journal of Hand Surgery* 27A(2):265-276, March 2002.
49. Greenwald D, **KEITH MW**, Aguiar J, Singh S: Special topic Current Surgical Therapy for Quadriplegia: Functional Electrical Stimulation. *Plastic and Reconstructive Surgery* 109:1378-1385, April 2002.
50. Bhadra N, Peckham PH, Keith MW, Kilgore KL, Montague F, Gazdik M, Stage T: Implementation of an implantable joint-angle transducer, *Journal of Rehabilitation Research and Development*, 39(3):411-422, May/June 2002.
51. **KEITH MW**, Hoyen HA: Indications and Future Progress in Implementation of the Tetraplegic Upper Limb Neuroprosthesis. A Review in *The Hand Clinics* 18:519-528, August 2002.
52. Hoyen HA, Gonzalez E, Williams P, **KEITH MW**: Management of the paralyzed elbow in tetraplegia. *The Hand Clinics* 18:113-133, 2002.
53. Murray WM, Bryden AM, Kilgore, KL, **KEITH MW**: The Influence of Elbow Position on the Range of Motion of the Wrist Following Transfer of the Brachioradialis to the Extensor Carpi Radialis Brevis Tendon. *The Journal of Bone and Joint Surgery* 84A(12):2203-2210, December 2002.
54. Knutson JS, Naples, GG, Peckham PH, **KEITH MW**: Electrode fracture rates and occurrences of infection and granuloma associated with percutaneous intramuscular electrodes in upper-limb functional electrical stimulation applications, *Journal of Rehabilitation Research and Development* 39(6):671-684, November-December 2002.
55. Kilgore KL, Peckham PH, **KEITH MW**, Montague FW, Hart RL, Gazdik MM, Bryden AM, Snyder SA, Stage TG. The durability of implanted electrodes and leads in upper extremity neuroprostheses. *Journal of Rehabilitation Research and Development (JRRD-03-03-0030)* 40(6):457-468, November/December 2003.
56. Memberg WD, Crago PE, **KEITH MW**: Restoration of elbow extension via functional electrical stimulation in individuals with tetraplegia. *Journal of Rehabilitation Research and Development*, 40(6):477-486, November-December 2003.
57. Bryden AM, Kilgore KL, Kirsch RF, Memberg WD, Peckham PH, **KEITH MW**, An implanted neuroprosthesis for high tetraplegia, *Top Spinal Cord Inj Rehabil*, 10(3):38-52, 2005.
58. Polasek K, Hoyen HA, **KEITH MW**, Tyler DJ: Nerve Thresholds and Selective Activation in the Human with the Spiral Nerve Cuff Electrode. *IEEE Trans Neural Eng and Rehab*, 15(1): 76, 2007.



59. Kilgore KL, Hoyen HA, Bryden AM, Hart RL, **KEITH MW**, Peckham PH: An Implanted Upper Extremity Neuroprosthesis Using Myoelectric Control, The Journal of Hand Surgery, 33A(4) 539-550, April 2008.
60. Polasek KH, Hoyen HA, **KEITH MW**, Tyler DJ: Human nerve stimulation thresholds and selectivity using a multi-contrast nerve cuff electrode, Orthopaedic Journal, Case Western Reserve University, 5(1):42-49, 2008.
61. Bryden AM, Kilgore KL, **KEITH MW**, Peckham PH: Assessing activity of daily living performance after implantation of an upper extremity neuroprosthesis, Top Spinal Cord Inj Rehabil, 13(4):37-53, 2008.
62. **KEITH MW**, Masear V, Chung K, Maupin K, Andary M, Amadio PC, Barth RW, Watters WC, Goldberg MJ, Haralson RH, Turkelson CM, Wies JL: Diagnosis of Carpal Tunnel Syndrome, Journal of the AAOS, 17(6): 390-396, June 2009.
63. **KEITH MW**, Masear V, Amadio PC, Andary M, Barth RW, Graham B, Chung K, Maupin K, Watters WC, Haralson RH, Turkelson CM, Wies JL, McGowan R: Treatment of Carpal Tunnel Syndrome, Journal of the AAOS, 17(6):397-405, June 2009.
64. **KEITH MW**, What do we do while waiting for clinical standards? AAOS NOW 3(6):41-43, June 2009
65. Anglen J, Kyle RF, Marsh JL, Virkus WS, Watters WC, **KEITH MW**, Turkelson CM, Wies JL, Boyer KM: Locking Plates for Extremity Fractures, Journal of the AAOS, 17(7):465-472, July 2009.
66. Polasek KH, Hoyen HA, **KEITH MW**, Kirsch RF, Tyler DJ: Stimulation Stability and Selectivity of Chronically Implanted Multicontact Nerve Cuff Electrodes in the Human Upper Extremity, IEEE Trans Neural Syst Rehabil Eng 17(5): 428-37, October 2009.
67. Bryden AM, Peljovich, AE, Hoyen HA, Nemunaitis G, Kilgore KL, **KEITH MW**: Surgical restoration of arm and hand function in people with Tetraplegia. Topics in Spinal Cord Injury Rehabilitation, 18(1):43:49, 2012.
68. Paterno M, Sanders JO, Watters WC3rd, Goldberg MJ, **KEITH MW**, Turkelson CM, Wies JL, Raymond L, Boyer KM, Hitchcock K, Sluka P, Boone C, Patel N: American Academy of Orthopaedic Surgeons Clinical Practice Guidelines on: The Diagnosis and Treatment of Osteochondritis Dissecans. J Bone and Joint Surg Am 2012 Jul 18; 94(14):1322-4. PubMed PMID: 22810404
68. Knutson JS, Chae J, Hart RL, **KEITH MW**, Hoyen HA, Harley MY, Hisel TZ, Bryden AM, Kilgore KL, Peckham PH: Implanted neuroprosthesis for assisting arm and hand function after stroke: a case study. J Rehabil Res Dev (in press)

## BOOK CHAPTERS

1. Peckham PH, Thrope GB, Buckett JR, Freehafer AA, **Keith** MW: Coordinated Two Mode Grasp in the Quadriplegic Initiated by Functional Neuromuscular Stimulation. In IFAC Control Aspects of Prosthetics and Orthotics. R.M. Campbell, ed., Pergamon Press, New York NY, 1983.
2. **Keith** MW, Heiple KG: Chapter VI - Hand Trauma in the Injured Child. In Trauma in Children, R.E. Marcus, M.D., ed., Aspen Publishers, Inc., Rockville MD, pp 147-166, 1986.
3. Freehafer AA, Peckham PH, **Keith** MW: Surgical Treatment for Tetraplegia: Upper Limb. In Operative Orthopaedics. Michael W. Chapman, ed., J.B. Lippincott Co., Philadelphia PA, vol. 2, pp 1459-1467, 1988.
4. Peckham PH, Freehafer AA, **Keith** MW.: The Influence of Muscle Properties. In Clinical Mechanics of the Hand, Paul W. Brand, ed., C. V. Mosby Company, St. Louis MO, pp 310-324, 1985; 2nd edition, 1992.
5. Freehafer AA, Peckham PH, **Keith** MW: New Concepts on Treatment of the Upper Limb in the Tetraplegic: Surgical Restoration and Functional Neuromuscular Stimulation. In Hand Clinics, Raoul Tubiana, ed., W.B. Saunders Company, Philadelphia PA, pp 563-573, 1988.
6. Freehafer AA, Peckham PH, **Keith** MW: Surgical Treatment for Tetraplegia: Upper Limb. In Second Edition Operative Orthopaedics, M.W. Chapman, ed., Vol. 3, J.B. Lippincott, Philadelphia PA, pp 1545-1553, 1993.
7. Peckham PH, **Keith** MW: Motor Prosthesis for Restoration of Upper Extremity Function. In Neural prosthesis: Replacing Motor Function After Disease or Disability, R.M. Stein, P.H. Peckham, D. Popovic, eds.. Oxford University Press, New York, 1992
8. Scott TR, Peckham PH, **Keith** MW.: Upper Extremity Neuroprostheses Utilizing Functional Electrical Stimulation. In Neuroprostheses, D.N. Rushton, G.S., Brindley, eds., Bailliere Tindall, London, 1995.
9. Creasey G, **Keith** MW: Principles of Upper Extremity Surgery in Tetraplegia. In Surgery of the Hand and Upper Extremity, C. Peimer, ed., McGraw-Hill, Inc., 1995.
10. **Keith** MW: Restoration of Tetraplegic Hand Function Using an FES Neuroprosthesis. In Tendon and Nerve Surgery in the Hand--A Third Decade Review, J.M. Hunter, L. H. Schneider, E. J. Mackin co-eds., C. V. Mosby Company, St. Louis MO, 1997.
11. Keith MW: Multi-channel Functional Electrical Stimulation in Spinal Cord Injury and Stroke. In Brain Hemorrhage '97, H. Ito and K. Yamashita co-eds., Neuron Publishing Co., Ltd, Tokyo Japan, 1997.
12. **Keith** M W: Wrist and Hand Reconstruction – Cerebral Palsy in the Upper Extremity, Vascular Disorders, Tumors of the Hand, Tetraplegia, Brachial Plexus Injuries,. In Orthopaedic Knowledge Update 6: Home Study Syllabus. J. H. Beaty MD Editor, American Academy of Orthopaedic Surgeons, 1999.
13. **KEITH** MW: Neuroprostheses. In Hand Surgery Update 2 Terry Light MD, Editor, American Society for Surgery of the Hand. 1999.
14. Peckham PH, **KEITH** MW: Restoration of Upper Extremity Function in Tetraplegia. In Topics in Spinal Cord Injury Rehabilitation. CH Creasey and PH Peckham, Issue Editors, DF Apple, Editor, A Thomas Land Publication, Vol 5. No. 1, Summer 1999.

15. Kilgore KL, Peckham PH, **KEITH MW**: Advances in Upper Extremity Functional Restoration Employing Neuroprostheses in Neural Prosthesis for Restoration of Sensory and Motor Function, JK Chapin, KA Moxon, Editors. pp 45-74, CRC Press, Boca Raton FL, 2001
16. **KEITH MW**, Gonzalez E: Surgical Management of the Upper Limb in Tetraplegia in The Spinal Cord Injured Patient Second Edition, by Lee and Ostrander Editors, pp 231-276, DEMOS Medical Publishing Inc, New York NY, 2002.
17. **KEITH MW**, Peljovich AE, Kucera KA, Gonzalez-Hernandez E: Rehabilitation of the Hand and Upper Extremity in Tetraplegia in Rehabilitation of the Hand and Upper Extremity Fifth Edition by Hunter, Mackin, Callahan, Skirven and Schneider Editors, pp 854-876, Mosby Inc, St Louis MO, 2002.
18. Hoyen HA, **KEITH MW**: Chapter 26 The surgical treatment of the Upper Limb in Tetraplegia. In Hand Surgery Update 3, Thomas Trumble MD, Editor, American Society for Surgery of the Hand, 2003.
19. **KEITH MW**, Chapter 32 Tetraplegia. In Hand, Elbow & Shoulder: Core Knowledge in Orthopaedics, TE Trumble, JE Budoff, R Cornwall, eds, Mosby Elsevier, Philadelphia PA, pp. 456-464, 2005.
20. Bickel B, Shapiro DB, **KEITH MW**, Hoyen HA: Chapter 4 The Management of Extensor Tendon Injuries in Hand and Upper Extremity Reconstruction, Kevin Chung, ed., Saunders Elsevier, Philadelphia PA, pp. 47-59, 2009.
21. Kilgore KL, **KEITH MW**, Peckham PH: Chapter 62 Stimulation for Return of Upper and Lower Extremity Function in Neuromodulation Volume 2, Krames ES, Peckham PH, Rezai, eds, Elsevier, San Diego CA, pp. 767-776, 2009
22. Peljovich AE, Bryden AM, Malone KJ, Hoyen H, Hernandez-Gonzalez E, **KEITH MW**: Chapter 132 Rehabilitation of the Hand and Upper Extremity in Tetraplegia in Rehabilitation of the Hand and Upper Extremity Sixth Edition Volume 2, Skirven T, Osterman AL, Fedorczyk JM and Amadio PC eds, Elsevier Mosby, Philadelphia PA, pp.1684-1705, 2011.
23. Peljovich AE, Keith MW: Chapter 11 Tendon Transfer for Hand Reconstruction in Spinal Cord Injury in Tendon Transfer Surgery of the Upper Extremity: A Master Skills Publication, Van Heest A and Goldfarb CA eds, American Society for Surgery of the Hand, Chicago IL, pp. 121-144, 2012.

## PUBLISHED ABSTRACTS

1. Freehafer, A. A., Peckham, P.H., and **Keith**, M.W.: The Contribution of the Rehabilitation Engineer in Tendon Transfer Surgery. Proceedings of the 4th Annual Conference of Rehabilitation Engineering, pp 212-213, Washington, D.C., August, 1981.
2. Peckham, P.H., Thrope, G.B., Strother, R.B., Buckett, J.R., Freehafer, A.A., and **Keith**, M.W.: Functional Neuromuscular Stimulation Systems for Control of the Hand in the Quadriplegic. Proceedings of the 4th Annual Conference on Rehabilitation Engineering, pp 209-211, Washington DC, August, 1981.
3. Roscoe, D.D., and **Keith**, M.W.: Cat Forelimb Model Providing Force and EMG Activity from a Single Elbow Extensor in the Unanesthetized Animal. Neuroscience Abstracts, 11th Annual Meeting, Los Angeles, CA, 1981.
4. Peckham, P.H., Thrope, G.B., Buckett, J.R., Freehafer, A.A., and **Keith**, M.W.: Coordinated Two Mode Grasp in the Quadriplegic Initiated by Functional Neuromuscular Stimulation. Proceedings of the IFAC Symposium on Control Aspects of Prosthetics and Orthotics, paper 1.5, Columbus OH, May, 1982.
5. Riso, R.R., Szeto, A.Y.J., and **Keith**, M.W.: Comparison of Subdermal vs. Surface Electrocutaneous Stimulation. Proceedings of the Fourth Annual Conference, IEEE/Engineering in Medicine and Biology Society, Philadelphia, PA., September 20-21, 1982.
6. Peckham, P.H., Thrope, G.B., Freehafer, A.A., and **Keith**, M.W.: Coordinated Two Mode Grasp in the Quadriplegic Initiated by Functional Neuromuscular Stimulation. Abstracts of the 12th Annual Meeting of the Society for Neuroscience, Vol. 8, 274.12, 955, November, 1982.
7. Peckham, P.H., Freehafer, A.A., and **Keith**, M.W.: Restoration of Hand Function in the High Level Quadriplegic by Functional Neuromuscular Stimulation. 38th Annual Meeting of the American Society for Surgery of the Hand, March, 1983.
8. Riso, R.R., **Keith**, M.W., Gates, K.R., and Ignagni, A.R.: Subdermal Stimulation for Electrocutaneous Communication. Proceedings of the Sixth Annual Conference on Rehabilitation Engineering, pp 321-323, San Diego, CA, June, 1983.
9. Riso, R.R., Gates, K.R., Ignagni, A.R., **Keith**, M.W., and Williams, W.D.: Subdermal Implanted Electrodes for Electrocutaneous Sensory Feedback in Upper Extremity FES Orthoses. Society for Neuroscience Abstracts, Vol. 9, Part 2, pp 1083, 1983.
10. Roscoe, D.D., **Keith**, M.W., Fay, L.M., Jackson, J.C., and Smith, B.: An Animal Model for Studying Far-Field Somatosensory Evoked Potentials During Peripheral Nerve Regeneration. Society for Neuroscience Abstracts, Vol. 1, Part 2, pp 1195, 1983.
11. **Keith**, M.W., Peckham, P.H., Freehafer, A.A., Thrope, G.B., Sobel, M: Implementation of a Functional Neuromuscular Stimulation System for a Tetraplegic Upper Extremity. American Spinal Cord Injury Association Annual Meeting, Atlanta GA, April, 1985.
- 12.. Thrope, G.B., Peckham, P.H., Buckett, J.R., **Keith**, M.W., Freehafer, A.A.: A Total System Approach to Implementing a Functional Neuromuscular Stimulation Motor System Neuroprostheses. 1985 Annual Scientific Meeting of the International Medical Society for Paraplegia, Edinburgh Scotland, 1985.
13. Buckett, J.B., Braswell, S., Peckham, P.H. Thrope, G.B., **Keith**, M.W.: A Portable Functional Neuromuscular Stimulation System. IEEE/EMBS Symposium, Chicago IL, September, 1985.
14. Riso, R.R., Ignagni, A.R., **Keith**, M.W.: Tactile Feedback Through Peripheral Nerve Stimulation. 38th ACEMB, Americana Congress Hotel, Chicago IL, September 30 -October 2, 1985.

15. **Keith, M.W., Peckham, P.H., Freehafer, A.A.:** Implementation of Functional Neuromuscular Stimulation: Role of Electrodiagnostic Mapping of Lower Motor Neuron Paralysis, 32nd Annual Orthopaedic Research Society, pp 177-178, New Orleans LA, February 17-20, 1986.
16. Nelson, D.L. Pazirandeh, P.H., Heiple, K.G., Shaffer, J.W., **Keith, M.W.,** Lacey, S.H., Davy, D.T., Sauer, J., Michaels, D., Vennekotter, D., Froehlich, L., Bautista, M., Hrach, B.: Flexor Tendon Healing and Intermittent Passive Motion, 32nd Annual Orthopaedic Research Society, New Orleans LA, February 17-20, 1986.
17. **Keith, M.W., Peckham, P.H., Thrope, G.B., Menger, V., Freehafer, A.A.:** Implementation of an Upper Extremity Functional Neuromuscular Stimulation, American Orthopaedic Association 99th Annual Meeting, Hot Springs VA, June 23-26, 1986.
18. Menger V.L., Thrope G.B., Peckham, P.H., **Keith, M.W.,** Stroh, K.: Clinical Assessment of the Case Neural Prosthetic Functional Neuromuscular Stimulation Hand System, RESNA 9th Annual Conference, pp 270-272, Minneapolis MN, June, 1986.
19. Kilgore, K.L., Peckham, P.H., **Keith, M.W.,** Thrope, G.B.: Characterization of a Lateral Prehension-Release Grasp Using Functional Neuromuscular Stimulation:, RESNA 9th Annual Conference, pp 451-453, Minneapolis MN, June, 1986.
20. Peckham, P.H., **Keith, M.W.,** Thrope, G.B., Menger, V.L., Stroh, K., Buckett, J.R., Smith, B.: Implementation of a Functional Neuromuscular Stimulation Neuroprosthesis for Control of the Tetraplegia Hand, Proceedings of the IEEE/Eighth Annual Conference of the Engineering in Medicine and Biology Society, Dallas, TX, November, 1986.
21. Crago, P.E., Owens, N.E., Tills, K., Thrope, G.B., Peckham, P.H., **Keith, M.W.:** Open and Closed-Loop Control of FNS Hand Grasp, IEEE/Eighth Annual Conference of the Engineering in Medicine and Biology Society, Dallas TX, November, 1986.
22. Peckham, P.H., Smith B., Buckett, J.R., Thrope, G.B., **Keith, M.W.:** Implantable Stimulator System for Control of Paralyzed Muscle, Government Microcircuit Applications Conference, San Diego, California, November, 1986.
23. Carter, R.R., Crago, P.E., **Keith, M.W.:** Components of the Human Stretch Reflex, Society for Neuroscience Annual Meeting, Washington DC, November, 1986.
24. **Keith, M.W., Peckham, P.H., Kilgore, K.:** Tendon Transfers in Tetraplegia Controlled by FNS, Proceedings of the IEEE/Ninth Annual Conference of the Engineering in Medicine & Biology Society, Boston MA, November, 1987.
25. Smith, B., Peckham, P.H., Gazdik, M., Letechipia, J.E., Banks, S.A, **Keith, M.W.:** Development & Evaluation of an Externally Powered, Multichannel, Implantable Stimulator, Proceedings of the IEEE/Ninth Annual Conference of the Engineering in Medicine & Biology Society, Boston MA, November, 1987.
26. Peckham, P.H., **Keith, M.W.,** Thrope, G.B., Memberg, W.D.: Intramuscular Electrodes for Neuromuscular Stimulation, Proceedings of the IEEE/Ninth Annual Conference of the Engineering in Medicine & Biology Society, Boston MA, November, 1987.
27. Buckett, J.R., Peckham, P.H., Smith, B., Thrope, G.B., **Keith, M.W.:** A Modular Approach to a Functional Neuromuscular Stimulation System: The Portable Control Hardware, Proceedings of the

IEEE/Ninth Annual Conference of the Engineering in Medicine & Biology Society, Boston MA, November, 1987.

28. Mendelson, L.S., Peckham, P.H., **Keith**, M.W., Freehafer, A.A.: Analysis of Tendon Transfer Surgery in the Tetraplegic Upper Extremity, Society for Neuroscience, 17th Annual Meeting, New Orleans LA, November, 1987.

29. Stroh, K., Thrope, G., Peckham, P.H., **Keith**, M., Menger, V.: Candidate Selection for Use with a Functional Neuromuscular Stimulation Hand System. International Conference of the Association for the Advancement of Rehabilitation Technology (ICAART 88), Montreal Quebec Canada, June 25-30-1988.

30. Peckham, P.H., **Keith**, M.W., Thrope, G.B., Stroh, K.C.: Upper Extremity Assist Devices. World Congress on Medical Physics and Biomedical Engineering, San Antonio TX, August 6-12, 1988.

31. Carter, R.R., Crago, P.E., **Keith**, M.W.: Compensation for Muscle Yield and Lack of Stiffness Regulation by Stretch Reflexes. Society for Neuroscience Abstracts, 14:1302, 1988.

32. Hart, R.L., Thrope, G.B., Stroh, K.C., Peckham, P.H., **Keith**, M.W., Ignagni, A.R., Buckett, J.R., Kilgore, K.L., Woods, L., Makuch, W.: Technology Transfer of an Upper Extremity Functional Neuromuscular Stimulation Program. RESNA 12th Annual Conference, New Orleans LA, June 25-30, 1989.

33. Memberg, W.D., Peckham, P.H., Thrope, G.B., **Keith**, M.W.: A Retrospective Analysis of Percutaneous Intramuscular Electrodes for Functional Neuromuscular Stimulation in Quadriplegic Subjects. RESNA 12th Annual Conference, New Orleans LA, June 25-30, 1989.

34. Peckham, P.H., **Keith**, M.W., Smith, B., Marsolais, E.B., Memberg, W., Kilgore, K.: Implantable Systems for Neuromuscular Stimulation. Osaka International Workshop on Functional Neuromuscular Stimulation, Osaka Japan, November 19-21 1989.

35. **Keith**, M.W., Peckham, P.H.: Strategies for Tendon Transfer Using FES in Tetraplegia. Osaka International Workshop on Functional Neuromuscular Stimulation, Osaka, Japan, November 19-21, 1989.

36. Peckham, P.H., Thrope, G.B., Naples, G., Stroh, K.C., Hart, R., **Keith**, M.D., Gorman, P.: System for Restoring Grasp Release. 4th International Congress on Upper Extremity Reconstruction, Palo Alto CA, March 13-16, 1991.

37. Stroh, K.C., Van Doren, C., Peckham, P.H., **Keith**, M.W.: Quantitative Evaluation of Performance of FES Systems for Restoring Grasp-Release in O:1, OCu:1, and OCu:2 Tetraplegia. 4th International Congress on Upper Extremity Reconstruction, Palo Alto CA, March 13-16, 1991.

38. **Keith**, M.W., Peckham, P.H.: A Decision Algorithm for Treatment of High Level Tetraplegia Including FES and Tendon Transfer. 4th International Congress on Upper Extremity Reconstruction, Palo Alto CA, March 13-16, 1991.

39. Peckham, P.H., Thrope, G.B., **Keith**, M.W., Naples, G., Stroh, K.C., Gorman, P.H.: Multi-site Evaluation of an FES Motor Prosthesis for Hand Function. American Spinal Injury Association Meeting, Seattle WA, April 8-10, 1991.

40. Riso, R.R., **Keith**, M.W.: Neuromotor Control of Grasp Function and Implications for FNS Neuroprostheses Hand Control. Engineering Foundation Conference on Neural Prostheses: Motor Systems III, Banff Alberta Canada, August, 1991.

41. Peckham, P.H., **Keith**, M.W., Thrope, G.B., Naples, G., Stroh, K.C., Hart, R.L., Gorman, P.H.: Multi-Center Evaluation of a Motor Prosthesis for Restoration of Hand Function. Annual Fall Meeting of the Biomedical Engineering Society, Charlottesville VA, October 12-14, 1991.
42. Mulcahey, M.J., Betz, R.R., Smith, B.T., Triolo, R. J., Weiss, A.A., **Keith**, M.W., Peckham, P.H., Mitra, A.: A Bipolar Latissimus Dorsi Transposition and Functional Neuromuscular Stimulation to Restore Elbow Flexion in a C4 Quadriplegic with C5 Denervation. Journal of the American Paraplegia society, Special Section, ASIA Annual Meeting Abstracts, 15(2):76, April, 1992.
43. **Keith**, M.W., Peckham P.H., Stroh, K.C., Kilgore, K.L., Hart, R.L.: Restoration of Functional Grasp-Release in Tetraplegia with Implantable Neuromuscular Stimulation and Tendon Transfers. Journal of the American Paraplegia Society, Special Section, ASIA Annual Meeting Abstracts, 15(2):74, April, 1992.
44. Peckham, P.H., **Keith**, M.W., Kilgore, K.L., Stroh, K.C., Hart, R.L.: Surgical Alterations and Functional Electrical Stimulation for Restoration of Hand Function. RESNA International '92, Toronto, Canada, June 6-11, 1992.
45. Thrope G.B., Naples, G.G., Hart, R.G., Stroh, K.C., Buckett, J.R., Ignagni, A.R., **Keith**, M.W., Peckham, P.H., Van Doren, C.L.: Technology Transfer of a Functional Electrical Stimulation Hand System. RESNA International '92, Toronto Ontario Canada, June 6-11, 1992.
46. Peckham, P.H., **Keith**, M.W., Stroh, K.C., Kilgore, K.L., Hart, R.L.: Restoration of Functional Grasp-Release in Tetraplegia with Implantable Neuromuscular Stimulation and Tendon Transfer. 9th International ISEK Conference, Florence Italy, June, 1992.
47. Peckham, P.H. **Keith**, M.W., Kilgore, K.L., Stroh, K.C., Hart, R.L., Smith, B., Buckett, J.R., Thrope, G.B.: Implantable Systems for Control of the Paralyzed Upper Extremity in Spinal Cord Injury. International Symposium on Therapeutic Stimulation, Liverpool Great Britian, August 24-28, 1992.
48. Peckham, P.H., Thrope, G.B., **Keith**, M.W., Naples, G.G., Smith, B., Van Doren, C.L., Kilgore, K.L.: Technology Transfer of an Upper Extremity Neuroprosthesis for Restoration of Hand Function. 4th Vienna International Workshop on Functional Electrostimulation, Vienna Austria, September 24-27, 1992.
49. Kilgore, K.L., Peckham, P.H., Thrope, G.B., **Keith**, M.D.: Implementation of an Implanted Upper Extremity Neuroprosthesis in the Clinical Setting. Journal of the American Paraplegia Society 16:2, p 100, April, 1993.
50. Billian, C., Hines, A.E., Crago, P.E., **Keith**, M.W., Lin, C.C.: Opening of the Spastic Hemiplegic Hand By Functional Electrical Stimulation. American Academy of Neurology 45th Annual Meeting, Scientific Program, New York NY, April 27-29, 1993.
51. Kilgore, K.L., Peckham, P.H., Thrope, G. B., **Keith**, M.W.: Implementation of an Implanted Upper Extremity Neuroprosthesis in the Clinical Setting. ASIA, San Diego CA, May 10-12, 1993.
52. Kilgore, K.L., Peckham, P.H., **Keith**, M.W., Thrope, G.B.: An Implanted Upper Extremity Neuroprosthesis. RESNA '93, Las Vegas NV, June 12-17, 1993.
53. Stroh, K.C., Van Doren, C.L., Thrope, G.B., **Keith**, M.W.: A Hand Grasp and Release Test for Tetraplegic Patients Using a Hand Neuroprosthesis. RESNA '93, Las Vegas NV, June 12-17, 1993.
54. Peckham, P.H., Kilgore, K.L., **Keith**, M.W., Thrope, G.B., Betz, R.: An Implanted Neuroprosthesis for Restoration of Grasp and Release. The Ljubljana FES Conference, Ljubljana, Slovenia, August 22-26, 1993.

55. Lemay, M.A., Crago, P.E., **Keith**, M.W., Peckham, P.H.: Wrist Flexion/Extension Control in C5 and C4 Quadriplegic Subjects Using Functional Neuromuscular Stimulation. 16th IEEE/EMBS Conference, Baltimore MD, November 3-6, 1994.
56. Peckham, P.H., Wuolle K.S., Van Doren, C., **Keith**, M.W.: Functional Assessment of an Hand Neuroprosthesis for Tetraplegic Patients. Surgical Rehabilitation of Upper Limb in Tetraplegia, Vth International Conference, Melbourne Australia, March 26-29, 1995.
57. Peckham, P.H., Wijman, C.A.C., **Keith**, M.W.: Finger Grasp and Key Pinch Strength in Tetraplegia after Tendon Transfer Surgery: Effect of Forearm and Wrist Position. Vth International Conference, Melbourne Australia, March 26-29, 1995.
58. Peckham, P.H., Mendelson, L.S., **Keith**, M.W., Freehafer, A.A.: Assessment of Muscle Firing Patterns after Tendon Transfer Surgery in the Tetraplegic Upper Extremity. Vth International Conference, Melbourne Australia, March 26-29, 1995.
59. Peckham, P.H., **Keith**, M.W., Thrope, G.B., Grill, J.H.: A Multi-Center Study for Evaluation of a Hand Neuroprosthesis for Grasp-Release Function. Vth International Conference, Melbourne, Australia, March 26-29, 1995.
60. Kilgore K, Peckham PH, **Keith** MW: An Implanted Upper Extremity Neuroprosthesis: A Twenty Patient Follow-Up. ASIA, Orlando FL., May 1-3, 1995.
61. **Keith**, M.W., Kilgore, K.L., Peckham, P.H., Wuolle, K.S.: Tendon Transfers and Functional Electrical Stimulation for Restoration of Hand Function in Spinal Cord Injury. American Society for Surgery of the Hand, 50th Annual Meeting, San Francisco CA, September 13-16, 1995.
62. Kilgore KL, Peckham PH, **Keith** MW, Bryden AM, Wuolle KS: Restoration of Grasp and Release with an Implanted Neuroprosthesis. IFESS '96, Cleveland OH, May, 1996.
63. Adamczyk MM, Crago PE, Gorman PH, **Keith** MW, Egelseder A, Marshall L, Bryden AM, Kilgore KL, Maher M: Stimulated Tendon Transfers for Integrated Neuroprosthetic Wrist/Hand Grasp Control in Tetraplegia. IFESS '96, Cleveland OH, May, 1996.
64. Crago PE, Usey M, Memberg WD, **Keith** MW, Kirsch RF, Chapman GJ, Katorgi MA, Perreault EJ: An Elbow Extension Neuroprosthesis for Individuals with Tetraplegia. IFESS '96, Cleveland OH, May, 1996.
65. Peckham PH, **Keith**, MW, Kilgore, KL, Wuolle KS, Bryden AS: Restoration of Grasp and Release with an Implanted Neuroprosthesis. 35th Annual Scientific Meeting of IMSOP, Atlanta GA, August, 1996.
66. Kirsch RF, Acosta AM, Perreault EJ, Memberg WD, **Keith** MW, Crago, PE: Approaches for Restoring Elbow Extension in Tetraplegia: Muscle Tendon Transfer and Functional Neuromuscular Stimulation. 18th Annual International Conference IEEE Engineering in Medicine & Biology Society, October 18, 1996.
67. Kirsch RF, **Keith** MW, Acosta AM: Standard Measures of Elbow Extension Function Following Posterior Deltoid to Triceps Muscle Transfer in Tetraplegia. 1st Annual Conference of The International Functional Electrical Stimulation Society, 1:65, 1996.



## **EDUCATION**

Participation in National Continuing Education Course  
1980 - Hand Rehabilitation, Philadelphia PA

### **FES TRAINING OF SURGICAL TEAMS**

Roessingh Research & Development, Enschede, The Netherlands, Sibrand Schepel MD PhD , 3/4/96  
Centre Propara, Montpellier, France, Yves Allieu MD, 3/6/96.  
Austin Hospital, Melbourne, Australia, Gerard Sormann MD, 3/29/96.  
Freehand System - A Training Seminar for Hand Surgeons and Therapists, Cleveland OH 5/9/96-5/11/96.  
Tampa Veterans Administration Medical Center, Tampa FL, David Greenwald MD, 6/24/96.  
Burwood Hospital, Christchurch, New Zealand, Khalid Mohammed MD, 11/11/96 and 11/12/96.  
Austin Hospital, Melbourne, Australia, Gerard Sormann MD, 11/15/96.  
Fujita Health University Center, Nagoya, Japan, Tetsuo Kanno MD, 11/18/96  
Del Ray Community Hospital, Del Ray FL, David Applebaum MD, 12/9/96.  
Swedish Hospital, Englewood CO, Dr. Charles Hamlin and Dr. Eric Britton, 12/18/97  
Willis-Knighton Medical Center, Shreveport LA, Dr. Charles Knight, 1/19/98  
Clark Memorial Hospital, Jeffersonville IN, Dr. John Shaw, 1/20/98  
Long Beach Memorial Hospital, Long Beach CA, Dr. Ross Nathan, 8/31/98  
University Hospital of Copenhagen, Copenhagen Denmark, Dr. Claus Falck Larsen, 4/28/99  
Swiss Paraplegic Center, Nottwil Switzerland, Dr. Simeon Grossmann, 4/29/99 and 4/30/99  
San Antonio TX, Dr. David Green, 1/29/01 and 1/30/01  
Charlottesville VA, Dr. Gregory Degnan, 3/7/01  
Salt Lake City UT, Dr. Douglas Hutchinson, 3/20/01  
Camden NJ, Dr. James Yue, 4/6/01  
New Orleans LA, Dr. Greg Kinnett, 9/11/01  
Swiss Paraplegic Centre, Nottwil Switzerland, Dr. Simeon Grossmann, 10/8/01 Revision implant  
Sahlgrenska University Hospital, Goteborg Sweden, Dr. Arvid Edjeskar, 10/10/01

### **RESIDENT EDUCATION - CONFERENCE PARTICIPATION**

Hand Conference, Orthopaedic Grand Rounds  
MetroHealth Medical Center, 1979-present

Conference Program Director - Orthopaedic Continuing Education and Basic Science Lectures, University  
Hospitals of Cleveland, 1979-1985

### **PRECEPTOR**

#### **FELLOWSHIPS - HAND FELLOW**

Peter S. Barre MD 1985-1986  
Scott A. Riley MD 1988-1989  
Roland Reyes MD 1993-1994  
Howard Dash MD 1993-1994  
John Krebs MD 1993-1994  
John Camp MD 1994-1995  
Clark Davenport MD 1994-1995  
Anthony Sudekum MD 1995-1996  
Paul Schrickler MD 1995-1996  
Ernest Normington MD 1995-1996  
Andrew Ress MD 1996-1997  
Monique Abner MD 1996-1997  
Steven Care MD 1996-1997  
Mustafa Haque MD 1997-1998  
Harry Hoyen MD 1997-1998

Richard Hainer MD 1997-1998  
Randeep Kahlon MD 1998-1999  
Christopher Walsh MD 1998-1999  
Eduardo Gonzalez MD 1998-Feb 2000  
Chaitanya Mudgal MD 1999-2000  
Mehrun Elyaderani MD 1999-2000  
Antonio Flores MD 1999-2000  
Keith Morrison MD 2000-2001  
Patrick Williams MD 2000-2001  
Jason Schneider MD 2002-2003  
Laszlo Harmat MD 2002-2003  
Chad Manke MD 2003-2004  
Timothy Pater MD 2004-2005  
Kraig Burgess DO 2004-2005  
Geoffrey Buncke MD 2005-2006

Joseph Robison MD 2006-2007  
Aaron Anderson MD 2006-2007  
Brent Bickel MD 2007-2008  
Joy Sharma MD 2007-2008  
Shafic Sraj MD 2008-2009  
Michael Darowish MD 2008-2009  
Daniel Penello MD 2009-2010  
Francisco Rubio MD 2009-2010

Khurram Pervaiz MD 2010-2011  
Ngozi Akabudike MD 2010-2011  
Blaine Todd Bafus MD 2011-2012  
Nathan Everding MD 2012-2013  
Surbhi Panchal MD 2012-2013  
Erica Taylor MD 2012-2013

#### **FELLOWSHIPS - FUNCTIONAL ELECTRICAL STIMULATION**

Richard Hu, M.D., 1989-1990  
Francois Bethoux, M.D., Nov 1994-Oct 1995  
Niloy Bhadra, M.D., May 1994-May 1995  
Ken Kondo, M.D., Sep 1994-Mar 1996  
Khalid Mohammed, M.D., Apr 1996-Jul 1996  
Isao Okuma, MD, May 1997-Jun, 1998

Residents - Orthopaedic Residents  
Undergraduate Students - Medical Apprenticeship Program  
Medical Student Advisor

#### **GRADUATE EDUCATION -Case Western Reserve University**

Graduate Student Thesis Committees. 1979-present  
Department of Biomedical Engineering

## THESES COMMITTEE MEMBER

### PhD Theses

<b>Name</b>	<b>Title</b>	<b>Date Completed</b>
Zi-Ping Fang	Selective Activation of Peripheral Nerve Fibers With Application to the Motor System	May 1988
Ning Lan	Design & Evaluation of Feedback Controllers for Functional Neuromuscular Moment Model to Synthesize Grasp Parameters for Use in FNS	Aug 1989
Mark Johnson	Design and Evaluation of an Implantable Two-Degree-of-Freedom Joint Angle Transducer	May 1994
Michel Lemay	Feasibility of Wrist Movement Control Using FNS	Dec 1994
Ali Esteki	Dynamic Model of the Hand with Application in Functional Neuromuscular Stimulation	Aug 1995
Richard Lauer	Command-Control of Upper Extremity Assistive Devices	May 2001
A. Acosta	Musculoskeletal Modeling of the Upper Extremity	May 2002
Jayme Knutson	Myoelectric Control of Hand Grasp Neuroprosthesis for Low cervical Tetraplegia	Oct 2003
Govert J. Snoek	Patient Preferences for Reconstructive Interventions of the Upper Limb in Tetraplegia, Roessingh Research and Development, Affiliated with the University of Twente. Enschede, Netherlands	Jan 2006

### MS Theses

<b>Name</b>	<b>Title</b>	<b>Date Completed</b>
Donald Bittner	Control of Elbow Position by Electrical Stimulation of Triceps Muscles	Jun 1985
Randy Carter	Components of the Human Stretch Reflex	Jan 1987
Karen Gallaher	Linearization of Thumb Force & Position During Electrical Stimulation of Paralyzed Muscle	Jun 1987
John Schild	An Implantable Multi-channel Biotelemetry Device: Design, Development & Evaluation	Mar 1988
Scott Banks	Methods for Detection of Failure Modes of a Multi-Channel Implantable Stimulation Device	Apr 1988
Anthony Ignagni	An Evaluation System for Usage Monitoring of the CWRU Upper Extremity Neuroprosthetic Stimulator	Aug 1989
Joseph Corey	Tissue Response & Corrosion Studies of the Peterson Intramuscular Electrode	Sep 1989
Tony Barrencota	Wrist Command Control of an FES Neuroprosthesis	Aug 1992

June Akers	Evaluation of Tissue Response to Chronic Stimulation w/Epimysial & Intramuscular Electrodes	Dec 1992
Niloy Bhadra	Command Control of a Hand Neuroprosthesis by Implanted Joint Angle Sensor	Nov 1999

## **RESEARCH GRANT SUPPORT**

Past Support:

Co-Principal Investigator, Orthopaedic Research and Education Foundation, Grant #225, 2/1/83 - 1/31/84, \$30,000.00.

Principal Investigator, National Institute of Health, Grant #5R01 GM30838-03, Myoelectric Controller for Orthotic/Prosthetic Systems, 9/82 - 9/84, 9/84 - 3/87, \$113,847.00.

Co-Principal Investigator, National Institute of Health, Implantable Systems for Stimulation of Skeletal Muscle, 1983-85, \$193,523.00.

Co-Principal Investigator, National Institute of Health, Grant #ROI-NS17955, Implantable Systems for Stimulation of Skeletal Muscle, 1983 - 12/88, \$280,296.00.

Co-Investigator, National Institute of Health, Grant #NO1-NS-6-2303, Closed Loop Control of Functional Neuromuscular Stimulation, 7/86 - 12/89, \$304,134.00.

Co-Investigator, National Institute of Health, Natural Skin Sensors for Neuromotor Prostheses Control, Grant # RO1-NS-27456-01 CMS FN, 8/1/89 to 7/31/90, \$94,276.00,

Co-Principal Investigator, National Institute of Handicapped Research, Grant #G008300118-84, Rehabilitation Engineering Program for Restoration of Upper Extremity Control, 1983 - 1988, \$1,385,000.00.

Co-Principal Investigator, Project No. 3 (FES-3) Development of Upper Extremity Control Employing Functional Electrical Stimulation, National Institute on Disability and Rehabilitation Research, Grant #H133E80020, Rehabilitation Research and Demonstration Program, Rehabilitation Engineering Center-Functional Electrical Stimulation, 4/88- 3/93, \$500,000.00/yr (\$2.5 M/5yr).

Co-Principal Investigator, Spinal Cord Research Foundation, Grant #NDF 574-6, Implantable Sensor for Two Degree of Freedom Position Transduction, 8/86 - 8/87, \$31,316.00.

Co-Principal Investigator, Spinal Cord Research Foundation, Grant # 574-TF-3-2; Implantable Sensor for Two Degree of Freedom Position Transduction, 1/1/87 -12/31/90, \$34,740.

Co-Investigator, Veterans Administration, Functional Neuromuscular Systems for Upper Extremity Control, 1984 - 1987, \$1,274,000.00.

Co-Investigator, Veterans Administration, Functional Neuromuscular Systems for Upper Extremity Control, 1988 - 1991, \$566,580.00/year.

Co-Principal Investigator, National Institute of Health Multichannel Implantable System for Neural Control, #1R01NS29549, 4/1/91 - 3/31/94, \$127,861/2nd yr.

Co-Investigator, Spinal Cord Research Foundation, Multichannel Implantable System for Neural Control, Grant #1053 7/1/92 - 6/30/94, \$52,234/1st yr.

Co-Investigator, Veterans Administration, Functional Neuromuscular Systems for Upper Extremity Control, 1991-1994, \$1,600,000.00.

Co-Investigator, National Institute of Health, Project 5 (FNS Control-5), Grant # NO1-NS-9-2356, Functional Neuromuscular Stimulation for Restoration of Hand Grasp, 8/21/89 to 8/20/92, \$119,139.00.

Co-Investigator, National Institute of Child Health and Human Development, Grant #1 R01 HD30214-01, Intraneural Micro-Stimulation for Prosthetic Sensation, 8/30/92 - 8/31/93, \$297,459.00

Co-Investigator, Federal Drug Administration, Grant #FD-000832-01, Implantable Systems for Restoration of Hand Function, 9/30/92 - 9/29/95, \$97,400.00/yr.

Co-Investigator, National Institute of Health, (FNS Control) Grant #N01-NS-9-2356, Closed Loop Control of Functional Neuromuscular Stimulation, 9/92 –8/95, \$177,176.00.

Co-Investigator, National Institute of Health, (FNS Control) Grant #N01-NS-6-2338, Closed Loop Control of Functional Neuromuscular Stimulation, 2/96-1/00.

Principal Investigator, Edison BioTechnology Center, Improvement of Early Range of Motion of Flexor Tendons after Tenolysis Using Percutaneous Electrical Stimulation, 11/90 to 11/95, \$64,867.00.

Co-Investigator, Whitaker Foundation, Mechanical Effects of Muscle Tendon Transfer and Functional Neuromuscular Stimulation, 10/94 - 9/97, \$179,085.00.

Co-Investigator, Department of Veterans Affairs, Grant #B011,FES Control of the Upper Extremity in Spinal Cord, 4/98 – 3/01, \$1,089,600.00.

Co-Investigator, Department of Veterans Affairs, Grant #B835-3RA, “The significance of this research is that proximal arm function will greatly enhance the patient’s ability both to grasp and manipulate objects in the environment and to assist in self care by performing weight shifts and transfers”, 10/98 – 9/01, \$823,000.00

Co-Investigator, NIH/NCMRR, #R29 HD32653, Restoration of Shoulder Movement in C5 Tetraplegia 7/96-6/02, \$349,983 (total direct)

Co-Principal Investigator, NIH, 2R01NS29549, Multichannel Implantable Systems for Neural Control 4/99-3/04, \$1,331,000 (total)

Co-Investigator, NIH Contract, NO1-NS-1-2333, Restoration of Hand and Arm Function by Functional Neuromuscular Stimulation, 6/01-5/05, \$3,348,847 (total)

Co-Principal Investigator, FDA, FD-R-112389, Restoration of Hand-Arm Function with Neuroprostheses, 10/3/03-9/30/07, \$681,152 (total)

Co-Investigator, NIH NICHD R21 HD 0552562, Implanted Neuroprosthesis for Restoring Arm and Hand Function after Stroke, 1/08-1/31/2011, 0.12 CY months east, \$100,000/yr

CURRENT SUPPORT:

NIH-NINDS (Peckham – PI)

Type: U01 NS-069517

Active dates: 6/01/10 – 5/31/15 \$1,497,544 annual

Role: Key Person

Multi-functional Neuroprosthetic System for Restoration of Motor Function

This project is to develop a networked neuroprosthetic system that is capable of restoring multiple functions for individuals with spinal cord injury. The functions to be restored include cough, grasp, stable wheelchair seating, rolling over in bed, and bladder function.

Craig H. Neilsen Foundation (Peckham – PI)

Active dates: 7/01/10 – 7/01/13 \$124,940 annual

Role: Co-Principle Investigator

The overall goal of this project is to provide functional independence of the upper extremity for individuals with cervical level spinal cord injury (SCI) through the implementation of implanted neuroprosthetic systems. The implanted functional electrical stimulation (FES) neuroprosthesis will provide individuals who have sustained C5 and C6 injuries with control of grasp and release, forearm pronation, and elbow extension by electrical stimulation of their paralyzed muscles.

Telemedicine and Advanced Technologies Research Center (Kirsch – PI)

W81XWH-07-2-0044

Prosthetic Arm Control Device for Amputees

Role: Investigator (subcontract from Ardiem, Inc.) Active dates: 3/2007 – 9/2013

Description: The goals of this project are to develop an advanced control system for a myoelectric arm prosthesis that is based on (1) implanted EMG recordings, (2) a wireless telemetry link to an external controller located with the prosthetic arm, and (3) sensory feedback delivered through peripheral nerve cuff electrodes based on sensor measurements from the prosthetic limb.

## **RESEARCH REVIEW COMMITTEES**

Veterans Administration, 1981 - present  
Paralyzed Veterans of America  
Easter Seals Foundation

## **REVIEWER FOR PUBLICATIONS (Peer Review Journals)**

Clinical Orthopaedics and Related Research  
Journal of Hand Surgery  
Journal of Bone and Joint Surgery  
Yearbook Publishers  
Journal of Rehabilitation, Research and Development  
Editorial Board: Restorative Neurology and Neuroscience 1988 - 1996



## **INVITED LECTURER**

1. American Paraplegia Society 30th Annual Meeting, Symposium on Functional Electrical Stimulation of the Extremities, Las Vegas NV, September 16-19, 1984.
2. 2nd Small Group International Conference on Surgical Rehabilitation of the Upper Extremity in Tetraplegia, Functional Electrical Stimulation of the Tetraplegic Upper Extremity, Hyeres France, October 9-11, 1984.
3. American Society for Surgery of the Hand, Members Day Symposium Functional Neuromuscular Stimulation in the Upper Extremity, Las Vegas NV, 1/20/85.
4. American Spinal Injury Association, Implementation of Functional Neuromuscular Stimulation of the Upper Extremity in Tetraplegia, Atlanta GA, 4/16/85.
5. Edward Hines Veterans Administration Hospital, Upper Extremity Functional Neuromuscular Stimulation, Hines IL, 6/30/85.
6. Paralyzed American Veterans Symposium, Maximizing Function After Spinal Cord Injury, Washington DC, 7/31/85.
7. Paralyzed American Veterans Symposium, Upper Extremity Function: Hand Surgery and Functional Neuromuscular Stimulation, Washington DC, 7/31/85.
8. American Society for Surgery of the Hand, Panels in Hand Surgery, Prosthetics and Orthotics, New Orleans LA, 2/18/86.
9. American Academy of Orthopaedic Surgeons, State of the Art of the Upper Extremity Prostheses, 1987 Instructional Courses, San Francisco CA, 1/24/87.
10. Hines Veterans Administration Hospital, Hand Rehabilitation - An Update, Assessment and Management of Hand Function and Disabilities, Hines IL, 5/15/87.
11. PAV Distinguished Lecturer in Spinal Cord Injury, Functional Electrical Stimulation in Quadriplegia to Improve Arm Function, Seattle WA, 7/23/87.
12. 9th International Symposium on External Control of Human Extremities, Implantable Upper Extremity Functional Neuromuscular Stimulation Systems in Tetraplegic Hands, Dubrovnik Yugoslavia, 8/31/87.
13. American Society for Surgery of the Hand, Participant in Panel Discussion on Upper Limb Prosthetics and Orthotics, Myoelectric and Related Externally Powered Active Prostheses, San Antonio TX, 9/10/87.
14. 1987 W.R.V.S. Lecture, The Paralyzed Hand, Surgery and Stimulation, Edinburgh Scotland, 11/26/87.
15. American Society for Surgery of the Hand, The Paralyzed Hand, Surgery and Stimulation, Baltimore MD, 9/15/88.
16. The American Association for Hand Surgery, Panel Discussion Bioprosthetics, Toronto Ontario Canada, 10/1/88.
17. 13th Annual Spinal Cord Management Seminar Update for the 1990's and Predictions for the Year 2000, Neural Prosthesis Motor Systems, Chicago IL, 9/29/88.

18. The Miami Project to Cure Paralysis, Visiting Professor, Upper Extremity Functional Neuromuscular Stimulation, Miami FL, 10/5/88.
19. Osaka International Workshop on FNS, Clinical FES in the Upper Extremity, Osaka Japan, 11/21/89.
20. Osaka International Workshop on FNS, Implantable Stimulator for Upper Extremity Paralysis, Osaka Japan, 11/22/89.
21. Osaka International Workshop on FNS, Clinical Use of Functional Neuromuscular Stimulation, Osaka Japan, 11/23/89.
22. Site Visit, Neural Prosthesis Center, Barrows Institute, Phoenix AZ, 11/29/90.
23. International Conference on Orthotics, Role of Functional Electrical Stimulation, Dundee Scotland, 9/18/91.
24. Robert Jones & Dame Agnes Hunt Hospital, Functional Neuromuscular Stimulation in the Upper Extremity, Oswestry, UK. 9/20/91.
25. Internal Conference on FES, Functional Surgery for the Tetraplegic Upper Extremity, Montpellier, France, 2/2/92.
26. 1st International FES Symposium, Results of FES Control and Muscle Transfer, Sendai, Japan, 7/24/92.
27. The Ohio Academy of Trial Lawyers New Horizons for Trial Lawyers-Purpose, Practice and Social Responsibility Negligence Law Seminar, Medical-Legal Aspects of a Personal Injury Case-From the Doctor's Perspective, Cleveland OH, 4/30/93.
28. Canterbury Health, Department of Orthopaedic Surgery and Musculoskeletal Services, Management of Tetraplegia and Paraplegia, Christchurch, New Zealand, 2/7/94.
29. Canterbury Health, Department of Orthopaedic Surgery and Musculoskeletal Services, Tendon Transfers & Functional Electrical Stimulation for Restoration of Hand Function in Spinal Cord Injury, Christchurch, New Zealand, 3/24/95.
30. Craig Hospital, "FES Neuroprosthesis for Tetraplegia", Englewood CO, 9/11/96.
31. Fujita Health University, Department of Neurosurgery, "Functional Electrical Stimulation Neuroprosthesis for the Tetraplegic Upper Extremity", Nagoya, Japan, 11/18/96.
32. Keio University Rehabilitation Center, Departments of Orthopaedics & Rehabilitation, "Functional Electrical Stimulation Neuroprosthesis for the Tetraplegic Upper Extremity", Mishima, Japan, 11/19/96.
33. Tohoku University, Department of Engineering, "Functional Electrical Stimulation Neuroprosthesis for the Tetraplegic Upper Extremity", Sendai, Japan, 11/21/96.
34. Royal North Shore Hospital Grand Rounds, Departments of Orthopaedics, Neurosurgery and Plastic Surgery, "Functional Electrical Stimulation Results of Multi-Center Clinical Trials", Sydney, Australia, 4/16/97.
35. Fujita Health University, Department of Neurosurgery, "Restoration of Upper Extremity Function

Using Tendon Transfers and an FES Neuroprosthesis”, Nagoya, Japan, 11/26/97.

36. Second Intracerebral Hemorrhage (2<sup>nd</sup> ICH’97), ““Restoration of Upper Extremity Function Using Tendon Transfers and an FES Neuroprosthesis”, Ube, Japan, 11/28/97.

37. NASA-NINDS Workshop on Spinal Cord Injury, Nerve, Growth and Space Flight, Ames Research Center, “Clinical Aspects of Spinal Cord Injury and Recovery”, Moffett Field, CA, 12/8/97.

38. American Academy of Neurology, 50<sup>th</sup> Annual Meeting, “Neurorehabilitation: Beyond Traditional Neurology”, Minneapolis MN, 4/26/98.

39. Hong Kong Society for Surgery of the Hand Annual Congress 98. Hong Kong 6/13/98-6/14/98 “Functional Neuromuscular Stimulation, History of Development and Current Status”

- 1) Complex Injury Associated with Bone and Vascular Damage
- 1) Principles of Tendon Transfers
- 2) General Assessment, Indication and Timing of Surgery
- 3) Procedures for Hand and Elbow Reconstruction
- 4) Rehabilitation of Tetraplegics after Reconstructive Surgery

40. Spinal Cord Injury: Issues and Advances, Concurrent Sessions #, Presentation #35, “Tendon Transfers: Advances Including the Freehand System (Advanced Session), Surgical Technique for Neuroprosthetics: Impairment Appropriate Reconstruction”, Seattle WA, 5/14/98.

41. Barnes Jewish Hospital Department of Neuroscience Grand Rounds, “Fundamentals of Functional Electrical Stimulation, St. Louis MO, 5/8/99.

42. VoCare/Freehand System Training Seminar, Washington University School of Medicine, Spinal Cord Injury Unit/Dept. of Neurology, “Introduction to Neuroprosthetics”, St. Louis MO, 5/9/99.

43. DGH German Society for Surgery of the Hand, Palsy of the upper extremity and hand, “Neuroprostheses and newer tendon transfer procedures in the treatment of tetraplegia”, Heidelberg Germany, 5/25/99.

44. Chang Gung Memorial Hospital, Grand Rounds, Functional Electrical Stimulation of the Upper Limb and the Use of Tendon Transfer, Taipei Taiwan, 10/16/99.

45. Chang Gung Memorial Hospital, Grand Rounds, New Concepts of Using EEG to Control the Paralyzed Hand, Taipei Taiwan, 10/16/99.

46. Howard H. Steel Conference on Pediatric Spinal Cord Injury: Contemporary Principles and New Directions, Evaluation for Upper Extremity Management for Tetraplegia, Rancho Mirage CA, 12/5/99.

44. Howard H. Steel Conference on Pediatric Spinal Cord Injury: Contemporary Principles and New Directions, Multicenter FES Results, Rancho Mirage CA, 12/5/99..

48. Swiss Paraplegic Center, Rehabilitation of the Hand in the first year after spinal cord injury, Nottwil Switzerland, 3/28/00.

49. 3<sup>rd</sup> International Symposium on Experimental Spinal Cord Repair and Regeneration, Brescia Italy, 3/30/00-4/2/00

- 1) Outcomes of upper extremity neuroprosthesis surgery
- 2) Advanced control of neuroprostheses, EEG, EMG, IJAT devices
- 3) Standing transfer and walking using FES
- 4) FES neuroprostheses in children

50. University of Cincinnati, College of Medicine, PM&R Grand Rounds, Restoration of Tetraplegic Hand Function Using a FES Neuroprosthesis, Cincinnati OH, 5/19/00.
51. Cooper Hospital/Magee Rehabilitation Symposium, Restoration of Tetraplegic Hand Function Using a FES Neuroprosthesis, Camden NJ, 5/26/00.
52. Swiss Paraplegic Center, Recent advances in electronic control, Nottwil Switzerland, 6/26/00.
53. The American Academy of Orthopaedic Surgeons, Orthopaedics Update, Helping Quadriplegics in Daily Life, New York NY, 10/17/00.
54. University of Texas, Orthopaedic Grand Rounds, "Neuroprostheses to Restore Hand Function in Tetraplegia", San Antonio TX, 1/30/01.
55. University of Utah, Department of Orthopaedics Grand Rounds, "Neuroprostheses to Restore Hand Function in Tetraplegia", Salt Lake City UT, 3/21/01.
56. Jackson Memorial Hospital Grand Rounds, "Surgical Strategies for Improving Upper Extremity Function in Tetraplegia", Miami FL, 4/5/01.
57. Rehabilitation Institute of Michigan/Detroit Medical Center Grand Rounds, "Neuroprostheses to Restore Hand Function in Tetraplegia", Detroit MI, 5/17/01.
58. Cooper Hospital/Magee Rehabilitation Symposium on FES, "Neuroprostheses to Restore Hand Function in Tetraplegia", Camden NJ, 5/26/01.
59. Icelandic Health Authorities/World Health Organization, "Advanced Surgery and Neuroprostheses for Restoration of Tetraplegic Hand Function", Reykjavik Iceland, 6/1/01.
60. Swiss Paraplegia Centre, Orthopaedic Grand Rounds, "Neuroprostheses to Restore Hand Function in Tetraplegia", Nottwil, Switzerland, 6/4/01.
61. 7<sup>th</sup> International Conference on Tetraplegia: Surgery and Rehabilitation, Bologna Italy, 6/5/01-6/8/01
- 1) A Shorthand for Description of Surgery of the Upper Limb, 6/6/01
  - 2) Changes in Hand Functions after Upper Extremity Reconstructive Surgery as Measured by the Grasp and Release Test, 6/6/01
  - 3) Elbow Torque Varies with Shoulder Position after Posterior Deltoid Transfer, 6/6/01
  - 4) Case Report: Triceps FES and Biceps to Triceps in the Same Patient, A comparison, 6/6/01
  - 5) Elbow Release and Rotation Osteotomy Improve Hand Position, 6/7/01.
  - 6) Round Table Discussion Advanced Research, M. Keith Chairperson, 6/8/01
62. University of Michigan Plastic Surgery and Physical Medicine & Rehabilitation Grand Rounds, "Neuroprostheses", Ann Arbor MI, 8/20/01.
63. 4<sup>th</sup> International Symposium on Experimental Spinal Cord Repair and Regeneration, "Networked Neuroprostheses and Control Strategies", Brescia Italy, 3/27/02.
64. 4<sup>th</sup> International Symposium on Experimental Spinal Cord Repair and Regeneration, "Advanced Prostheses for the Upper Extremity", Brescia Italy, 3/27/02.
65. 3<sup>rd</sup> Deauville International Conference on Spinal Cord Injury, "Advanced Neuroprostheses and Surgery in Tetraplegia", Normandy France, 4/12/02.

66. American Spinal Injury Association/International Medical Society of Paraplegia Pre-Meeting Workshop, “Surgical Management of the Hand in Tetraplegia”, Vancouver, British Columbia, Canada, 5/3/02.
67. Simon Fraser University, Department of Kinesiology, “Neuroprostheses”, Vancouver, British Columbia, Canada, 3/27/03.
68. Veterans Administration Medical Center/University of California/Irvine Spinal Cord Conference and Training, “Strategies and Neural Prostheses for Spinal Cord Injury”, Long Beach CA, 6/7/03.
69. 8<sup>th</sup> International Conference – Upper Limb Surgery for Tetraplegia, February 24-27, 2004, Christchurch, New Zealand
1. Symposium Moderator– early intervention after spinal cord injury for hand reconstruction
  2. Presenter – Comparison of deltoid to triceps and biceps to triceps for elbow extension
  3. Presenter – Minimally invasive implantation of upper extremity FES systems during initial SCI rehabilitation
  4. Presenter – Advanced neuroprostheses for upper extremity spinal cord injury
  5. Symposium Moderator – Functional electrical stimulation: lessons learned from Freehand
70. Crucial Elements in Hand Surgery, “Tendon Transfers”, Magee-Womens Hospital of UPMS, Pittsburgh PA, 2/4/06
71. Orthopaedic Rehabilitation Association, “Outcomes Assessment for Reconstructive Surgery”, Chicago IL, 3/25/06
72. 2006 Florida Hand Society, Orlando FL, May 19-20, 2006
1. Advanced Neuroprostheses for Paralysis  
Surgery, Neuroprostheses and Advanced Operations for the future.
  2. A Conflict of Outcomes and Health Policy  
The role of "choice" in Evidence Based Medicine.
  3. Discussion Resident Training, Simulation and Capacity- open forum  
The AOA view of Volume Competency- JBSJ May 2006  
The ASSH view of Hand Surgery On-Call Incentives- [www.hand-surg.org](http://www.hand-surg.org)
73. Presidents’ Circle of the National Academy of Sciences, National Academy of Engineering and Institute of Medicine (National Academies), “Surgical Prospective on Smart Prosthetics”, Woods Hole MA, 6/11/07.
74. International Meeting on Upper Limb in Tetraplegia, Sept 17-20, 2007, Shriners Hospital for Children, Philadelphia PA.
1. Founder’s Lecture – To Whom Should We Listen?
  2. Symposium Moderator – Summary of Outcomes Pre-Course: Recommendations for Direction and Initiatives for Outcomes Research on UE in SCI
  3. Symposium Moderator – Contemporary Trends in Upper Limb Management: Asian Perspective
75. 7<sup>th</sup> Congress of Asian Pacific Federation of Societies for Surgery of the Hand 2008, “Reconstruction of the Hand and Upper Extremity after Paralysis, Surgery and Neuroprostheses”, Hong Kong, Feb 15, 2008.
76. AO Foundation, AO Hand Course, Principles of Neutralization Plates, Hong Kong, Feb 18, 2008
1. Practical 4: Neutralization plating
  2. Practical 5: Compression plating
  3. Practical 6: Replantation pate

77. 7<sup>th</sup> Congress of Asian Pacific Federation of Societies for Surgery of the Hand-Shenzhen Post-Congress Meeting, “Reconstruction of Paralysis Using Implanted Smart Neuroprosthetics”, Shenzhen, China, Feb. 19, 2008.
78. The State Societies Strategy Meeting of the National Orthopaedic Leadership Conference, “Clinical Practice Guidelines”, Washington DC, April 29, 2009.
79. Xth International Meeting on Surgical Rehabilitation of the Tetraplegic Upper Limb, Sep 20-22, 2010, Musee des Invalides, Paris France
1. Identification of shoulder problems and classification, Proposal of a new classification
  2. New methods of restoring shoulder function in high Tetraplegia
  3. Paper presentations
    - a) Involuntary, electrically excitable nerve transfer for denervation: results from an animal model
    - b) A networked neuro-prosthetic system
    - c) A multi-center assessment of surgical tensioning of the brachioradialis to flexor pollicis longus tendon transfer
    - d) Shoulder range of motion and strength in Tetraplegia
80. Georgia Society for Surgery of the Hand 2011 Annual Meeting, “Management of Upper Limb Paralysis in Spinal Cord Injury” and “Evidence Based Medicine, Guideline and Appropriate Use. AAOS and National Standards”, Sea Island GA, September 23, 2011.
81. Georgia Orthopaedic Society 2011 Annual Meeting, Orthopaedic Practice Guidelines: Evidence Based Medicine”, Sea Island GA, September 24, 2011.
82. Ohio Industrial Commission Statewide Hearing Officers' Training, “Upper Extremity Injury, Rescue, Reconstruction, Rehabilitation, Research” and “Orthopaedic Quality Management”, Maumee Bay Lodge, Maumee OH, October 13, 2011.
83. Minimum Clinically Important Difference (MCID): Defining Output Metrics for Orthopaedic Devices, “Clinician Scientist Perspective on Use of MID”, US FDA White Oak Campus, Silver Spring MD, November 27, 2012.

## **PRESENTATIONS TO NATIONAL MEDICAL AND SCIENTIFIC SOCIETIES**

(Primary Author)

1. American Congress of Rehabilitative Medicine, Stroke in a Midwestern Hospital, San Juan, Puerto Rico, 1971
2. Groups D'Etude de la Main, Winter Meeting, Silastic Implant Arthroplasty for Traumatic and Inflammatory Arthritis of the Proximal Interphalangeal Joint, Paris France, November, 1978.
3. American Society for Surgery of the Hand, Determination of Length Tension Properties of the Muscle Tendon Unit by Electrical Stimulation, Dallas TX, 1978. : *American Journal of Hand Surgery*, Vol. 4, No. 4, 1979.
4. Hand Rehabilitation 1980, Functional Electrical Stimulation for the Tetraplegic Hand, Philadelphia PA, 3/28/80.
5. Eleventh Annual Meeting of the Society for Neuroscience, Cat Forelimb Model Providing Force and EMG Activity from a Single Elbow Extensor in the Unanesthetized Animal, Los Angeles CA, October, 1981.

6. American Society for Surgery of the Hand, Electrical Stimulation of Muscle-A Technique for Intra-operative Assessment of Excursion During Tendon Transfer Surgery. Abstracts of the 36th Annual Meeting, page 28, Las Vegas NV, February, 1981.
7. Ohio Orthopaedic Society, Silastic Implant Arthroplasty for the Proximal Interphalangeal Joint, April, 1982.
8. Trauma Update '82, Trauma Symposium, What's New in Stabilization, Cleveland OH, June 11-12, 1982.
9. Veterans Administration Workshop on Functional Electrical Stimulation, Washington, DC, October 12-13, 1982.
10. American Society for Surgery of the Hand, Restoration of Hand Function in the High Level Quadriplegic by Functional Electrical Stimulation, 1983.
11. Ohio Academy of Orthotists and Prosthetists, Experimental Implantable Prosthetics and Orthotics, Akron OH, 9/17/83.
12. American Society for Surgery of the Hand, Evoked Potentials During Nerve Repair, Atlanta GA, February, 1984.
13. 2nd State Hospital Rehabilitation Engineering Center, Functional Electrical Stimulation, Vienna Austria, October 14-17, 1984.
14. 15th Neural Prosthesis Workshop, Functional Electrical Stimulation, Bethesda MD, November 13-15, 1984.
15. 1st Annual Jefferson Hand Club Meeting, Functional Electrical Stimulation, Philadelphia PA, November 15-16, 1984.
16. American Society for Surgery of the Hand, Panel Discussion, Upper Extremity Functional Electrical Stimulation, Las Vegas NV, 1/22/85.
17. Veterans Administration Functional Electrical Stimulation Workshop II, Upper Extremity Functional Neuromuscular Stimulation-Update, Washington DC, January 30-31, 1985.
18. American Orthotics and Prosthetics Association, Progress in Telemeterized Control of Prosthetics and Orthotics, Westlake OH, 5/4/85.
19. Engineering Foundation Conferences, Neural Prosthesis: Motor Control, Strategies for Combining Upper Extremity Functional Neuromuscular Stimulation and Surgery, New England College, Henniker NH, 8/19/85.
20. 1985 Annual Scientific Meeting of the International Medical Society for Paraplegia, Implementation of a Functional Neuromuscular Stimulation System for a Tetraplegic Upper Extremity, Edinburgh Scotland, September, 1985.
21. 2nd Annual Jefferson Hand Club Meeting, Scientific Session, Electrical Neuropathology Determines Upper Extremity Functional Neuromuscular Stimulation Implementation, Philadelphia PA, 11/2/85.
22. 16th Neural Prosthesis Workshop, Surgical Augmentation of Upper Extremity Tetraplegia Functional Neuromuscular Stimulation, Bethesda MD, 11/6/85.

23. American Academy of Orthopaedic Surgeons, 1986 Instructional Courses, State of the Art of the Upper Extremity Prostheses, New Orleans LA, 2/25/86.
24. Orthopaedic Research Society, Implementation of Functional Neuromuscular Stimulation: Role of Electrodiagnostic Mapping of Lower Motor Neuron Paralysis, New Orleans LA, 2/18/86.
25. National Spinal Cord Injury Association Convention, Applied Bioengineering and Computer Assisted Technology - Clinical Demonstration, Milwaukee WI, 8/1/86.
26. National Spinal Cord Injury Association Convention, Functional Restoration Strategies for Improved Movement in the Upper Extremity, Milwaukee WI, 8/2/86.
27. 17th Neural Prosthesis Workshop, Upper Extremity Functional Electrical Stimulation Surgical Strategies with Tendon Transfers, Washington DC, October 14-17, 1986.
28. American Congress of Rehabilitation Medicine/American Academy of Physical Medicine and Rehabilitation, Strategies for Improved Manipulation and Grasp in the Tetraplegic Upper Extremity Using Functional Electrical Stimulation, Baltimore MD, 10/20/86.
29. National Institute of Handicapped Research, Workshop on Electrical Stimulation, Tendon Transfer and Functional Electrical Stimulation for Tetraplegia, Washington DC, October 31- November 1, 1986.
30. American Academy of Orthopaedic Surgeons, Upper Extremity Surgery II: Spinal Injury, Stroke, Head Trauma, 1987 Instructional Courses, San Francisco CA, 1/27/87.
31. Loyola Orthopaedic Spring Symposium, Functional Electrical Stimulation to Improve Hand Function in the Neurologically Impaired Hand, Loyola University Medical Center, Maywood IL, 5/14/87.
32. American Society for Surgery of the Hand, Upper Limb Reconstruction in the Quadriplegic Patient, 1990 Instructional Course, Toronto Ontario Canada, 9/26/90.
33. 4th International Congress on Upper Extremity Reconstruction in Tetraplegia, Algorithm for the Treatment of High Level Tetraplegia Including FNS and Tendon Transfers, Palo Alto CA, 3/14/91.
34. Applied Neural Control Research Day, Upper Extremity Motor Prostheses, Cleveland OH, 5/20/91.
35. Engineering Foundation Conference, Neural Prostheses: Motor Systems III, Surgical Approaches to Enhanced Function with FES, Banff Alberta Canada, 8/12/91.
36. American Society of Hand Therapists, Medical Management of Cumulative Trauma Disorders, Orlando FL, 9/28/91.
37. American Society for Surgery of the Hand, 46th Annual Meeting, Upper Limb Reconstruction in the Tetraplegic Patient, Instructional Course, Orlando FL, 10/2/91.
38. American Spinal Injury Association, Multi-site Evaluation of an FES Motor Prosthesis for Hand Function, Seattle WA, 4/8/92.
39. Magnetic Resonance Imaging Course, Aspects of MRI - An Orthopaedist Viewpoint, Cleveland OH, 3/7/92.
40. American Spinal Injury Association, Restoration of Functional Grasp-Release in Tetraplegia with Implantable Neuromuscular Stimulation and Tendon Transfers, Toronto Ontario Canada, 5/8/92.



41. American Society for Surgery of the Hand, Regional Review Course, Principles of Tendon Transfers to the Hand, Erie PA, 10/4/92.
42. Winter Conference on Brain Research, Panel Discussion, Neural Prosthesis and Surgical Reconstruction of Upper Extremity Function, Whistler British Columbia Canada, 1/28/93.
43. National Medical Enterprises, Del Ray Community Hospital, Surgery for FES for Neuromuscular Diseases, Del Ray FL, 1/17/93.
44. National Medical Enterprises, RHD Memorial Medical Center, Surgery and FES for Neuromuscular Diseases, Dallas TX, 2/8/93.
45. National Medical Enterprises, Sierra Medical Center, Surgery and FES for Neuromuscular Diseases, El Paso TX, 2/9/93.
46. National Medical Enterprises, Lutheran Medical Center Seminar, Surgical & Electronic Reconstruction of Tetraplegia, FES Program - Clinical Aspects, St. Louis MO, 6/26/93.
47. American Society for Hand Therapists CM Meeting, Diagnosis of Cumulative Trauma Disorders, San Diego CA, 2/25/94.
49. American Society for Hand Therapists CM Meeting, Panel Discussion - Innovations in Diagnosing and Treating Cumulative Trauma, San Diego CA, 2/25/94.
50. American Society for Hand Therapists CM Meeting, Panel Discussion - Future Trends in Managing and Preventing Cumulative Trauma, San Diego CA, 2/27/94.
51. The Hand: Another Decade of Tendon and Nerve Surgery, Panel Discussion - Nerve Regenerative and Healing, Philadelphia PA, 3/12/94.
52. The Hand: Another Decade of Tendon and Nerve Surgery, Panel Discussion - Tendon Transfers, Philadelphia PA, 3/13/94.
53. The Hand Another Decade of Tendon and Nerve Surgery, Electro Stimulation of Paralyzed Muscles in Spinal Cord Injury, Philadelphia PA, 3/13/94.
54. Engineering Foundation, Neural Prosthesis: Motor Systems IV, Clinical Issues Associated with Implementing Implantable Technologies, Mt. Sterling OH, 7/24/94.
55. American Society for Surgery of the Hand Regional Review Course, Flexor Tendon Injuries and Peripheral Nerve Repair, The Cleveland Clinic Foundation, Cleveland OH, 9/25/94.
56. V International Conference Surgical Rehabilitation of Upper limb in Tetraplegia (Quadriplegia), Tendon Transfers & Functional Electrical Stimulation for Restoration of Hand Function in Spinal Cord Injury, Melbourne Australia, March 26-27, 1995.
57. 6th Congress of the International Federation of Societies for Surgery of the Hand (IFSSH), Tendon Transfers and Functional Electrical Stimulation for Restoration of Hand Function in Tetraplegia, Helsinki Finland, 7/7/95.
58. Societe Francaise de Chirurgie de la Main, Tendon Transfers and FES for Restoration of Hand Function in Spinal Cord Injury, Paris France, 7/10/95.

59. American Society for Surgery of the Hand, Tendon Transfers and FES for Restoration of Hand Function in Spinal Cord Injury, San Francisco CA, 9/14/95.
60. Upper Extremity FES Implant Technology: Tech Transfer Workshop, “Role of Tendon Transfer Program in FES Implementation”, Philadelphia PA, 1/27/96.
61. International Neuromodulation society (INS) 3rd International Meeting, American Neuromodulation Society (ANS) 1st Scientific Meeting, Functional Electrical Stimulation: Upper Extremities. Orlando FL, 3/9/96.
62. American Society of Hand Therapists, Cumulative Trauma Disorder. “Diagnosis of CTDs - Definition and Epidemiology”, Boston MA, 5/31/96.
63. American Society of Hand Therapists, Cumulative Trauma Disorder. “Surgical Management of Cumulative Trauma Disorders”, Boston MA, 5/31/96.
64. American Society of Hand Therapists, Cumulative Trauma Disorder. “Panel: Clinical Controversies in Managing the CTD Patient”, Boston MA, 5/31/96.
65. Clinical Investigators’ Meeting - The Freehand System, Session moderator, Cleveland OH, June 28-29, 1996.
66. FDA Devices Panel Testimony, FES Neuroprosthesis (Freehand System, NeuroControl Corporation), Washington DC, 9/25/96.
67. American Society for Surgery of the Hand, Instructional Course, Outcome Assessment of the Upper Extremity: Getting Started, Denver, CO, 9/11/97.
68. American Society for Surgery of the Hand, “Restoration of Grasp and Release with an Implanted Neuroprosthesis “. Denver, CO, 9/13/97.
69. American Academy of Physical Medicine & Rehabilitation 59<sup>th</sup> Annual Assembly, “Mini-course Functional Neuromuscular Stimulation in Spinal Cord Injury Rehabilitation”, Atlanta GA, 11/14/97.
70. American Academy of Physical Medicine & Rehabilitation 59<sup>th</sup> Annual Assembly, “Meet the Experts, Functional Neuromuscular Stimulation in Spinal Cord Rehabilitation”, Atlanta GA, 11/14/97.
71. Combined Meeting Orthopaedic Associations of the English Speaking World, FES Tendon Transfer Improved Hand and Wrist Movement in Tetraplegia, Auckland, New Zealand, 2/3/98.
72. Carolinas Medical Center, Department of Orthopaedics Grand Rounds, “Restoration of Tetraplegic Hand Function Using a FES Neuroprosthesis”, Charlotte NC, 2/23/98.
73. IFSSH 98, “The Provision of Wrist Extension for C5 Level Spinal Cord Injury Through Tendon Transfers of Voluntary and Paralyzed Muscles”, Vancouver, Canada, 5/25/98.
74. American Society for Surgery of the Hand Instructional Course, IC-16 Outcome Assessment: The Next Generation, Anaheim CA, 9/11/98.
75. American Society for Surgery of the Hand Instructional Course, IC-07 Restoration of Tetraplegia Hand Function using and FES Neuroprosthesis, Anaheim CA, 9/11/98.
76. International Neuromodulation Society, 4<sup>th</sup> International Congress, “FES-Systems for Control and Restoration of Upper Extremity Functions”, Lucerne, Switzerland, 9/19/98.

77. Orthopaedic Rehabilitation Association, Specialty Day Program, “Functional Electrical Stimulation in the Upper Extremity, Anaheim CA, 2/7/99.
78. 17<sup>th</sup> Annual Jefferson Hand Club, “Overcoming Paralysis after Spinal Cord Injury”, Philadelphia PA, 11/18/00.
79. 56<sup>th</sup> Annual American Society for Surgery of the Hand, Baltimore MD 10/2/01-01/6/01 Instructional Course – Surgical Rehabilitation of the Upper Extremity in Tetraplegia, 10/4/01
80. 56<sup>th</sup> Annual American Society for Surgery of the Hand, Baltimore MD Achievement of Tetraplegia Ipsilateral Hand Control Using an Implanted Joint Angle Transducer and an Advanced FES Neuroprosthesis, 10/4/01.
81. International Shoulder Group, “Surgical and Neuroprosthetic Approaches to Restore Shoulder Movement Following High Cervical Spine Injury”, Cleveland OH, 6/17/02.
82. American Society for Surgery of the Hand, Instructional Course Lecture, “Writing Outcome Research Grants and for the Journal of Hand Surgery”, Phoenix AZ, 10/3/02.
83. Medical College of Ohio, Department of Orthopaedics, “Principles of Tendon Transfer Surgery” and “Management of the Upper Extremity in Tetraplegia”, Toledo OH, 5/1/03.
84. American Spinal Injury Assn. Annual Meeting, Dallas TX, Instructional Course Lecture – Measuring Functional Outcomes in Tetraplegia, 5/12/05.
85. American Spinal Injury Assn. Annual Meeting, Instructional Course Lecture – Practical Update in Spinal Cord Injury Functional Electrical Neuromuscular Stimulation Research, Boston MA, 6/27/06.
86. American Spinal Injury Assn. Annual Meeting, Instructional Course Lecture – Facilitating Upper Extremity Function in Adults and Children with Tetraplegia, Boston MA, 6/26/06.
87. American Society for Surgery of the Hand, Instructional Course Lecture, “Update on FES Neuroprosthetics”, Las Vegas NV, 9/7/2011.
88. Tri-State Occupational Medicine Association, State of the Art in Occupational and Environmental Medicine 2011, “Carpal Tunnel Syndrome, Clinical Practice Guidelines for Diagnosis and Treatment Worker Compensation Issues, Cleveland OH, 10/22/2011.
89. American Association for Hand Surgery, Debate Professional Practice Guidelines: Critical for Patient Care or Ammo for Criticism of Care, Moderator: Dr. David Ring, PRO: Michael Keith, CON: A. Lee Osterman, Las Vegas NV, 1/13/2012.

#### **PRESENTATIONS TO LOCAL MEDICAL AND SCIENTIFIC SOCIETIES**

1. Cleveland Hand Therapists Interest Group, Nerve Regeneration, September 5, 1979.
2. Case Western Reserve University Department of Orthopaedics, Continuing Medical Education, Ring Injuries in the Hand, September 1979.
3. Case Western Reserve University Department of Orthopaedics, Continuing Medical Education, Case Presentation and Crush Avulsion Injuries to the Hand and Skin Flap Coverage, September, 1979.
4. Case Western Reserve University Hand Conference, Tendon Healing and Wound Repair, September, 1979.

5. Cleveland Metropolitan General Hospital Hand Rounds, Nerve Regeneration and Repair, September, 1979.
6. Hospital Improvement Fund, Total Hip Arthroplasty and Tharies Implants, October 12, 1979.
7. Cleveland Metropolitan General Hospital Hand Rounds, Two Stage Tendon and Pulley Reconstruction, October 25, 1979.
8. Cleveland Rotary Club, Hand Rehabilitation, October 30, 1979.
9. Case Western Reserve University Continuing Education Program for Attorneys, Back and Neck Injuries and Their Treatment, December 4, 1979.
10. University Hospitals of Cleveland Hand Conference, Dupuytren's Contracture, January 30, 1980.
11. Cleveland Metropolitan General Hospital Continuing Medical Education Program, Intrinsic Function in the Hand, January 31, 1980.
12. Cleveland Metropolitan General Hospital Continuing Medical Education Program, Two Stage Flexor Tendon Reconstruction, April 24, 1980.
13. Cleveland Metropolitan General Hospital Department of Occupation Therapy In-Service, Two Stage Flexor Tendon Reconstruction, April 29, 1980.
14. Family Practice Rounds, University Hospitals of Cleveland, Carpal Tunnel Syndrome and Other Nerve Compression Syndromes, July 23, 1980.
15. University Hospitals of Cleveland Hand Conference, Flexor Tendon Injuries, August, 1980.
16. Case Western Reserve University, Anatomy for Attorneys Symposium, Spinal Injuries, September 16, 1980.
17. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Fractures and Vascular Injuries, September 23, 1980.
18. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Disorders of the Elbow, September 23, 1980.
19. Case Western Reserve University, Anatomy for Attorneys Symposium, The Hand and Upper Extremity, September 23, 1980.
20. Industrial Commission of Ohio at Cleveland Metropolitan General Hospital, Upper Extremity Replantation, Amputation and Prosthetics, May 14, 1981.
21. Association of Operating Room Nurses of Greater Cleveland, Microsurgical Technique for Replantation, May 20, 1981.
22. Cleveland Metropolitan General Hospital Continuing Medical Education Program Hand Surgery, Nerve Regeneration, August, 1981.
23. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Fractures of Long Bones and the Hand, September 16, 1981.
24. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Clinical Correlation: Diseases of the Elbow, September 22, 1981.

25. Case Western Reserve University Department of Orthopaedic Continuing Medical Education, Anatomy of the Elbow: Dissection and Lecture, September 26, 1981.
26. Case Western Reserve University, Continuing Education for Attorneys, Spinal Injuries, September 29, 1981.
27. Case Western Reserve University, Continuing Education for Attorneys, Upper Extremity Injuries, October 6, 1981.
28. Cleveland Research Institute Biomechanics Course, Muscle and Tendon Transfer Biomechanics, October 21, 1981.
29. Case Western Reserve University Department of Orthopaedics, Continuing Medical Education, Nerve Reception Physiology, April 17, 1982.
30. Northeastern Ohio Rehabilitation Association, Coordination of Medical and Vocational Rehabilitation Service, June 23, 1982.
31. University Hospitals of Cleveland, In-Service Nurses Course, Limb Replantation, September 8, 1982.
32. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Clinical Correlation: Diseases of the Elbow, September 21, 1982.
33. University Hospitals of Cleveland, Research Seminar, Restoration Hand Function in High Level Quadriplegic by Functional Electrical Stimulation, February 2, 1983.
34. Southwest Family Practice Education Workshop, Nerve Entrapment in the Upper Extremity, Southwest General Hospital, Middleburg Heights, Ohio, March 23, 1983.
35. St. Luke's Hospital, Replantation of Digits, Orthopaedic Conference, St. Luke's Hospital, Cleveland, Ohio, June 9, 1983.
36. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Trauma of Long Bones and Hand, September 21, 1983.
37. Mt. Sinai Medical Center Biomechanics Course, Muscle and Tendon Biomechanics, Mt. Sinai Medical Center, Cleveland, Ohio, November 2, 1983.
38. TRW Health and Safety Group, Carpal Tunnel Syndrome, Cleveland, Ohio, February 24, 1984.
39. University Hospitals Family Practice Group, Reflex Sympathetic Dystrophy, Cleveland, Ohio, March 26, 1984.
40. University Hospitals of Cleveland, Research Seminar, Myoelectric Telemeters, Cleveland, Ohio, April 4, 1984.
41. Mt. Sinai Medical Center, Orthopaedic Grand Rounds, Implantable Electronic Devices in Rehabilitation of the Upper Extremity, Cleveland, Ohio, April 25, 1984.
42. Regional Program in Continuing Medical Education - Kaiser West, Major Hand & Upper Extremity Injuries & Limb Salvage Procedures, Cleveland, Ohio, May 22, 1984.

43. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Arm and Elbow, Anatomy Correlation August 31, 1984.
44. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Clinical Correlation of the Elbow, September 21, 1984.
45. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Trauma of Long bones and Hand, September 24, 1984.
46. University Hospitals of Cleveland, Research Seminar, Nerve Repair and Evoked Potentials, September 26, 1984.
47. Mt. Sinai Medical Center Biomechanics Course, Biomechanics of the Muscle Tendon Unit, Cleveland OH, October 24, 1984.
48. American Society for Surgery of the Hand, Regional Review Course, Fingertip Amputations, Skin Coverage Procedures, Biomechanics of Tendon Transfers, Cleveland OH, October 28, 1984.
49. Little Orthopaedic Club, Scientific Session, University Hospitals of Cleveland, Functional Neuromuscular Stimulation, Cleveland OH, November 3, 1984.
50. Industrial Commission Rehabilitation Division, Diagnosis and Treatment of Low Back Pain, Cleveland OH, April 8, 1985.
51. Cleveland Metropolitan General Hospital/Highland View Hospital, Emergency Treatment and Management: Medical and Surgical Concerns, Extremity Trauma: Management for Replantation, Cleveland OH, May 15, 1985.
52. University Hospitals of Cleveland, Research Seminar, Progress in the Development of Biosignal Telemetry, Cleveland OH, May 30, 1985.
53. Family Practice Association, Hand Injuries, University Hospitals of Cleveland, Cleveland OH, June 24, 1985.
54. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Small Group Discussion, Upper Extremity Anatomy, September 20, 1985.
55. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Conference on Trauma, Upper Extremity Trauma Management, September 23, 1985.
56. University Hospitals of Cleveland Emergency Room Conference, Limb Salvage, University Hospitals of Cleveland, Cleveland OH, September 30, 1985.
57. Orthopaedic Resident Teaching and Continuing Education Conference, Diagnosis and Management of Upper Extremity Nerve Conditions, University Hospitals of Cleveland, Cleveland OH, October 26, 1985.
58. Basic Science Lectures in Biomechanics, Muscle Tendon Biomechanics, Mt. Sinai Hospital, Cleveland OH, October 30, 1985.
59. Cleveland Metropolitan General Hospital, Operating Room and Recovery Room Nurses' Conference, Functional Electrical Stimulation in the Operating Room, February 4, 1986.
60. Department of Biomedical Engineering, Research Day, Upper Extremity Functional Electrical Stimulation, Case Western Reserve University Cleveland OH, May 9, 1986.

61. Orthopaedic Review Course, Hand - Anatomy, Tendon Injuries, Compartment Syndromes, Infections, Cleveland OH, May 20, 1986.
62. University Hospitals of Cleveland, Research Seminar, Experimental Design for Implantation Stimulator Evaluation in the Tetraplegic Upper Extremity, May 28, 1986.
63. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Shoulder - Anatomy, Cleveland OH, August 22, 1986.
64. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Brachial Plexus - Anatomy, Cleveland OH, August 23, 1986.
65. Case Western Reserve University, School of Medicine, Phase II Musculoskeletal Committee, Hand - Anatomy, Cleveland OH, August 27, 1986.
66. University Hospitals of Cleveland, Research Seminar, A Proposal: Electrical Exercise After Tenolysis, Cleveland OH, September 3, 1986.
67. Cleveland Chapter of the National Association of Orthopaedic Nurses, Limb Salvage, University Hospitals of Cleveland OH, September 10, 1986.
68. American Society for Surgery of the Hand, Regional Review Course, Dupuytren's Disease, Mt. Sinai Medical Center, Cleveland OH, October 18, 1986.
69. American Society for Surgery of the Hand, Regional Review Course, Flexor Tendon Injuries, Mt. Sinai Medical Center, Cleveland OH, October 18, 1986.
70. Basic Science Lectures in Biomechanics, Muscle-Tendon Biomechanics, Mt. Sinai Medical Center, Cleveland OH, November 5, 1986.
71. Orthopaedic Nurses In-Service Conference, Microvascular Repair, Cleveland Metropolitan General Hospital, Cleveland OH, February 25, 1987.
72. Hosmer's 1987 Electric Systems Workshops, Team Management and Decision Making for Myoelectric Prosthesis, Cleveland OH, March 2, 1987.
73. Orthopaedic Review Course, Shoulder and Brachial Plexus, Cleveland OH, June 3, 1987.
74. Orthopaedic Review Course, Peripheral Nerve Problems, Cleveland OH, June 3, 1987.
75. Upper Extremity Trauma - Progressive Management and Rehabilitation, Clinical and Descriptive Anatomy of the Shoulder and Arm, Cleveland Metropolitan General Hospital, Cleveland OH, October 16, 1987.
76. Upper Extremity Trauma - Progressive Management and Rehabilitation, Pathophysiology and Nerve Repair and Determination of Impairment in the Hand, Cleveland Metropolitan General Hospital, Cleveland OH, October 17, 1987.
77. Greater Cleveland Chapter of the National Association of Orthopaedic Nurses Program, Hand Trauma, Cleveland OH, October 24, 1987.
78. Metro Trauma Care Network, Topics in Trauma Nursing, Managing Upper Extremity Trauma, Cleveland OH, January 6, 1988.

79. Advances in the Management of Spinal Cord Injury, Cleveland Metropolitan General Hospital/Highland View Hospital, Surgical Implantation of Functional Electrical Stimulators, Cleveland OH, March 18, 1988.
80. Metro Life Flight Lecture Series, MetroHealth Medical Center, Limb Salvage, Cleveland OH, March 6, 1989.
81. Hand Study Group, MetroHealth Medical Center, Electromyography and Nerve Conduction Studies, Cleveland OH, March 15, 1989.
82. Upper Extremity Trauma, Surgical Management and Rehabilitation, Surgical Advances in Flexor Tendon Injuries, Cleveland OH, April 20, 1990.
83. Upper Extremity Trauma, Surgical Management and Rehabilitation, Panel Presentation: (Case Studies) Management of Major Traumatic Upper Extremity Injuries, Cleveland OH, April 21, 1990.
84. Ohio Rehabilitation Association 1990 Fall Conference, FES: Clinical Applications Available in Ohio-Today and Tomorrow, Cleveland OH, September 6, 1990.
85. Department of Plastic Surgery Grand Rounds, Management of Nerve Compression in the Upper Extremity, University Hospitals of Cleveland, Cleveland OH, November 17, 1990.
86. Case Western Reserve University, Magnetic Resonance Imaging, Newer Aspects of Clinical Orthopaedics, Cleveland OH, May 4, 1991.
87. University Hospitals of Cleveland, Research Seminar, Tendon Transfers Controlled by FES, Cleveland OH, August 28, 1991.
88. University Hospitals of Cleveland, Core Curriculum Lectures, Tendon Transfers: General Principles, What-Where-How, Cleveland OH, October 12, 1991.
89. Interdepartmental Spinal Cord Injury Lecture Series for Resident Physicians, MetroHealth Medical Center, Spinal Cord Injury Management IV: FES/Tendon Transfers/Recovery Research, Cleveland OH, December 19, 1991.
90. University Hospitals of Cleveland, Surgery Grand Rounds, Correcting Paralysis, Cleveland OH, September 25, 1992.
91. MetroHealth Medical Center, Dept. of Physical Medicine & Rehabilitation, Cumulative Trauma Disorders: Scope of the Problem, Review of the Controversy, and Approach to Treatment, Conservative and Surgical Management of Specific CTDs and Graphical Tools for Decision Making, Cleveland OH, December 1, 1994.
92. Freehand System, A Training Seminar for Hand Surgeons and Therapists, Getting It Right the First Time, Cleveland OH, September 28, 1995.
93. Freehand System, A Training Seminar for Hand Surgeons and Therapists, Pre-operative Preparation and Instruction on Determining Surgical Plan for the Patient, Cleveland OH, September 30, 1995.
94. University Hospitals of Cleveland, Orthopaedic Grand Rounds, Management of Acute Hand Injuries, Cleveland OH, November 18, 1995.
95. Cumulative Trauma Seminar, MetroHealth Medical Center. "Management of Cumulative Trauma Disorders", Cleveland OH, February 15, 1996



96. MetroHealth Foundation, MetroHealth Medical Center, “Functional Electrical Stimulation”, Cleveland OH, May 7, 1996.
97. Chester Summer Scholars, MetroHealth Medical Center, “Functional Electrical Stimulation”, Cleveland OH, August 8, 1996.
98. Physical Medicine & Rehabilitation Grand Rounds, MetroHealth Medical Center, “Overcoming Paralysis after Tetraplegia”, Cleveland OH, September 23, 1996.
99. Cleveland Clinic Foundation , Chairman’s Conference, “Functional Electrical Stimulation Results of Multi-Center Clinical Trials”, Cleveland OH, February 27, 1997
100. Mt. Sinai Hospital, Grand Rounds, “Functional Electrical Stimulation Results of Multi-Center Clinical Trials”, Cleveland OH, March 19, 1997.
101. MetroHealth Medical Center, Multidisciplinary Spine Conference, “Upper Extremity FES”, Cleveland, OH, February 20, 1998.
102. Ohio State University School of Medicine, Department of Orthopaedics Grand Rounds, “ Restoration of Tetraplegic Hand Function Using a FES Neuroprosthesis”, Columbus OH, March 5, 1998.
103. MetroHealth Medical Center, Surgical Reconstruction of the Tetraplegic Hand, “Neuroprosthetists for Spinal Cord Injury”, Cleveland OH, September 30, 1999.
104. Hillside Rehabilitation Center, “Building Relations-MetroHealth & Hillside Rehab”. Warren OH, May 1, 2001.
105. MetroHealth Medical Center, Physical Medicine and Rehabilitation Department, Spinal Cord Injury Series 2003, “Upper Extremity Management Options in Spinal Cord Injury, Tendon Transfer and Functional Electrical Stimulation”, Cleveland OH, December 4, 2003.
106. Ohio State University Department of Orthopaedics Grand Rounds, “Recent Progress in Neuroprostheses”, Columbus OH, April 2, 2004.
107. Nursing: Understanding Today and Preparing for Tomorrow, “New Functional Electrical Stimulation (FES) Technology for 2004, MetroHealth Medical Center, Cleveland OH, April 23, 2004.
108. 2004 Wallace Duncan Lecture, “Incorporating Technology into Hand Surgery”, W.O. Walker Center, Cleveland OH, 5/1/04.
109. The Injured Worker: Medical and Therapeutic Management that Makes a Difference, "Upper Extremity Injury", MetroHealth Medical Center, Cleveland OH, November 5, 2004.
110. 6<sup>th</sup> Annual Orthopaedics: Excellence Through Education, “Traumatic Hand Injuries, InterContinental Hotel and MBNS Conference Center, Cleveland OH 1/27/06
111. 4<sup>th</sup> Annual Cleveland Combined Hand Fellowship Grand Rounds and Duncan Lecture, “Ways to Manage a Paralyzed Upper Limb”, Cleveland OH, May 5, 2006
112. 21<sup>ST</sup> Annual Neural Engineering & Rehabilitation Lectures, “Moderator, Surgical Experiences with Peripheral Nerve Stimulation Short Presentation and Panel Discussion”, Cleveland OH 6/2/06
113. Case Western Reserve University, EBME507 Motor Systems Neuroprostheses, “Physicians Perspective on Neuroprostheses”, Cleveland OH 2/27/07.

114. Japanese Traveling Fellows Symposium, "Reconstruction of the Tetraplegic Hand with 24-Channel FES" Castele Learning Center Lutheran Hospital, Cleveland OH, 10/17/07.

### **SCIENTIFIC EXHIBITS (selected examples)**

1. Roscoe, D. D., and Keith, M.W.: Cat Forelimb Model Providing Force and EMG Activity from a Single Elbow Extensor in the Unanesthetized Animal. Accepted: Neuroscience Abstr., 11th Annual Meeting, Los Angeles, 1981.
2. Peckham, P.H., Thrope, G.B., Freehafer, A.A., and Keith, M.W.: Coordinated Two Mode Grasp in the Quadriplegic Patient Initiated by Functional Neuromuscular Stimulation. Presented at the 12th Annual Meeting Society for Neuroscience, Minneapolis MN, November, 1982.
3. American Society for Surgery of the Hand, Poster Session, Upper Extremity Functional Neuromuscular Stimulation, Las Vegas NV, January 20-23, 1985.
4. Orthopaedic Research Society, Poster Session, Upper Extremity Functional Neuromuscular Stimulation, New Orleans LA, February 17-20, 1986.
5. American Roentgen Ray Society, Poster Session, MRI of the Knee: Assessment of Clinical Utility, Miami Beach FL, April 26-May 1, 1987. Received Certificate of Merit Award-1987.
6. American College of Surgeons, Motion Picture Exhibition, Tendon Transfers in the Quadriplegic Upper Extremity: The Cleveland Method of Classification and Treatment, San Francisco CA, October 15, 1987.
7. Keith, M.W., P.H. Peckham and Kilgore, K. Implantation of Electrodes for Upper Extremity FNS Systems (Video presentation), Applied Neural Control Research Day, Case Western Reserve University, Cleveland OH, May 24, 1988.
8. Edison BioTechnology Center, Poster Session, Improvement of Early Range of Motion of Flexor Tendons After Tenolysis Using Percutaneous Electrical Stimulation, Cleveland OH, June 7, 1991.
9. American Spinal Injury Association, Poster Presentation, Functional Neuromuscular Stimulation and Surgical Reconstruction of the Hand in Long-Term Tetraplegia, San Diego CA, May 10-12, 1993.
10. The 8th Annual Applied Neural Control Research Day, Poster Session, Implementation of an Upper Extremity Neural Prosthesis. Cleveland OH, May 18, 1993.