Title: Restoring hand function in tetraplegia: clinical translation of the ai-hand neuroprosthesis

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Restoration of hand function in individuals with complete cervical spinal cord injury remains a major challenge in rehabilitation medicine. The AI-HAND project, funded under the Horizon Europe EIC Pathfinder program, aims to develop and validate a novel Active Implantable Medical Device based on intelligent and spatially selective stimulation of the peripheral nervous system.
The technology relies on multi-contact epineural cuff electrodes and custom-designed stimulators enabling tridimensional current shaping, offering unprecedented selectivity in targeting specific nerve fascicles. This paradigm eliminates the need for multiple intramuscular implants by leveraging fascicular selectivity, thereby reducing invasiveness.
Preliminary studies have shown that such selective stimulation can elicit strong and functionally relevant hand and forearm movements in individuals with complete tetraplegia[1,2]. As part of a first-in-human clinical trial, the Centre Hospitalier de Luxembourg is leading the surgical implantation, and the Rehazenter is leading the functional assessment, rehabilitation, and post-operative monitoring. This trial targets the restoration of key grasping functions and aims to evaluate safety, usability, and real-world functional outcomes.
This presentation will cover the therapeutic rationale, surgical procedure, rehabilitation protocol, and clinical challenges of implementing such advanced neuroprosthetic technology. The AI-HAND project offers a promising step toward restoring upper limb function in severely impaired individuals and opens new avenues in personalized neurorehabilitation.

References

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2) Tigra W, Dali M, William L, Fattal C, Gélis A, Divoux J-L, Coulet B, Teissier J, Guiraud D, Azevedo-Coste C. Selective neural electrical stimulation restores hand and forearm movements in individuals with complete tetraplegia. J Neuroeng Rehabil 2020 May 19;17(1):66. doi: 10.1186/s12984-020-00676-4.

SPEAKER BIOSKETCH – Dr. Frédéric CHANTRAINE (Rehazenter)

NAME, SURNAME: Frédéric CHANTRAINE, MD

TITLE: Physiatrist (Physical Medicine & Rehabilitation), Neurological Rehabilitation

CURRENT AND PAST POSITIONS:

- **Pysical Medecine & Rehabilitation (P &R), Neurological Rehabilitation**, Centre National de Rééducation Fonctionnelle et de Réadaptation – **Rehazenter**, Luxembourg (2003–present).
- **President, Medical Council (Conseil médical)**, Rehazenter (current).
- **Consulting physician**, outpatient practice at Rehazenter, 1 rue André Vésale, L-2674 Luxembourg (ongoing).

EDUCATION:

- **MD (Docteur en médecine)**, Université catholique de Louvain (1996).
- **Postgraduate training in Physical Medicine & Rehabilitation (PM&R)** (2001).

AWARDS AND HONORS:

- **Institutional leadership**: President of the Medical Council, Rehazenter.
- **Clinical research leadership**: Named investigator on CNER-approved neurorehabilitation study (Luxembourg, 2024).

OTHER RELEVANT PROFESSIONAL ACTIVITIES AND ACCOMPLISHMENTS:

- **Clinical & research focus:** gait analysis, neurorehabilitation after stroke, management of spasticity (including botulinum toxin and adjunctive therapies), and functional electrical stimulation (FES).
- **Teaching & mentoring:** contribution to a "Diplome inter- Universitaire : gait analysis (adults & children).

SPEAKER BIOSKETCH – Dr. Frank HERTEL (CHL)

NAME, SURNAME: Frank HERTEL, MD

TITLE: Prof. Dr. (Medical Doctor), Head of Department, Centre Hospitalier de Luxembourg, National Department of Neurosurgery.

CURRENT AND PAST POSITIONS:
2017–to date Principal Investigator & Professeur affilié, Full ADR, University of Luxembourg, Luxembourg Centre for Systems Biomedicine, Interventional Neuroscience Group.
2008–to date Head of Department, Centre Hospitalier de Luxembourg, National Department of Neurosurgery.
2008–to date Cooperative Functional Neurosurgeon, SHG Clinic Idar-Oberstein, Department of Neurosurgery.
2007–2008 Head of Department, SHG Clinic Idar-Oberstein, Department of Neurosurgery.
2003–2007 Senior Physician (Oberarzt), Krankenhaus der Barmherzigen Brüder Trier, Department of Neurosurgery.
2001–2003 Chief Resident (Funktionsoberarzt), Krankenhaus der Barmherzigen Brüder Trier, Department of Neurosurgery.
2001 Specialist in Neurosurgery. Neurosurgical Training
1996–2001 Resident (Assistenzarzt), Krankenhaus der Barmherzigen Brüder Trier, Department of Neurosurgery. Supervisor: Prof. M. Bettag (2000–2001) / Prof. K. Faulhauer (1996–2000)
1995–1996 Resident (Assistenzarzt), University Clinic Mainz, Department of Neurosurgery. Supervisor: Prof. A. Perneczky
1994–1995 Resident (Assistenzarzt), University Clinic Mainz, Department of Neuropathology. Supervisor: Prof. H.H. Goebel

EDUCATION:
Habilitation
im Fachgebiet der Neurochirurgie
title Methoden zur Automatisierung und Verbesserung der Planung, Durchführung und Evaluation der stereotaktischen Tiefen Hirnstimulation

MD thesis
title Die Expression von E-Cadherin in Tumoren des menschlichen Nervensystems – eine immunhistologische und immunelektronenmikroskopische Untersuchung

Master of Arts
in Management von Gesundheits- und Sozialeinrichtungen
title Digitale Transformation in der Neurochirurgischen Patientenversorgung – digitale Technologien im Management von Patienten mit Bewegungsstörungen und Tiefer Hirnstimulation; aktuelle Anwendungen und Potenziale für die Zukunft
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Education
1994 Practical Year, Université Louis Pasteur Strasbourg, Neurology / University of Homburg,Neurosurgery / University of Homburg, Internal Medicine and Traumatology.
1988–1993 Studies of Human Medicine, University of Mainz.3rd Staatsexamen in 1994
1986–1988 Studies of Electrical Engineering, Technical University of Kaiserslautern.

AWARDS AND HONORS:
2015 Siemens / Sincas SHAPE Award (best paper), F. Bernard, L Salamanca, J. Thunberg, F. Hertel, J. Goncalves, P. Gemmar, Shape aware 3D inpteroloation using statistical shape models.

2013 Best Poster Award German Neuromodulation Society, R. Bremm, K.P. Koch F. Hertel, Elektrische Feldmodellierung bei epiduraler Rückenmarkstimulation. Rue Ernest Barble, 4 – L-1210 Luxembourg – Luxembourg T +352 (4411) 8527 • B hertel.frank@chl.lu 2/4

2012 CHL Junior scientific excellence price for clinical research, A. Hana, A. Husch, F. Hertel, Integration of DTI fiber tracking into the neurosurgical workflow for brain tumor surgery

2003 Hirnforschugnspreis der deutschen Gesellschaft für Geriatrie, F. Hertel, C. Walter, Diagnostik des Normaldruckhydrozephalus, ein neues Verfahren der Hirndurchblutungsmessung.

OTHER RELEVANT PROFESSIONAL ACTIVITIES AND ACCOMPLISHMENTS:

2011–2016 Distance Studies on Management of Health Care Institutions, University of Kaiserslautern, Grade: A.
2009–2014 Vice-president of the DGNM, (Deutsche Gesellschaft für Neuromodulation).
2006 Co-founder of IKNTec, (Interdisciplinary Center for the Development of innovative Neurotechnology).
Since 2006 Prüfarzt für Klinische Studien (Clinical Investigator Certification), University of Düsseldorf.
Since 2001 Various national and international research projects on functional and oncological neurosurgery, Main topics: brain–computer interfaces, neurostimulation techniques, image guided & computer aided surgery.
Since 2001 Over 760 deep brain stimulation interventions, Covering a broad range of diseases (including Parkinson's', Essential Tremor, Dystonia, OCD, Anorexia Nervosa) in adults as well as an children.