# Functional Electrical Stimulation in Spinal Cord Injuries

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RESEARCH & DEVELOPMENT

Cleveland

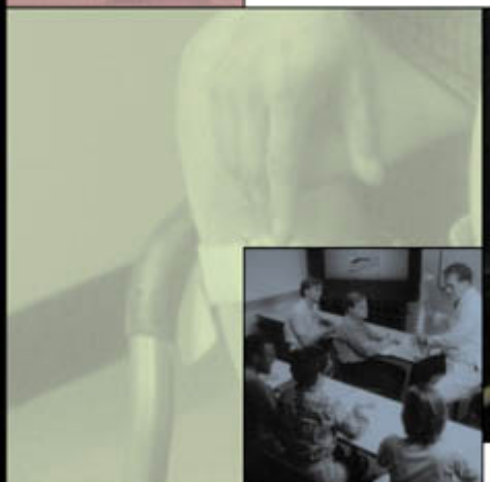
FES Center

CLINICAL IMPLEMENTATION



FOR HEALTH FUNCTION

INDEPENDENCE



EDUCATION & TRAINING



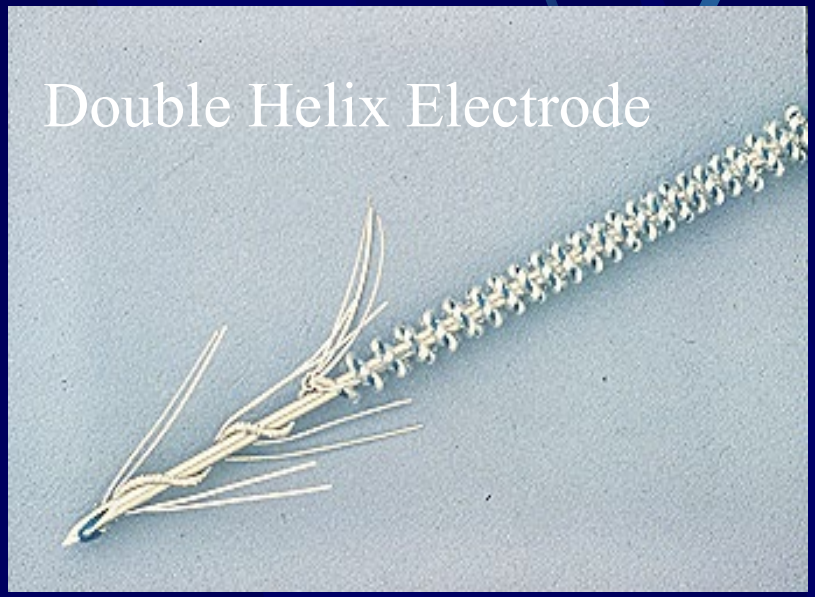


FUNCTIONAL ELECTRICAL STIMULATION (FES)

RESTORING FUNCTION FOLLOWING PARALYSIS.

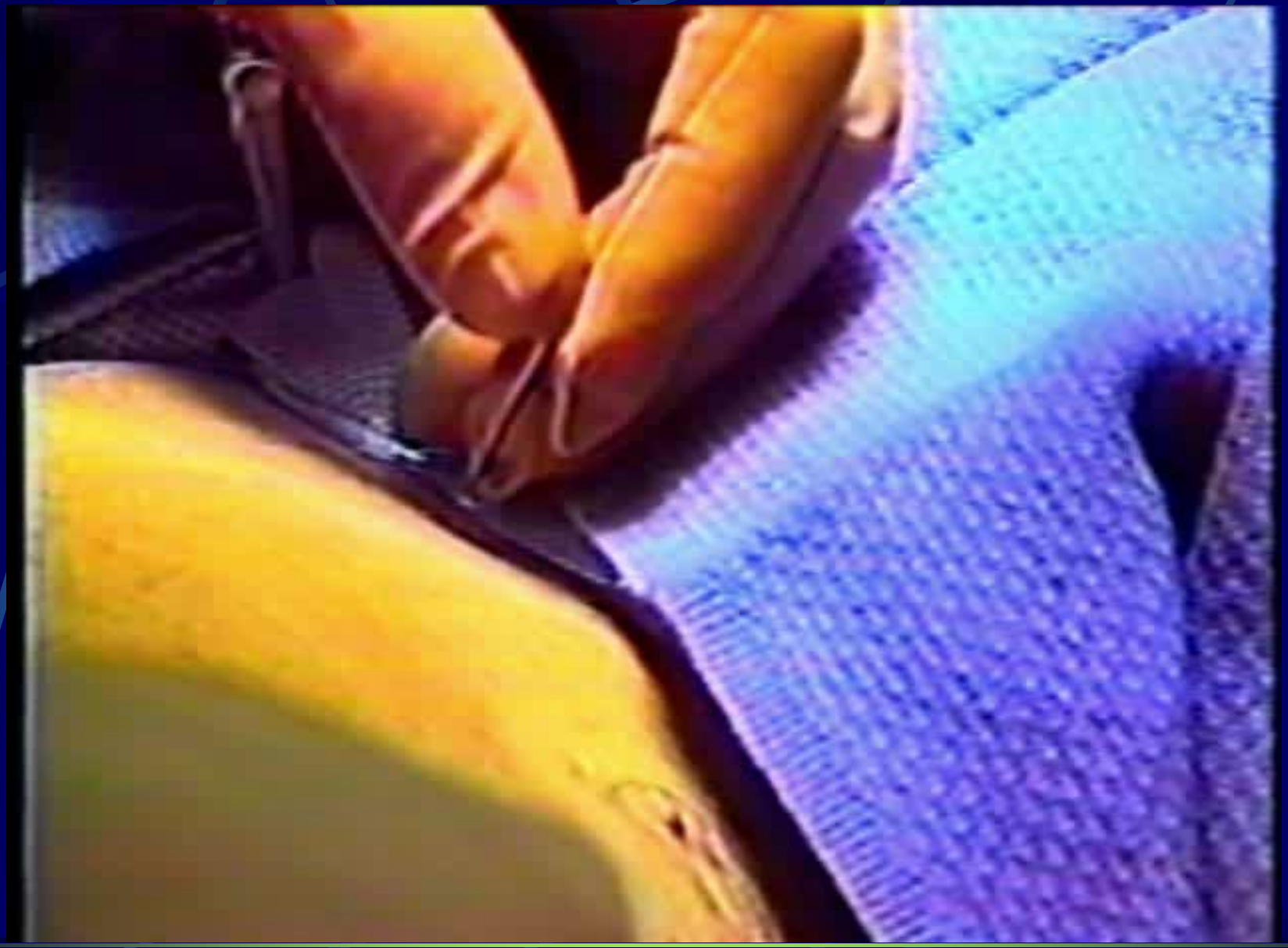
# ELECTRODE

- Coil wire electrodes had poor tissue fixation and mechanical weakness.
- Double Helix was designed and used during later part of follow up.

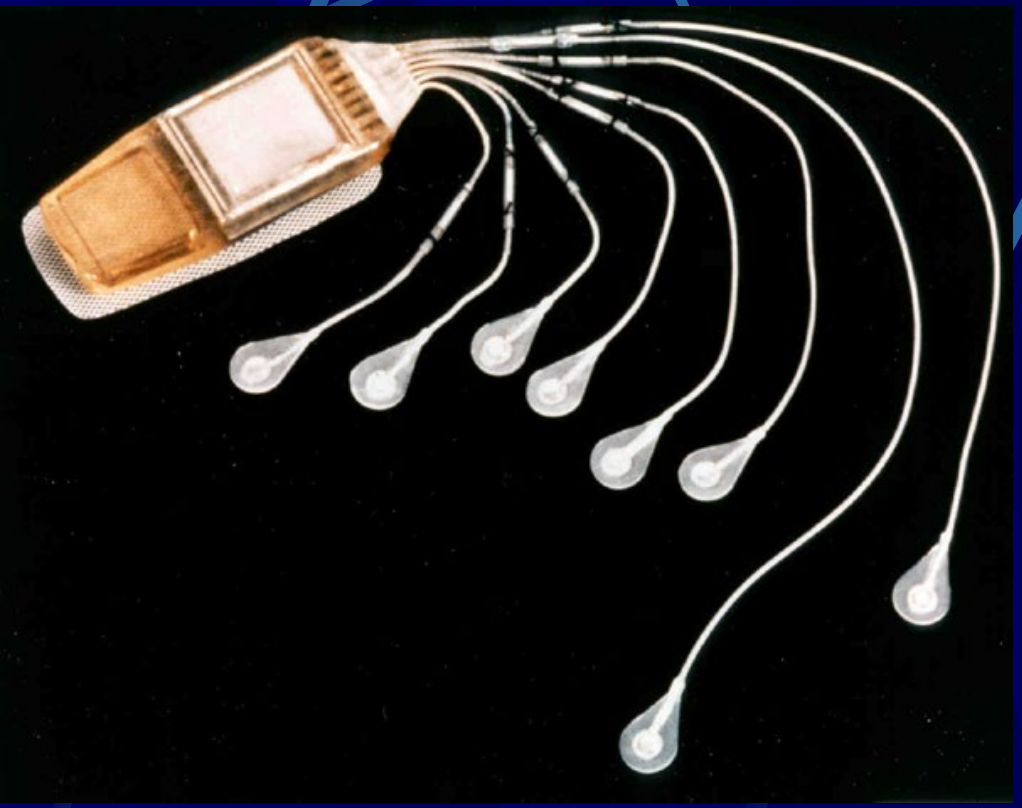



1 year survival rate= 80%

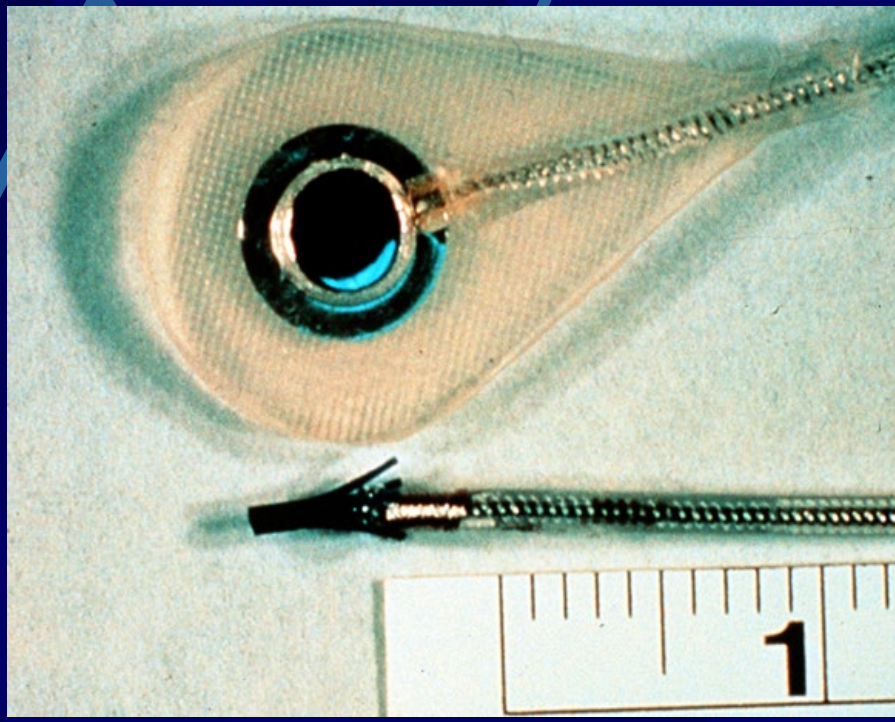
5 year survival rate=48%



# Internal components early 80's



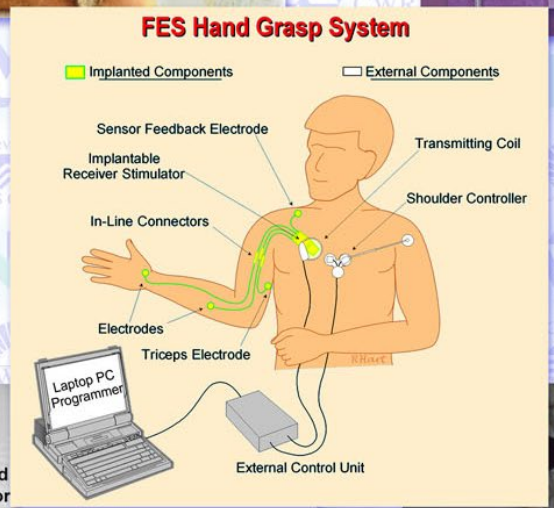
8-Channel Implanted Receiver-Stimulator

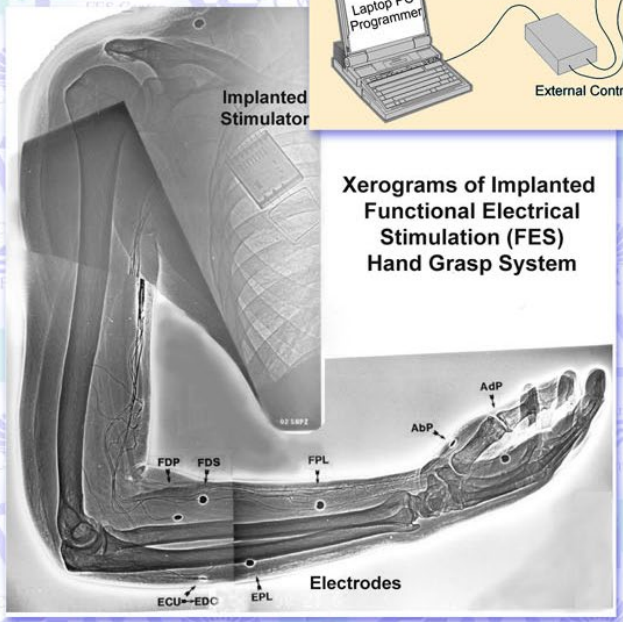



Epimysial & Surgically-Implanted Intramuscular Electrodes

# Upper Extremity

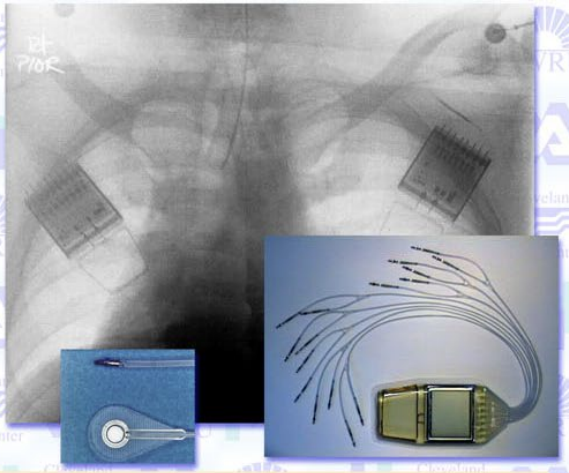
- First implant 1986
- FDA approved in US 1997
- Over 200 implanted

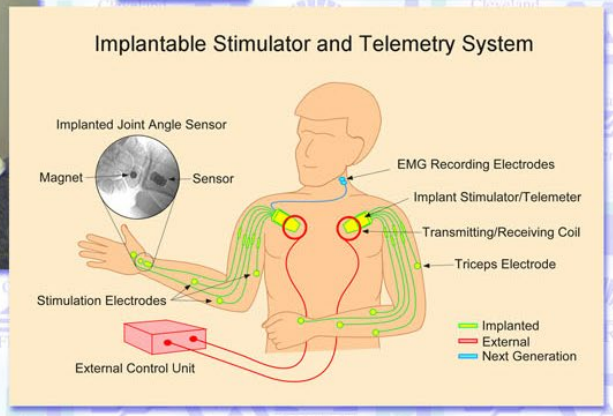


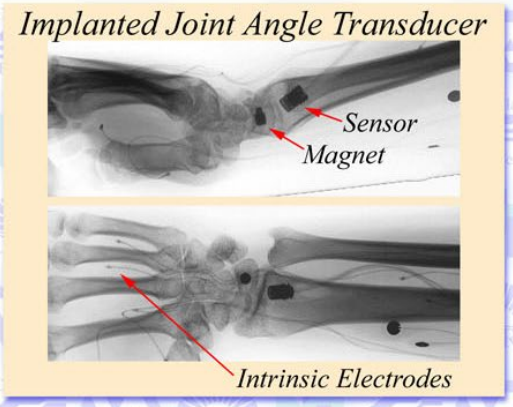




# Enhanced Upper

- Implanted joint angle
- Extra stimulator
- Shoulder elevation



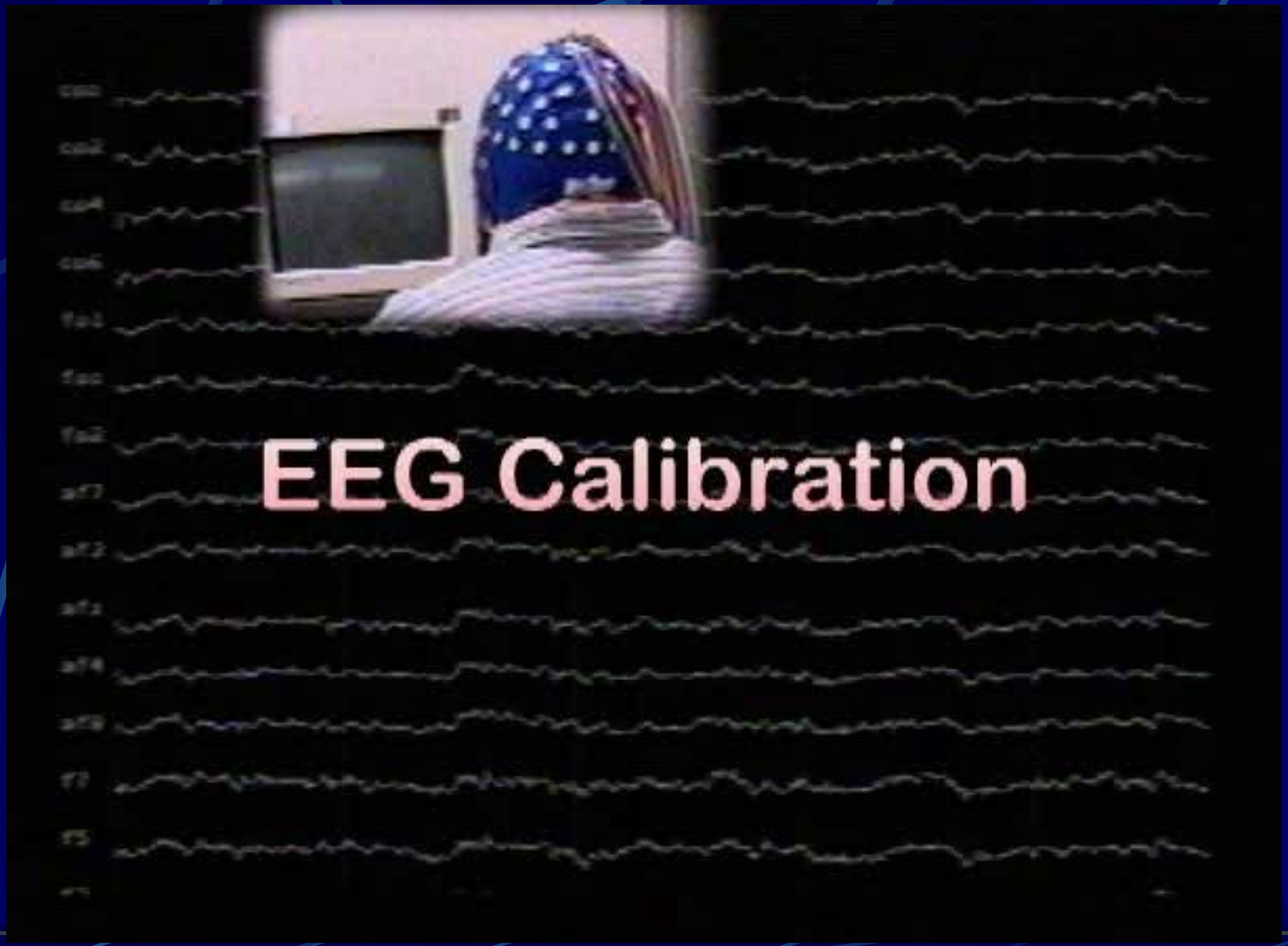




V8


Without
Triceps
With
Triceps


EEG Calibration

# Lower Extremity

- 1982


S. K.
T-8/9, COMP.
MAY '83

# Hybrid System Compared to FES-only

- Advantages
  - stability
  - erect posture
  - reduced stimulation
  - low energy for standing
- Disadvantages
  - slower walking
  - restricted motions
  - difficult transfers
  - cosmesis
  - pressure points


HI–TECH HELP

# Congressional Demo

- 1990
- House of Representatives
- Senator Edward Kennedy

# Subject DC

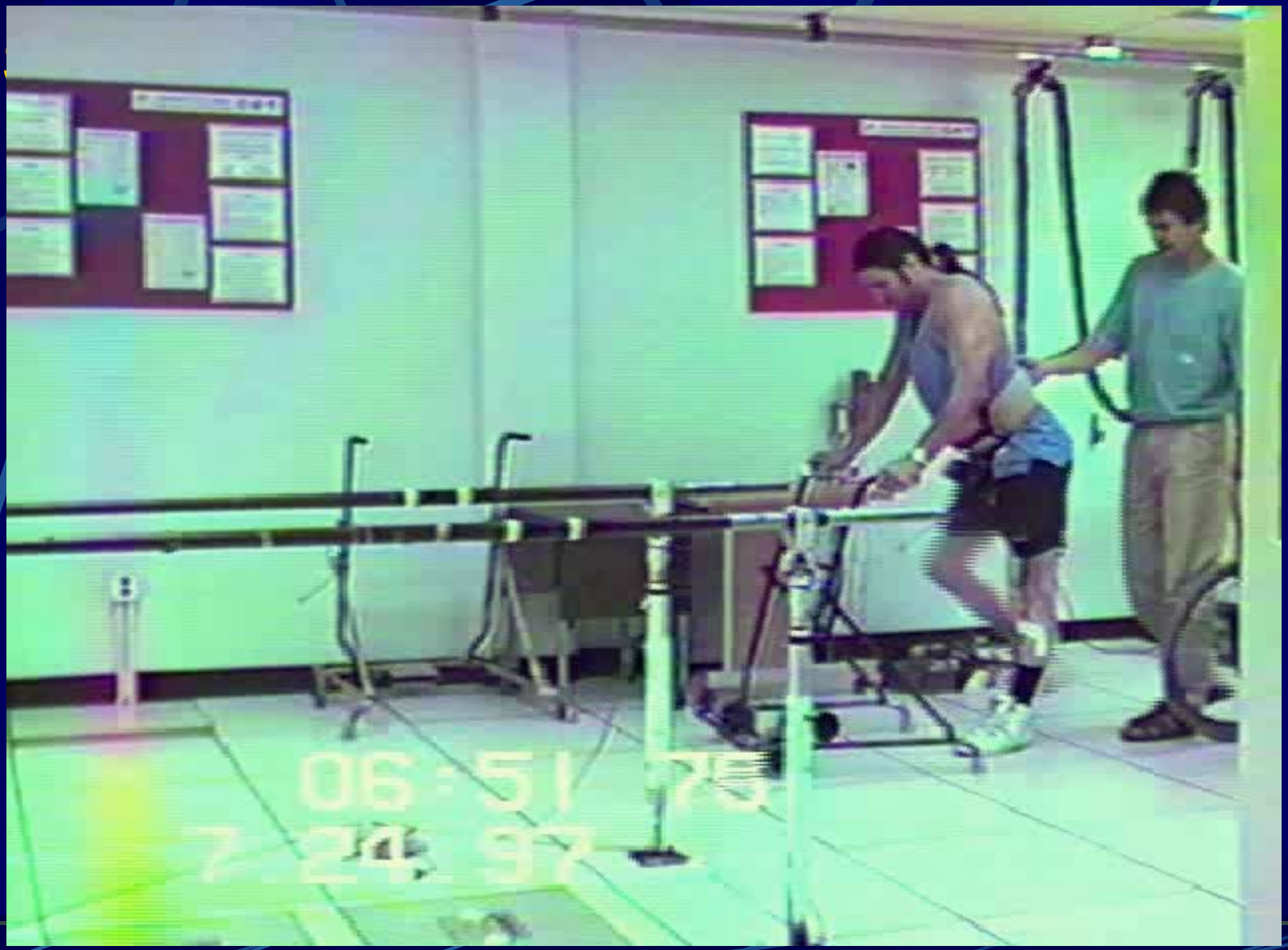
- Age: 38
- Injury Level: T-7
- Time Post Injury: 16
- Used FES for: 15.5
- System Used:
  - 15-channel percutaneous

# Subject DC

- Primary system use:
  - walking in place for cardiovascular exercise
  - electrical exercise for muscle tone
    - 18min 5x/wk
- Secondary system use:
  - transfer to RV
    - occasional

# Subject DC

- Can stand for 20 min with minimal weight on his arms
- Walks up to 100m at .4m/s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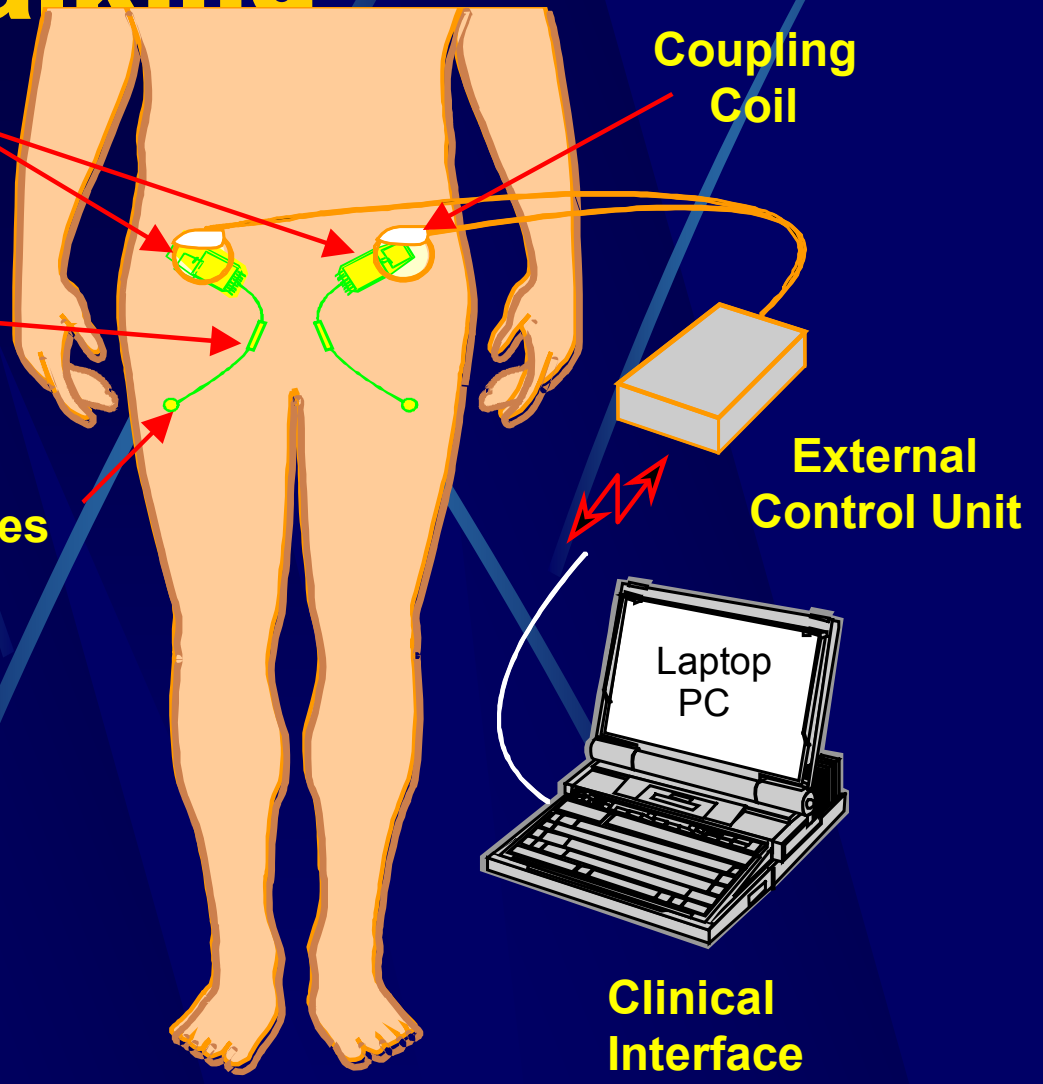
# Transfer to RV

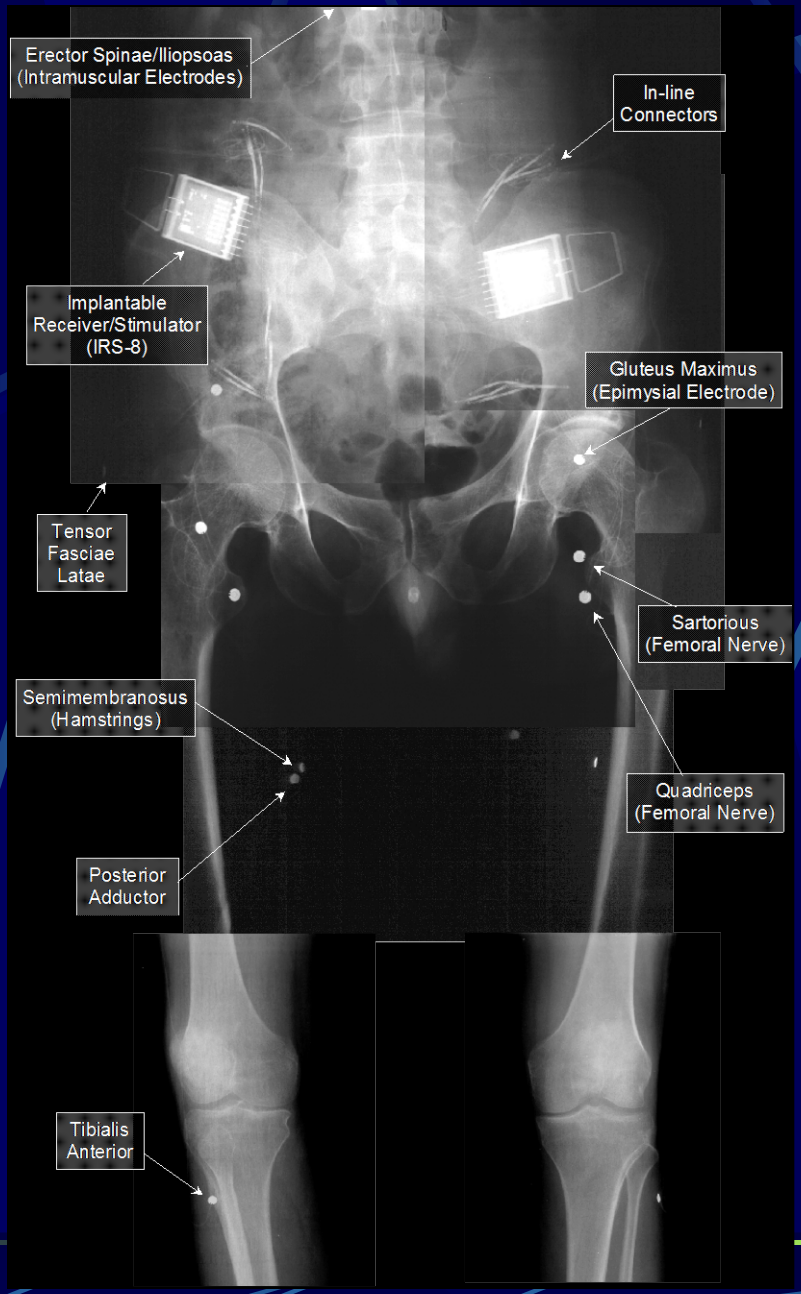
# SS's Implanted FES System for walking

Nov 18
1996




## Target Muscles:

- Vastus Lateralis
- Gluteus Maximus
- Semimembranosus
- Erector Spinae
- Iliopsoas
- Sartorius
- TFL
- Tibialis Anterior




# Subject SS with two 8-channel IRS

# Subject SS

- Age: 42
- Injury level: T-10/11
- Time post injury: 7 years
- Used FES for: 3 years
- System used:
  - two 8-channel IRS
    - 15 channels functional


AM10:23
NOV.18 1996

# Functional Outcome for Subject SS

- Stands up to 8min
  - standing limited by arm fatigue
    - arms support 25% of body weight
- Walks 20 m at 0.1m/s
  - distance limited by arm fatigue
    - forward lean 15 to 30 degrees
- Useful for exercise and short distance walking

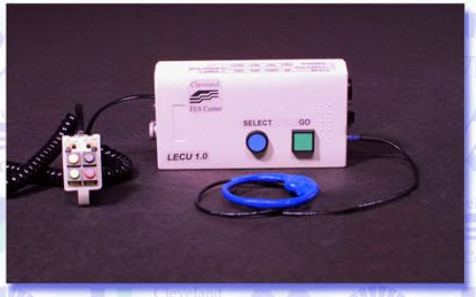
# FES Use in Subject SS

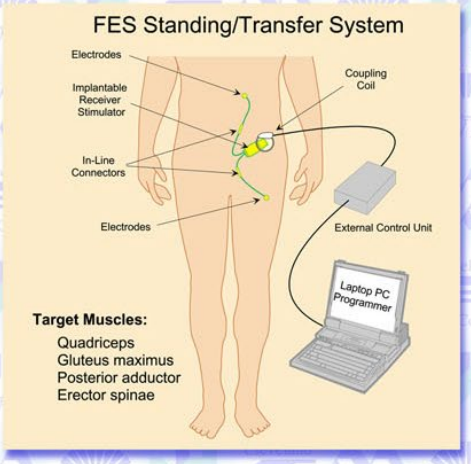
- System use for exercise standing and walking
- Claims FES reduces spasticity and makes him feel healthier

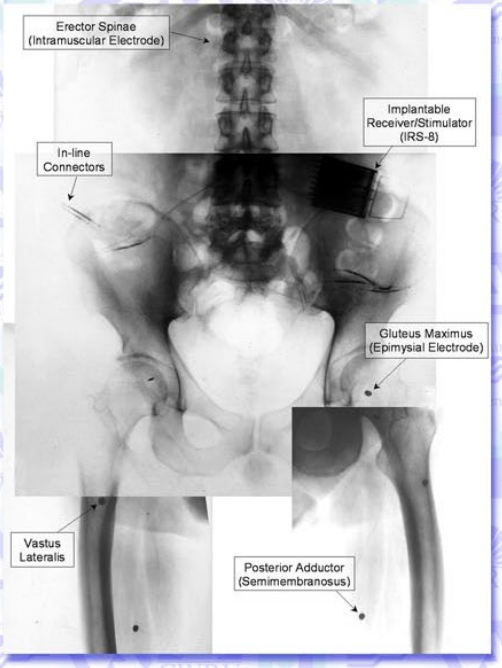
# Standing & Transfer

- 8 channels

- Quadriceps
- Glutius Maximus
- Posterior Abductor
- Erector Spinae





PM 4:01
NOV. 25 1998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NOV. 25 1998

# Current research

- Improve the reliability of epimysial and intramuscular electrodes in lower ex.
- Improve implantation technique for intramuscular electrodes
- Improve surgical technique for iliopsoas implantation
- Make Hybrid system  and controlled joint lock design practical like a BK prosthesis

# Summary

- We believe we have demonstrated the feasibility of significantly augmenting function in selected SCI patients with FES.
- The current goals are:
  - Minimize the surgical experience
  - Maximize function
  - Maximize system durability

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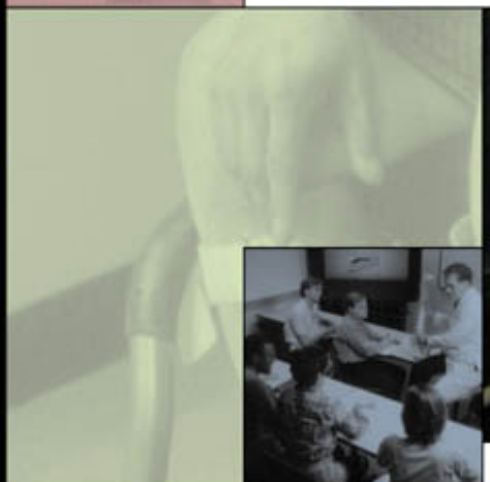

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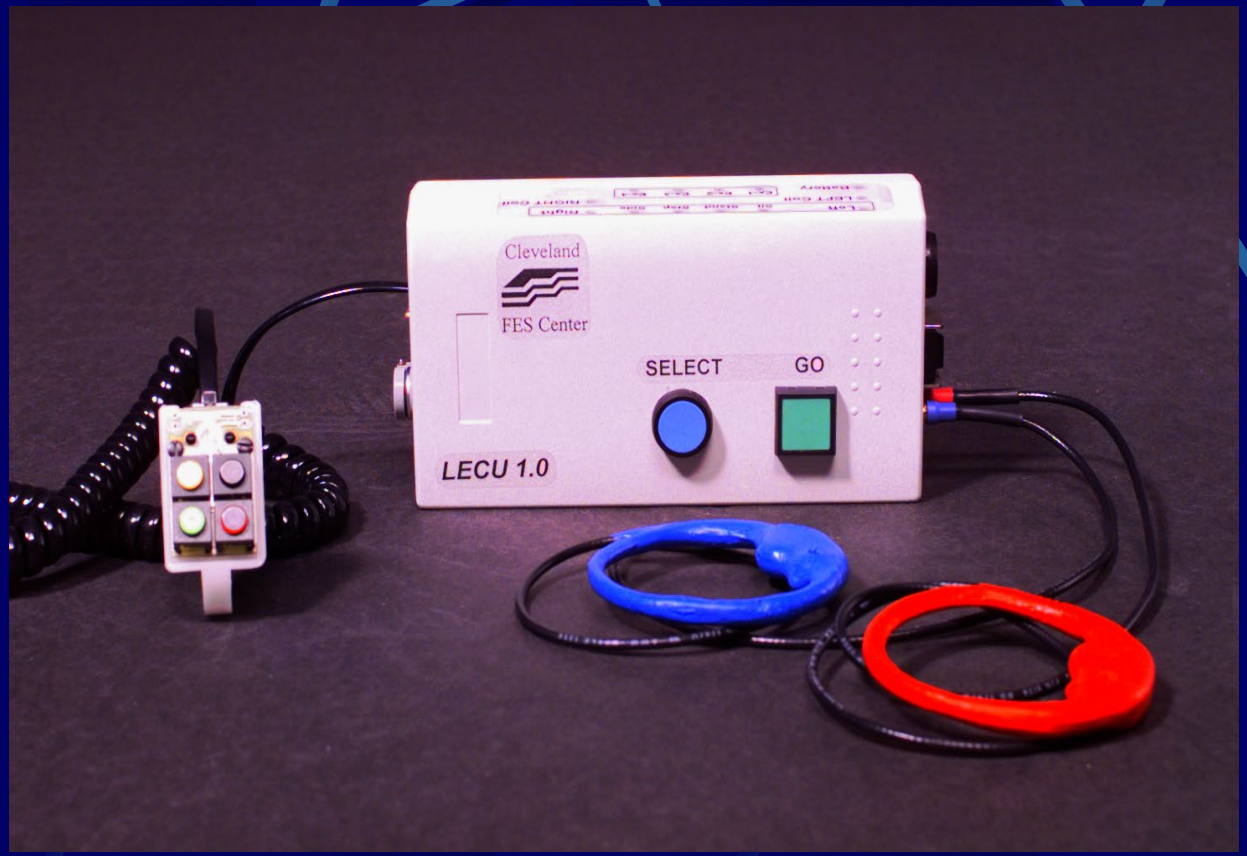
# External components




Portable External Control Unit (ECU), Command Ring & Transmitting Coils


Charger & AC Adapter

Supplemental Battery Pack


DISC 01