JAXA’s Countermeasure Technology R &D

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JAXA
1) Onboard studies
   • JAXA Holter ECG
     (• Bisphosphonate study, collaboration between NASA and JAXA)
2) Selected by international AO (2010)
   • Hybrid training
   • Artificial gravity with ergometric exercise
3) CMT candidate
   • KAATSU training
4) Related Items
   • Space Gym Suit
JAXA Holter ECG System is used for Biological Rhythms experiment to monitor cardiovascular and autonomic function of station astronauts.

The system is the commercial medical equipment by Fukuda Denshi.

**ECG**
- channels: 2ch, 3ch
- Recording: 24 hours
- Sampling Frequency: 125Hz

**Recorder**
- (W)65 X (H)62 X (D) 18 mm
- 78 g
- AAA Alkaline Battery x1

**Components**
- Multi Media Card 64MB
- Electrode

**Software**
- SCM-510 Holter Software
Cardiovascular reconditioning and biological rhythm disruption are induced by space flight and living in south pole, and they are closely related to autonomic function.

24 hours ECG to monitor
1) Arrhythmia
2) ST change
3) Autonomic function
   for space flight and
   antarctic mission

Monitoring for Japanese
wintering party in the Antarctic

Collaboration with
Japan National Polar Research Institute
Hybrid Exercise
utilizing the force generated by an electrically stimulated antagonist to resist the motion of a volitionally contracting agonist

Flexion
- Joint Motion
- Agonist: Volitional Concentric Contraction
- Load: Electrical Stimulated Eccentric Contraction
- Antagonist: Electrical Stimulation

Extension
- Joint Motion
- Antagonist: Electrical Stimulated Eccentric Contraction
- Load: Volitional Concentric Contraction
- Agonist: Electrical Stimulation

Concept
Dumbbell-like exercise is possible without dumbbell
Dumbbell-like exercise is possible in microgravity

(from Prof. Shiba, Kurume University, JAPAN)

Upper Extremity

1) Hybrid ex group  n=6
2) Isotonic exercise group (IE) group n=6
3) Electrical stimulation (ES) group n=6

Exercise Program

Hybrid and ES Groups
8 weeks
3 times a week (Monday, Wednesday, Friday)
10 sets/day (1 set: 45 deg/sec  elbow curl 10 times)
15 min 40 sec including 1 min rest between sets
6 min 40 sec without rest interval

Stimulation electric current
80% of maximal comfortable electric current
(20-25% MVC of isometric contraction)

Isotonic exercise
40% MVC (dumbbell)

Cross section of upper arm

(from Prof. Shiba, Kurume University, JAPAN)
Lower Extremity

1) Hybrid ex group  n=12
2) Isotonic exercise group (IE) group n=12

Exercise Program
Hybrid Group
- 6 weeks
- 3 times a week (Monday, Wednesday, Friday)
- 10 sets/day (1 set: 45 deg/sec knee flex & ext 10 times)
- 15 min 40 sec including 1 min rest between sets
- 6 min 40 sec without rest interval
- 3 min 20 sec stimulation in each muscle

Stimulation electric current
- 80% of maximal comfortable electric current
  (20-25% MVC of isometric contraction)

Isotonic Group
- 40% MVC

(from Prof. Shiba, Kurume University, JAPAN)
1. Simultaneous exercise of both agonist & antagonist.
2. Deep layers of muscle can be activated by volitional contraction.
3. Electrically stimulated eccentric contraction produces 50% more tension than that produced by concentric with the same electric current.
4. Longitudinal loads are applied to bone.

(from Prof. Shiba, Kurume University, JAPAN)
Artificial gravity with ergometric exercise

- Dr. Iwase (PI) and international team
- The most challenging proposal
- Selected by international AO in 2010 (ISLSWG)
- Need international cooperation
Future KAATSU Training as CMT Candidate

Specially designed pressure tourniquet

Resistance Exercise with vascular occlusion
(“KAATS” training™ patented by Sato)

Elbow flexion exercise
pressure: ~110 mmHg
Intensity: 30-50% 1RM
Volume: ~15 reps.
Frequency: 2 / week
Period: 4 months
Subject: 60 years-old female
Mean pressure: ~110 mmHg
Exercise regime: Dumbbell curl
30-50%1RM X 15 reps X 3 sets,
2/week, 4 months

*P < 0.05

Increase in mean strength after KAATSU training

Muscular hypertrophy induced by KAATSU training

(from Prof. Ishii, Tokyo Univ.)
Prototype of KAATSU belts and pressure controller

(From Mr. Yamazaki, JAMSS, Tsukuba)
New space gym Suit

- antibacterial, odor free, seamless, ventilation able, absorb sweat, dry quickly
- Collaboration with Tokyo Women's University, TORAY, Goldwin