Physical therapy

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PHYSIOTHERAPY – PHYSICAL THERAPY

Physiotherapy: treatment with „natural energies”

Physical therapy: treatment with pure physical methods

PHYSIO THERAPY

Physiological effect:

Local:

- hyperaemia
- anti-inflammatory
- muscle strength enhancement

Reflectoric:

- pain management
- motion-coordination
- muscle-relaxation
- specific effects

Meltzack & Wall: Gate-control theory

- competitive peripheral input
- downstream central control

PHYSIO THERAPY

General indication:

- prevention (e.g. gymnastic)
- specific treatment (e.g. D-vitamin intake, PUVA)
- rehabilitation (e.g. post op.)
- symptomatic treatment (e.g. pain management)

Who can conduct it?

- physiotherapical specialist (MD)
- physiotherapical nurse
- gymnastic nurse

Effect of late/no physiotherapy:

- increasing pain
- contractures, immobility
- chronic muscle weakness
- organic side-effects...

PHYSIO THERAPY

AREAS of PHYSIO THERAPY

* GYMNASTIC
* PHYSICAL THERAPY
  - Electrotherapy
  - Mechano therapy (US)
  - Fototherapy (UV, IR, laser)
  - Thermotherapy (Heat, Cold)
  - Hydrotherapy
* CHEMICAL ENERGIES
  - Balneotherapy
  - Inhalation
* OTHERS
  - Climate-therapy
  (-Diet)
### Electrotherapy

**Ancient Rome:** Paralytic children were treated with electric rays.

Scribonius Largo (Roman doctor): Headache, hysteria treated with electric fishes ("electroshock").

Galvani (XVIII c): Frog muscle contract for electric stimulus.

1900s: Galvan-therapy, hydrogalvan-therapy.

Selective electric stimulation.

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#### Low frequency treatment

**Generator circle:** (70-90 V, max 60 mA)

**Therapeutic circle:**
- Electrodes (point, field, vacuum)
- Bipolar (different sizes: active-inactive)
- Conductor material (texture, oil)

**Current direction:**
- Longitudinal (anode to cathode)
- Transversal

**Localizations:**
- Transregional
- Neural
- Ganglial
- Segmental

**Side effects:**
- Electric burn (less painful, slower recovery)
- Skin necrosis

**Physiological effects:**
- Motoneuron: upstream treatment ⇒ threshold ⇒ sensitivity
- Sensory neuron: downstream treatment ⇒ threshold ⇒ (anesthetic effect)
- Hypoesthesia, recanalization: ischemic tissue pain

**Indications:**
- Before selective muscle stimulation (decreased sensitivity)
- Pain management: nerve, muscle (downstream or transversal)
- Different pains, arthritides (neuralgia, neuritis, myalgia, tendinitis)
- Recanalization: bone fracture
- Calcium-electrolysis: iv Ca, facilitate the entry into bones

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**Hydrogalvan-treatment (Galvanic bath):**

1. Full body electric bath
   - Low current density (large surface, 600-1000 mAh)
   - Slow increase/decrease, patient should not stand up quickly
   - Bath ingredients (increase conductivity)

2. Partial electric bath
   - Four limb bath

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**Schematic Action Potential**

- Membrane potential:
  - Resting potential: -70 to -90 mV
  - Threshold potential
  - Depolarizing phase
  - Hyperpolarizing phase

**Biological effects:**
- Vasodilatation in deep arteries: soften thrombus
- Decrease sympathetic tone
- Temperature increase

**Indications:**
- Patellar reflex, vasodilatation, enhance circulation, anti-inflammatory (degenerative illness, RA)

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**Iontoforesis**

- Conductance: point, field, vacuum

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**Living organs:**
- Electrolytes
- Plasma membrane: isolator
- Frequency-sensitive
Iontophoresis
Introduction of medicine into the skin via electric current

Biological effect:
- iontophoretic effect: active, passive
  - active effect: current intensity
  - passive effect: mobility of ions (MW)
- local – generalized effect: sc. depo → capillaries → circulation
- duration of effect

Advantages:
- lower dose of medicine
- local effect
- non-invasive, no infection
- if no other method available for drug intake

Disadvantages:
- no exact quantification

Cathophoresis (+pole): hyaluronic acid, actinomycin, steroid, lidoceain
Anoforesis (- pole): potassium iodide, non-steroid gels

Electrophoresis

Electrotherapy
Low frequency treatment

Impulse current (1-100 Hz, alternating current)

TENS (Transcutaneous electric nerve stimulation)
stimulate the nociceptively sensitive neurons only

- pain sensitive, demyelinated neurons inhibited
- 80-100 Hz, 50-500 µs - paraesthesia
- no contraction
- 2-10 Hz: acupuncture-like feeling

Indication: wide range of pain relief, use at home

Electromyography

Technical data:

- current (rheobase)
- duration of stimuli (chronaxia)
- refactor period
- accommodation

Therapeutic techniques:
- Direct stimulus: electrodes between muscle origin and end
- “breakthrough”: antagonist muscle contraction
- Indirect stimulus: neuron stimulation

Therapeutic aims:
- only the chosen muscle contracted
- strong but painless contraction of degenerated, atrophic muscle
- metabolism enhanced
- protect inactivity atrophy
- nerve injury regeneration (indirect stimulus)
- prevent contractures
- bladder atony (incontinence): exogen – endogen stimuli
- rectal incontinence

Long treatment (2-6 months, congenital arm paresis: 18 months)
Forster stimulation: “exogen” electric stimulus + “endogen” stimulus
(self-control, biofeedback)
### ElectrOTHERAPY

#### Middle frequency treatment

1. **Nemec-type treatment**
   - Two crossed circles, 4000, 4250 Hz, current under threshold
   - Interference: flutterimpulsus, modulation frequency
   - Skin receptors less stimulated (less current-feeling)
   - Deeper effect (no erythema)
   - Prevent nerve fiber accommodation

2. **Amplitude modulation**
   - Two electrode stimulation
   - Amplitude change according to nerve depolarization
   - Frequency-difference: different biological effect

#### Highfrequency treatment

Effect:
- MHz range
- No direct contact with skin
- Endogenous heat production (no current feeling)

**Diathermy**
- Subcutaneous, deeper heat production
- Produced by: radiofrequency, microwave, ultrasound
- Therapy: painkilling, spasmolysis

**Shortwave condensator-field treatment**
- Treatment in condensator-field (no radiation): body as a dielectric isolator
- 10 MHz: no ion motion
- Fieldforce current producing
- Vibrational force of electrons are converted into heat

**Biológical effect:**
- (depends on: distance, intensity, tissue-type)
- Vasodilatation, hyperaemia, ischaemia decrease
- Metabolism, circulation enhancement
- Neuroendocrin reflex: enhanced endocrinal activity
- Pain receptor threshold, analgetic effect
- Spasmolysis, soften collagenfibers
- Oedema, fluid absorption

**Therapy:**
- Orthopedic illness
- Inflammation
- Electrocaution (radiosurgery):
  - Coagulation, cutting, haemostatic

### PHOTOThERAPY

#### Sunlight therapy (heliotherapy)

- Indication: dermatologic disease, bone, joint fibrosis
- Contraindication: cardial decompensation, fever, hypertension, photosensitivity

**Infrared radiation**
- Shortwave IR (780 nm – 1400 nm)
- Penetration: 0.5-1 cm
- Biological effect: endogenous heat production, erythema, pain relief (head zones)
- Consensual reaction (contralateral vasodilatation)
- Decrease sympathetic tone

**Therapy:** sinusitis

#### Ultraviolet radiation

- Wavelengths: UV-A: 400-315 nm
- UV-B: 315-280 nm
- UV-C: 280-200 nm
- Biological effects: depends on wavelengths + intensity + exposition time
  - UV-A: skin pigmentation
  - UV-B: erythema, Type burn, hyperaemia, D3-vitamin production from ergosterin, metabolism enhancement
  - UV-C: disinfection
- **Therapy:** local
  - Generalized: PUVA (psoralen + UV-A): psoriasis, ekzema
  - Rachitis prevention: D-vitamin production
- Side effects: phototoxicity (eye, skin), photocarcinogen (skin), photosensitizer drugs (steroid, tetracyclin)

**Polarized light**

- Bioptron lamp: polarized visible light + infrared (UV filtered)
- Effect (empiric): pain relief, chronic inflammation, wound healing, depression

#### POLARIZED LIGHT

- Brewster’s law
- Brewster angle

\[ \theta_B = \text{Brewster angle} \]
ULTRASOUND-THERAPY

**Ultrasound**
- Production: inverse piezoelectric effect
- Longitudinal wave
- Mechanical wave: direct contact with tissues (reflected on air surface)
- Medical frequency range: 0.8 – 3 MHz

**Features:**
- Frequency: high – absorption in surface layer, effective therapy
- Low – deep effect (energy transfer less effective)
- Propagation speed: tissue acoustic impedance

**Effects:**
1. Mechanical effect: tissue compression – dilatation (cavitation)
2. Endogenous heat production: order of heating – bone > muscle > skin > viscera > fat
3. Depressing effects: aerosol therapy, inhalation
4. Chemical effects: oxidation, enhanced chemical reactions
5. Biological effects: hyperaemia, heat production – vasodilatation – O2 distribution better – skin regeneration
- Painkilling, micromassage – fibrinolysis, spasmolysis

**Specific ultrasound therapies**
- Sonophoresis: medicine introduction with US
- ATDD: Acoustic targeted drug delivery
- Focused ultrasound surgery
- MR associated
- ESWL - extracorporeal shock-wave lithotripsy (Urology)

THERMOTHERAPY

**Heat-effect**
- Vasodilatation, hyperaemia
- Muscle tone decrease
- Anti-inflamatory

**Cold-effect**
- Vasorestriction
- Vasospasmolytic
- Anti-inflamatory

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Effect</th>
<th>Pain stimulus</th>
</tr>
</thead>
<tbody>
<tr>
<td>35 °C</td>
<td>Indifferent skin temperature</td>
<td></td>
</tr>
<tr>
<td>40 - 42.5 °C</td>
<td>Heat signal (Ruffini body)</td>
<td>Heat stimulus</td>
</tr>
<tr>
<td>32 - 16 °C</td>
<td>Cold signal (Krause body)</td>
<td>Cold stimulus</td>
</tr>
<tr>
<td>18 °C</td>
<td>Analytic effect: receptor inhibition</td>
<td>Pain stimulus</td>
</tr>
</tbody>
</table>

**Heat-effect:**
- Sudden, quick heat: primary vasoconstriction, secondary vasodilatation, reactive hyperaemia
- Gradual heat: vasodilatation
- Enduring heat: vasoconstriction in deep blood vessels, hypotonia, collapse, shock

**Cold-effect:**
- Sudden, quick cold: primary vasoconstriction, secondary vasodilatation, reactive hyperaemia
- Enduring cold: vasoconstriction in surface vessels

**Consensual reaction** (contralateral effect)
### THERMOTHERAPY

**Heat therapy**

**Heat conduction:**
- Fomentation (heat pack)
- Paraffin: slow heat transmission, 60-70 °C, picks up the body’s shape, indication: joint inflammation

**Heat stream:**
- Hot air chamber: full-body heat effect, 60-80 °C
  - CNS heat central ➔ sweating
  - Vasodilatation ➔ hypotonia ➔ heat-stasis ➔ blood pressure increase, circulation enhanced
  - Indication: increase condition, give up weight
- Humidity chamber: 60-70 % humidity, sudden straining for the body

**Heat radiation:**
- Sauna: increasing heat, sudden cold, very strong, straining effect, enhance circulation
  - Sun, IR, microwaves, US, high frequency current...

### THERMOTHERAPY

**Cryotherapy**

Local cryotherapy:
1. Short cold stimulus: freezing with Chloro-ethyl, ice
   - Sudden heat drain ➔ quick cool down ➔ fast heat-up
   - Short vasoconstriction, longer vasodilatation
2. Long-term cryotherapy
   - Cold pack
   - Cryogel
   - Liquid nitrogen

(-110 °C to -160 °C)

Full body cryotherapy:
- Liquid nitrogen chamber

**Indication:** post traumatic pain relief, contractura pre-therapy, sclerosis multiplex

### HYDROTHERAPY

**Physical parameter of water:** temperature
- Buoyancy: active motion with lower muscle force
- Hydrostatic pressure: oedema absorption
  - Surface vein compression, enhanced deep vein circulation

**Hydrotherapeutic types:**
- Watery pack (hot/cold)
- Bath therapy (cold, hot)
- Contrast bath (hot-cold immersion)
- Shower treatment (massage)
- Carbonic acid bath (stimulate breathing)
- Weight bath: stretch spine, unload nerve roots

**Bathotherapy (spa):** chemicals

### SUMMARY

**Physical stimulus**
- Mechanic (massage, US)
- Electric
- Temperature (hot, cold, infrared)

**Physiological effects:**
- Local or reflecting stimulation
- Stimulate circulation, hyperaemia
- Depress pain

**Therapeutic effects:**
- Pain relief, enhanced circulation
- Anti-inflammatory