Equine Aquatic Therapy

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Claims

• Reduced weight bearing of 40-100%
• Reduced impact on limbs
• Soft tissue mobilization
• Modulation and reduction of pain
• Joint decompression
• Reduction of friction between articulating joints
• Hydrostatic pressure to assist blood and reduce swelling

Claims

• Reduced recovery time by 50-60%
• Improved performance
• Accelerated conditioning
• Encourages muscle development
• Increases cardiovascular fitness
• Improves flexibility
• Promotes correct posture and a balanced gait
• Minimizes performance injuries
Aquatic Therapy

- Buoyancy effects – 0 to 100%
  - Reduced weight bearing > Increased mobility
- Hydrostatic pressure
  - Increased pressure on skin > Stimulate mechanoreceptors > Reduced pain
- Viscosity
  - Increased resistance > Increase strength and endurance
  - Increased sensory awareness
- Thermal effects
  - Heat > Vasodilatation
  - Increased BP > Increased circulation

Buoyancy

- Unweighting tendons or joints within the distal limb
- Reduced ground reaction forces – reduced concussive stresses on joints and tendons
- Allows exercise without further trauma induced by weight bearing or concussive forces
- Reduced body weight decreases postoperative and convalescent complications
- Reduces contralateral limb complications, such as laminitis associated with increased compensatory weight bearing


Olecranon
10.5% (± 1.8) weight reduction

Distance: Above Olecranon
31.3% (± 2.4) weight reduction

Distance: Olecranon to Withers
53.8% (± 3.4) weight reduction
Distance: Below Withers

75.2% (± 2.0) weight reduction

Distance: 4-6 cm Over Withers

100% weight reduction

Hydrostatic Pressure

- Immersion causes water displacement and increased hydrostatic pressure
- Redistribution of blood flow from the peripheral limbs into the intrathoracic circulation
- Increased circulating plasma volume via fluid through the capillary walls
- Decreased hemoglobin and hematocrit level within 25-60 minutes of water immersion in humans

Viscosity

- Viscosity — Resistance of a fluid to motion
  - Low viscosity with slow movement
  - Increased resistance at higher speeds
    - Due to increased turbulence and drag
- Turbulence — Irregular flow
- Forms wakes and eddies
- Hydrojets
  - Aerate water
  - Provide increased drag or resistance on limb motion

Mechanical Massage

- Primarily effects of Hydrojets on limbs and body surfaces

Water Temperature

- Maximize comfort
  - For active exercise and swimming — 65° to 75° F
  - Less vigorous exercise — 90° to 104° F
- The least adverse physiologic effects occur at 97° F
- UT — 82° F
Water Temperature

- Minimize Homeostatic stress
- Changes in blood constituents were less at 99° to 104°F
  - Than immersion in 104° to 109° F or in 109° to 113° F
- Increased water temperature causes increasing peripheral circulation and perspiration
- Responses induced by cold are mainly due to increased sympathetic nervous activity


Mechanisms of Action

- Minimal controlled data is available to document the benefits of aquatic exercise
  - Buoyancy
  - Reduced pain
  - Flexibility
  - Motor learning
  - Resistance – Strength, conditioning
  - Cardiovascular effects
  - Mechanical massage

Reduced Pain

- Reduced joint loading
- Exercise effects on reducing pain
- Increased range of joint motion
- Thermal effects – hot or cold
- Mechanical massage
Flexibility – Range of Joint Motion

- Increased range of joint motion in both fore and hind limbs
  - Re-establishment of joint range of motion after joint surgery is a significant contributor to return to function
- In dogs, increased flexion and ROM during swimming compared to walking in both normal and operated stifle joints post-CCL surgery
  - The increased ROM was due to increased joint flexion
  - Ground treadmill walking produces greater stifle extension than swimming


Joint Flexion/Height & Water Height

- Height of water will effect degree of joint flexion
- May be used to target specific joints
- Once level of carpus is reached joint flexion and limb height very little

Hoof Level Carpal Level
Motor Learning

• Underwater Treadmill
  – Produces controlled exercise
  – Produces a symmetrical gait
  – May reduce gait abnormalities of high-speed treadmill due to slower and more controlled speed
  – Differences in passive gait associated with treadmill versus over-ground locomotion

• Swimming
  – Uncoupling of respiratory cycle and limb patterns during swimming


Normalized Gait Patterns

• In dogs, post-CCL surgery
  – Higher peak vertical forces and vertical impulses 6 months after surgery, compared to no rehabilitation


Muscle Development

• 18 two-year old TB’s, over 5 months of race training
  – A – Walk, trot, canter, gallop only
  – B – Running plus incrementally increased swimming
  – C – Running plus constant level of swimming

• Race training group
  – No significant changes

• Swimming groups
  – Fast twitch, high oxidative fibers increased
  – Increased aerobic capacity of muscles
  – Fast twitch, low oxidative fibers decreased
  – No change in slow twitch fibers

Training – Musculoskeletal Injuries

- A race training program that includes swimming
  - Improvement in performance capacity
  - Reduced locomotor disease (tendonitis) in 2-year-olds in training
  - Allow for a smooth progress in future training
- Incidence of musculoskeletal injuries
  - Five of 8 (62%) (that were recurrent) with race training only
  - One of 8 (12%) with race training and progressive swimming exercise


Strength – Resistance Training

- Water density is 12 times greater than air
  - Increased resistance to limb or body movement
- Increased energy costs compared to walking at similar speeds on land
- Maintenance of muscle development and muscle tone due to working against resistance
- Provides better balance of muscle groups working against increased resistance while maintaining a symmetrical gait


Autonomic Nervous System Effects

- Immersion bath in humans
  - Decreased vasomotor tone
  - Reduced cardiac sympathetic activity
- Immersion in warm spring water in horses
  - Increase in parasympathetic (vagal) activity may provide a means of relaxation

Cardiovascular Effects

- Aerobic exercise helps develop cardiovascular fitness
- Heart rates
  - Increased up to 130-180 beats/min
  - Lower heart rates than during ground exercise
- Increased mean arterial pressure
  - Changes in blood pressure by immersion are not uniform


Cardiovascular Effects

- Decreased systemic vascular resistance
- Changes in total peripheral resistance dependent on water temperature
- Increased cardiovascular benefits while working at slower speeds
- No relationship between heart rate and duration of swimming
- Stimulate cardiovascular function with reduced weight bearing and stress on limbs

Galloux P, et al. The Equine Athlete 1994; 7: 10-14

Hematology

- Blood lactate levels
  - Increased up to 3.8 mmol/l
  - Average increase 1.3 mmol/l
  - Normal 0.4 mmol/l
- Hematocrit
  - Increased up to 57% in horses (normal 42%)
  - Decreased 4% in humans

Galloux P, et al. The Equine Athlete 1994; 7: 10-14
Respiratory Function - Swimming

- Water pressure on the horse’s body during swimming prevents adequate ventilation
  - Alteration in lung volume > Increased intrapulmonary pressure > Altered lung mechanics > Altered pulmonary circulation and tissue volume > Changes in regional lung perfusion > Pulmonary air trapping (emphysema)


Respiratory Function - Swimming

- Respiratory rate
  - Increased up to 30/min (normal – 10/min)
  - Cool down: 50-60/min
  - Locomotion on dry land: 100/min
- Inspiratory pressure
  - Increased up to 4.5 kPa (normal 0.5 kPa)
- Expiratory pressure
  - Increased up to 5.1 kPa (normal 0.5 kPa)
- Ventilation
  - Duty ration (time inspiration/expiration): 
    - No change at 0.33; expiration is twice as long as inspiration
    - Cool down at 0.5
    - Land exercise at 0.5


Respiratory Function - Swimming

- Venous and arterial blood gases
  - pHa – Reduced to pH 7.28 (normal 7.36)
  - PaO2 – Reduced to 90 (normal 114)
  - PaCO2 – increased to 51 (normal 41)
- Pulmonary arterial temperature
  - Increased to 39.0º C (normal 37.5º C)
- Water immersion can cause airway closure during tidal breathing
  - Low ventilation-perfusion ratios
  - Hypoxemia

Aquatic Therapy for Horses

- Underwater treadmill
- Swimming

Safety Considerations

- Horses are not natural swimmers
  - May panic and attempt to climb/jump out of the unit
  - Often cannot breathe or swim efficiently (swimming)
  - Induce excessive lordosis, which may induce back pain or muscle soreness (swimming)
  - Stifle injuries due to exaggerated kicking motion (swimming)
  - Drowning (swimming)
- Reconditioning of muscles or cardiovascular or mental status prior to full skeletal recovery
  - Increased risk of over-eager horses that produce more forces than bones, joints, ligaments or tendons can withstand
  - Increased risk of catastrophic musculoskeletal injuries 30-60 days after return to work if only work in water
  - Transient osteoporosis

Rehabilitation Goals

- Decrease pain
- Reduce lameness
- Reduce joint effusion
- Improve coordination, balance & core stability
  - Muscle re-education
- Restore joint mobility
- Increase limb strength
- Improve endurance
Underwater Treadmill

Underwater Treadmill Exercise

• Uses
  – Hydrotherapy
  – Rehabilitation
  – Conditioning
• Combined effects
  – Treadmill
  – Swimming pool
  – Whirlpool

Indications UW Treadmill

• Rehabilitation after injury or surgery
• Tendon injuries
  – Suspensory desmitis, etc
• Post-arthroscopic surgery
  – Replacement for hand walking
• Non-displaced fractures
• Joint stiffness, osteoarthritis
• Increase in muscle development
  – Encourages symmetric gait and back development
• Cardiovascular conditioning
  – Reconditioning after a lay-up
Contraindications – UW Treadmill

- Acute joint inflammation
- Skin infections
- Open wounds
- Upper limb lameness – Made worse with swimming
- Acute myositis
- Cardiovascular compromise
- Respiratory disease

Protocol Variables

- Injury and condition of patient
- Water level (above ground units)
  - Amount of buoyancy and limb weight bearing
  - Degree of joint flexion desired
- Water temperature
- Warm versus cold
- Treadmill speed
- Hydrojets – On or off
- Warm up period
- Duration of exercise – 5-20 minutes
- Cool down period
- Exertion during exercise
- Frequency of exercise

Initial Assessment

- Gait and performance evaluation
  - Straight and circle
  - Ground surface – hard, soft, deep, shallow
  - Walk, trot, canter, gallop
  - In-hand
  - Athletic activities
  - Lameness Locator
- Flexion Tests
- Palpation
  - Bone, joints, muscle, tendons, ligaments, subcutaneous
- Diagnostic imaging
UT Rehabilitation Program

• Acclimation period (1-2 days)
  – Walk in and walk out of underwater treadmill
  – Walk in, turn on treadmill, stop treadmill, walk out
  – May use sedation during acclimation if needed

UT Rehabilitation Program

• Begin rehabilitation program (Days 3-7)
  – Speed – walk at 2 -3 mph
  – Warm up – 5 minutes
  – Duration - 5 minutes
  – Cool down – 5 minutes
  – Frequency – Once per day
  – Rinse and dry off
• Outcome measures
  – Walking comfortably for 15 minutes duration @ 2 -3 mph
    • If successful proceed to next level

UT Rehabilitation Program

• Week 2
  – Increase duration of walk up to 10 minutes (20 total)
    • May increase speed
• Week 3
  – Increase duration of walk up to 15 minutes (25 total)
• Week 4
  – Increase duration of walk up to 20 minutes (30 total)
• Week 5
  – Maximum exercise intensity of 5 mph for 20 minutes (30 total)
    • May introduce cross-training activities (not sets)
• Warm up and cool down for each session
  – At least 5 minutes each at 2 mph
Post-Treatment Assessment

• Gait and performance evaluation
  – Straight and circle
  – Ground surface – hard, soft, deep, shallow
  – Walk, trot, canter, gallop
  – In-hand
  – Athletic activities
  – Lameness Locator weekly
• Flexion Tests
• Palpation
  – Bone, joints, muscle, tendons, ligaments, subcutaneous
• Diagnostic imaging

UT UnderWater Treadmill

Above Ground Units
Hudson - Aquapacer

- Unit 12’ long x 5’ wide
  - Covers about 12’ x 12’ floor space
  - Filled weight – 9300 lbs
- Control panel
- Treadmill belt lock for loading and unloading
- Direct drive motor – 1 to 11 mph
- Water storage chamber
- Filtration and heating
- Costs
  - Unit – approx $100,000
  - Installation - $1500-2000
  - Sales tax and shipping costs

HydroHorse, LLC – Hydro Ciser

- Unit – 13’ long x 13’ wide x 4’ (5”) tall
  - Up to 46” water height
- Roller-less belt, variable speed
- Shallow reservoir tank, filters, heater, jets
- Ground level entry
- Cost
  - 4’ tall - $53,000
  - 5’ tall - $58,000
  - Does not include 13’ x 13’ concrete pit

In Ground Units
HydroHorse LLC – Model 101A

- In ground, pre-plumbed
- 10’ treadmill in 46’ fiberglass spa
- Water heater, 2 filters, 12 Jacuzzi jets
- 2 skimmers
- 10 HP hydraulic supply
- Costs
  - Treadmill: $65,000
  - Installation: $16,000
  - Freight: $2.00/mi

HydroHorse LLC – Model 201

- In ground
- 10’ treadmill in 54’ concrete pool
- Water heater, 2 filters, 12 Jacuzzi jets
- 1 skimmer
- 10 HP hydraulic supply
- Single phase power
- Costs
  - Treadmill: $54,000
  - Installation: bid
  - Freight: $2.00/mi

HydroHorse LLC – Model 1000 Superior

- In ground
- 12’ treadmill in 56’ concrete pool
- Water heater, 2 filters, 12 Jacuzzi jets
- 3 skimmers
- 20 HP hydraulic supply
- Three phase power
- Costs
  - Treadmill: $73,000
  - Installation: bid
  - Freight: $2.00/mi
### Above-ground vs. Under-ground

#### Equipment

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#### Personnel Required

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Above-ground vs. Under-ground

- Rehabilitation and Training
  - Ease of entry and exit: +
  - Acclimatization: Yes
  - Safety exit, jump out: +
  - Visualization of limb movement: Yes
  - Ability to adjust water level: Yes
  - Higher water level: +
  - Change water temperature: Yes
  - Freedom of movement: +

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- Maintenance
  - Filter size – water quality: +
  - Water exchange rate: ++
  - Access to plumbing: ++
  - Energy usage: -
  - Access to treadmill: +++
  - Cleaning: +++
  - Waste water evacuation: +++
  - Overhead hoist: No

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Treadmill vs. Over Ground Exercise

- 7% longer stance duration of forelimbs
- Increased retraction angles of both fore and hind limbs
- Decreased protraction angles of hind limb
- Hind hoof contact after fore foot contact
  - Reversed with over ground locomotion
- 23% reduced vertical movement of withers
- Higher consistency of locomotion
  - Stride and stance duration

UW Treadmill vs. Ground Exercise

• Build and maintain musculoskeletal tissues
  – Bone, joints, muscle, tendons, ligaments
• Hand-walking rehabilitation
  – Controlled environment vs. loose in-hand
• Reduced concussion
  – Joint and tendon healing
• Resistive work
  – Muscle atrophy and development
• Variable speeds
  – Maintain and develop cardiovascular fitness

Swimming

• Horses are not natural swimmers
• Unnatural locomotion
  – High head carriage
  – Extended back – twisting motion for cornering
  – Forelimbs – regulate lateral balance
  – Hindlimbs – propulsion, exaggerated kicking motion
  – No ground contact – evolution, healing
• Resistive training
  – Hypermetria, increased range of joint motion
• Cardiovascular fitness
  – Water pressure on chest – respiratory stress

Swimming vs. Over Ground Exercise

• Loss of proprioceptive input
  – Altered proprioceptive input – Muscles, joints, tendons, ligaments
  – Altered proprioceptive processing
  – Reduced postural muscle stimulation
    • Importance of cross-training – varied ground surfaces
• Differences in muscle group stimulation
  – Swimming vs. galloping
    • Limited training benefits?
• Maximal oxygen consumption during swimming
  – Limited by the ventilatory system
  – Oxygen transport has to work harder
    • Facilitates oxygen transport development?
Swimming Pools

• Linear pool
  – 10 m long
  – Access ramps on each end
  – Swim against current

• Circular pool
  – 12-14 m diameter
  – 3-5 m deep