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“Deficit related training strategies for walking and running”

Restoring walking and running after pelvic floor insufficiency:
Assessments and therapy after urinary incontinence
A proposal of a criteria-based four-phase therapy strategy

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Introduction: Pelvic Floor insufficiency in combination with urinary incontinences is a common, but little known problem in recreational and high level sports activities (Dr Araùjo et al. 2008, BØ & Borgen 2001). Concerned persons reduce physical activity and do not benefit from the positive aspects of sports and movement (Eliasson et al. 2002, Nygaard et al. 2005).

One of the dominant sports activities is running (De Araùjo et al. 2008). Patients with bigger problems even lose urine during walking. Reasons for urinary stress incontinence could be congenital, traumatic, inflammatory, neo-plastic, degenerative, psychosomatic (Schär & Sarlos 2003, Cummings & Rodning 2000), hormonal changes (Perucchini & Tunn 2001), surgery, neurological diagnosis, age, pregnancy or childbirth (Fitzpatrick & Hearlity 2001). For high level athletes the main reasons are the high intensities of trainings and strains (high axial stresses and strains related to body weight) with or without psychological stresses (e.g. eating disorders, anxiety, accentuation of physicalness) or structural problems (e.g. relative weakness of the pelvic floor muscle fatigue at the end of the training, hypomobility or hypermobility of the arch of the foot (reduction of connective tissue and collagen structures) and reduced adipose (De Araùjo et al. 2008, Eliasson et al. 2002, Caylet et al. 2006, Nygaard et al. 1996, BØ 2004).

The following possibilities for testing and analysis are available: case history, appraisal, control of micturition and defecation, stress tests (e.g. balloon, trampoline, coughing), King's Health Questionnaire, manual (digital) muscle testing (MTT), Pad-Tests (20 min, 1 h, 24-48 h (ICS 1987)) provocation, ultrasound and vaginal electromyography of pelvic floor muscles (Kelleher et al. 1995, BØ & Finckenhagen 2001, Wijma et al. 2008).

No standardized and specific therapy concept in the treatment of pelvic floor muscles exists. Available therapeutic procedures like exercises, training methods, periodization of training, control of training with validated assessments and criteria are mainly based on practical experience rather than scientific evidence. In addition there is no measurement system in order to evaluate the specific capacity of the pelvic floor muscles in high level athletes.

Consequently, a possible criteria-based four-phase therapy strategy is presented.

Problems	Targets	Therapy methods and applications	Duration / Units	Assessments / Criteria
<ul style="list-style-type: none"> Perception of pelvic floor Recruitment of pelvic floor muscles 	<ul style="list-style-type: none"> Sensorimotor control Intramuscular coordination 	<ul style="list-style-type: none"> Intramuscular coordination training methods (if MMT ≥ 1; possibly combined with EMG-based Biofeedback or EMG-triggered electro-stimulation): <ul style="list-style-type: none"> Isolated contractions isometric or dynamic concentric (-eccentric): 1-5 reps; maximal intensity/strain/exhaustion; slow to explosive contractions; 3-5 series; 15"-1' rest between series Isolated contractions isometric: 3-5 reps each 2-4" duration; maximal intensity/strain/exhaustion, explosive; 3-5 series; 30-1 s between series Ultrasound (control of correct isolated contraction) <ul style="list-style-type: none"> Stochastic Resonance Therapy (SRT; MMT ≥ 0): vibration (6-8 Hz, 60" duration; 1' rest; 3-5 series); vibration + isolated MVC (up to 5" maximal contractions during series) Vaginal electrical muscle stimulation only (if MMT = 0): 70Hz, biphasic, low frequency, 5" Contr., 5" rest, 1".150 ms pulse length, 1' ramp Magnetic chair stimulation only (if MMT = 0) <ul style="list-style-type: none"> Sensory awareness: 10-15 Hz, 25% Gauss, 15-20", recruitment: 10-15 Hz, maximal intensity 15-20". 	<ul style="list-style-type: none"> As necessary Typically: <ul style="list-style-type: none"> 6-8 weeks 3-4/week up to daily inclusive home training = 18-40 training units 	<ul style="list-style-type: none"> King's Questionnaire Pad-Tests MMT: ≥ 0 EMG: <ul style="list-style-type: none"> Activity in general very low (few uV) Activation in standing position $>30\%$MVC Activation $>100\%$MVC during SRT not possible MVC contraction time reduced Quick flicks: contraction-time reduced, ability to relax reduced Reduced EMG baseline after MVC (relaxation) <ul style="list-style-type: none"> Median frequency ~ 50 Hz Ultrasound (control of coordination) General coordination (in complex movements)
	<ul style="list-style-type: none"> Intermuscular coordination Postural control Integration ADL 	<ul style="list-style-type: none"> Contract & relax (optionally EMG-based biofeedback) Isolated correct PFM-contractions / initial contraction (optionally. EMG-biofeedback) Integration M. transversus abdominis & M. obliquus internus & M. multifidus Complex movements: movements of the pelvis in extension and flexion, knee bending MTT: leg-press, adductor (complex movements in defined positions and under defined strains: $<30\%$ maximal strength, 5-20 reps, 2-3 series, 2' rest; with initial contraction Aqua training: aqua-jogging, walking on a treadmill (flat) 		
	<ul style="list-style-type: none"> Recommendations: standing only for a short time; slow walking short range; no heavy lifting or holding, no high impacts (> 1.1 g) 			

Phase 2: Hypertrophy / Stress tolerance				
Problems	Targets	Therapy methods and applications	Duration / Units	Assessments / Criteria
<ul style="list-style-type: none"> Hypotrophy (PFM mass) Stress tolerance 	<ul style="list-style-type: none"> Normotrophy / Hypertrophy 	<ul style="list-style-type: none"> Hypertrophy training methods: <ul style="list-style-type: none"> Isolated contractions isometric: 3-5 reps each 5-30", sub-maximal intensity, maximal strain/exhaustion, 3-5 series, 15" -3' rest Isolated contractions dynamic-concentric (-eccentric): 6-15 reps, sub-maximal intensity, maximal strain/exhaustion, slow to moderate contraction velocity, 3-5 series, 15" - 3' rest Vaginal electrical muscle stimulation: 35-50 Hz, biphasic, 5" contr., 5" rest, 150-220 ms pulse length, 1" ramp Magnetic chair stimulation: 5-10 Hz, maximal intensity, 10-15" SRT: vibration (6-8 Hz, 60", 1' rest, 3-5 series); vibration + isolated MVC (up to 15" maximal contractions during series) 	<ul style="list-style-type: none"> As necessary Typically: <ul style="list-style-type: none"> 10-12 weeks 2-3x/week inclusive home training = 20-36 training units 	<ul style="list-style-type: none"> King's Questionnaire Pad-Tests MMT: 3-5 EMG: MVC activation 90-100% constant Ultrasound (control of coordination; muscle mass of PFM)) General coordination (in complex movements under increasing load and exhaustion) Passive tone (digital stiffness test of PFM)
	<ul style="list-style-type: none"> Intermuscular coordination Postural control Integration ADL 	<ul style="list-style-type: none"> MTT (apparatus-based): Leg-press, adductor (with initial contraction) Functional gymnastics: trunk-extension with initial contraction, slight trunk flexion exonerating position Aqua training: aqua-jogging Walking on treadmill: flat, upward 		
	<ul style="list-style-type: none"> Recommendations: standing for a longer time; normal impacts during walking (up to 1.2 g), slight lifting or complex movements, holding, no high impacts (> 1.2 g) 			

Phase 3: Maximal strength				
Problems	Targets	Therapy methods and applications	Duration / Units	Assessments / Criteria
<ul style="list-style-type: none"> Recruitment Innervation frequency 	<ul style="list-style-type: none"> Intramuscular coordination 	<ul style="list-style-type: none"> Intra-muscular coordination / maximal strength training methods (possibly EMG-based biofeedback): <ul style="list-style-type: none"> Isolated contractions (1. isometric, 2. dynamic-concentric (-eccentric)): 1-5 reps; maximal intensity; maximal load/exhaustion; explosive contractions; 3-5 series; 1-3' rest Vaginal electrical muscle stimulation: 50-100 Hz, biphasic, 30" contr., 30" rest, 0,1-0,5 ms pulse length SRT: only vibration (6-8 Hz, 60", 1' rest, 3-5 series); vibration + isolated MVC (up to 15" during series) 	<ul style="list-style-type: none"> As necessary Typically: <ul style="list-style-type: none"> 6-8 weeks 3x/week inclusive home training = 18-24 training units 	<ul style="list-style-type: none"> King's Questionnaire Pad-Tests MMT: 4-5 EMG <ul style="list-style-type: none"> Activation >100% MVC at SRT not possible MVC activation 90-100% constant Ultrasound (control of coordination) General coordination (in complex movements under maximal load and exhaustion)
	<ul style="list-style-type: none"> Intermuscular coordination Postural control Integration ADL 	<ul style="list-style-type: none"> Reactive stresses and strains (e.g. mini-trampoline <u>with</u> initial contraction) MTT: Shuttle Aqua training: aqua-jogging 		
	<ul style="list-style-type: none"> Recommendations: standing as required, normal impacts in walking, slow jogging (possibly on treadmill, possibly with technical/specific coordination training, on soft grounds), normal stair climbing (up and down) or little jumps (up to 2 g), lifting or holding as necessary 			

Phase 4: Power / Power endurance				
Problems	Targets	Therapy methods and applications	Duration / Units	Assessments / Criteria
<ul style="list-style-type: none"> Innervation frequency Synchronization Reflex activity 	<ul style="list-style-type: none"> Rate of force development & Reactive force 	<ul style="list-style-type: none"> Power training methods (maximal strength reactions forces (voluntary contractions and reflex mode) <ul style="list-style-type: none"> Isolated contractions dynamic-concentric(-eccentric) and jumping (1. squatting, 2. counter movement jumps, 3. drop jumps): 4-6 reps with > 8' rest between each reps, maximal intensity, maximal explosive, 3-5 series; 1-3' rest SRT: only vibration (8-12 Hz, 60" duration, 1' rest, 3-5 series) 	<ul style="list-style-type: none"> As necessary Typically: <ul style="list-style-type: none"> 4-6 weeks 3x/week inclusive home training = 12-18 training units 	<ul style="list-style-type: none"> King's Questionnaire Pad-Tests EMG <ul style="list-style-type: none"> Activation in standing: ~ 30% MVC Baseline after MVC normal = good relaxation Median frequency ~ 60 Hz Quick flicks (high intensity & good relaxation) General coordination (in complex movements under typical loads) Endurance testing / strain testing (e.g. trampoline)
	<ul style="list-style-type: none"> Rate of force development & reactive force endurance 	<ul style="list-style-type: none"> Power training methods (maximal strength reactions forces (voluntary contractions and reflex mode) <ul style="list-style-type: none"> Isolated contractions dynamic-concentric(-eccentric) and jumping (1. squatting, 2. counter movement jumps, 3. drop jumps): 20-40 reps with > 6' rest between each reps, maximal intensity, maximal explosive, 3-5 series; 1-3' rest SRT: only vibration (8-12 Hz, 60" duration, 1' rest, 3-5 series) 		
	<ul style="list-style-type: none"> Intermuscular coordination Postural control Integration ADL 	<ul style="list-style-type: none"> Reactive stresses and strains: fast walking & jogging & running & stair climbing, complex movements (e.g. mini-trampoline, ball sports), normal specific sports activities (all activities possibly with coni) Recommendations: walking, jogging, running, jumping, complex movements (e.g. trampoline, ball sports), normal specific sports activities, 2-6 g or more, no initial contraction necessary 		

Discussion: The concept represents a therapeutic and training procedure on the basis of 4 phases. Each phase refers to defined (test/analysis) criteria and limitations concerning possible (increasing) stresses and strains in therapy and ADL. Based on the structural problems the goals are defined. The interventions include specific methods and applications which addresses the muscle structure of the pelvic floor. This training integrated aspects of maximal strength, maximal power, reactive stresses and strains, isolated and complex contraction modes with respect to the intramuscular coordination with the postural muscles. For the first time recommendations for walking and running are given. After phase 4 the training of the PFM must be structured in consideration to the sports-specific situation of the athlete. Further intervention studies (RCTs) are necessary to confirm this concept.

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