Clinical Ai Chi®

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- The Bad Ragaz Ring Method by Urs Gamper and Johan Lambeck

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Chapter 7
Ai Chi®: Applications in Clinical Practice

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In study of this chapter, the reader will:
- Learn the history and philosophy of Ai Chi
- Understand the foundations of Clinical Ai Chi, its relationship to the ICF system, and Ai Chi as a sequence of postural control movements
- Translate the objectives of Clinical Ai Chi into activities that assist in fall prevention and in mobilizing connective tissue
- Understand the relationship of Ai Chi to Halliwick principles
- Learn recent advances in research that relate to the use of Clinical Ai Chi

CLINICAL AI CHI®

History And Philosophy

Ai Chi was developed in 1993 by Jun Konno, owner of the Aquadynamics Institute in Yokohama. He created Ai Chi as a preparation for Watsu, which is based on stretching meridians and creating balance between yin and yang, according to the philosophy of Masunaga.[1] At this time, Ai Chi consists of 19 movements or kata's.

Ai Chi can be characterized as a series of continuous slow and broad movements, accomplished without force. It consists of movement patterns of the arms, arms and trunk, and arms, legs and trunk, with gradual narrowing of the basis of support combined with deep breathing. Movements are supposed to take place at breath rate, about 14 to 16 times per minute.
Ai Chi has elements of both Qi Gong (a more static and symmetrical posture during the initial 6 arm movements) and Tai Chi Chuan (more focused on continuously changing the centre of gravity within the basis of support in the latter part). The classical purpose within Eastern theory is to balance energy by stretch of certain meridians.

Meridians that are stretched are the meridians of:
- The lung (underneath the clavicula), by retracting the scapula
- The small intestines (underneath the scapula), by protracting the scapula
- The urine bladder (accross the sacrum), by rounding the back and "opening" the SI joint
- The kidney (across the stomach), by extending the thoracal-lumbar spine and "opening" the stomach area

- The gallbladder (at the lateral waist), by rotation in between pelvis and thorax

Three other meridians are addressed: the long intestines, the pericardium and the triple warmer. These all end at fingertips and cannot be stretched. Through supinating the forearms and hands at every inhalation and pronating at every exhalation, yin and yang can be balanced as well.

There are three key elements that are essential in learning and practicing Ai Chi.[2,3]

1. **Listening inward to feeling.** Listening inward to feeling is directing attention to ones internal environment. This is the preparation for the next key element.
2. **Breath Modulation.** As we listen inward to feeling one becomes aware of breathing. At this stage it is very important to focus attention on your abdomen and fully relax any tension there. With inhalation and exhalation, the body and mind naturally begin to relax and one can feel the changes in buoyancy that occur as the lungs fill and empty.
3. **Relax.** Relaxation is a natural process of letting go of excess tension in body and mind. As relaxation proceeds even deeper, breathing becomes more rhythmic and smooth. This begins to release tension in the muscles and joints which increases internal energy (Chi) flow.

These three key elements are components of a progression. One flows into the other as the components mix to become a foundation by which all other practice takes form.

This chapter however will not focus on the Eastern philosophy underlying Ai Chi. In western terms, Ai Chi could be described as an active relaxation technique in which postural control and breathing are important.

Clients stand in shoulder deep water, preferably in the Tai Chi positions with knees slightly flexed. The water (and air) temperature should be thermo-neutral in order to support active relaxation. Clients that are apprehensive can perform an adapted Ai Chi while holding a bar. This is called Wall Ai Chi (Figure 7-1). After Ai Chi, which is done individually, Ai Chi Ne (Figure 7-2) can be included as an activity in pairs in order to finally go into Watsu.

Figure 7-1. Wall Ai Chi.

Figure 7-2. Ai Chi Ne.

Ai Chi has also been adapted for clients who are unable to stand and thus are allowed to sit on a stool in shallow water. This may be useful for patients with paralysis in one or both legs or even low back pain patients and may be integrated with other techniques.

Clinical Ai Chi

The term Clinical Ai Chi is used in order to distinguish it from regular Ai Chi as applied in wellness. Clinical Ai Chi may be used for specific therapeutic applications, which should be based on a certain evidence level. The use of the term Clinical Ai Chi has been granted by Jun Konno to the International Aquatic Therapy Foundation (IATF) in Switzerland (Figure 7-3).

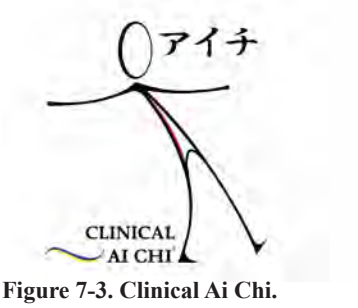

Figure 7-3. Clinical Ai Chi.

Ai Chi as a sequence of postural control movements.

The Ai Chi progressions are designed to present increasing difficulty as skills develop. Mechanical constraints that influence balance are added. In terms of the taxonomy developed by Gentile[4], Ai Chi is a closed skill (involving no inter-trial variability) done in a closed environment (no unexpected environmental changes, and with non-manipulating and body stabilizing movement dimensions) in which the regulatory conditions are changed. The goal is to fine-tune the movement to be performed with high level of consistency and little cognitive / physical effort as skills increase over time.[5]

The progressive change of regulatory conditions are:

Ai Chi: Contemplating, Floating, Uplifting, Enclosing and Folding

- A symmetrical trunk position with a wide symmetrical stance and a visual fixation point. There is no movement of the center of gravity (COG.) The arms move symmetrically.

Ai Chi: Soothing

- A symmetrical trunk position with a wide symmetrical stance and a visual fixation point. There is no movement of the COG. The arms move asymmetrically.

Ai Chi: Gathering.

- A trunk position as symmetrical as possible in a tandem stance, with a visual fixation point. There is no movement of the COG during the repetitive asymmetrical arm movements.

Figure 7-4a. Gathering

Figure 7-4b. Gathering

Ai Chi: Freeing.

- Trunk rotations in tandem stance, with the eyes following the moving hand. The COG changes because of the continuous change of side. The arms move asymmetrically.

Figure 7-5a. Freeing

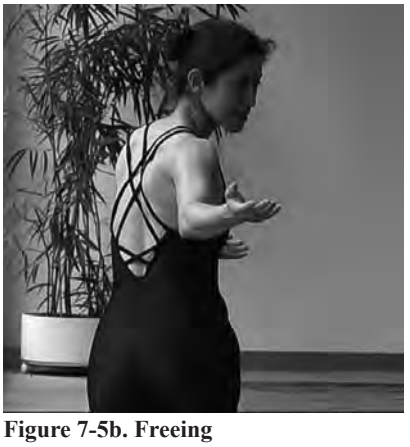

Figure 7-5b. Freeing

Ai Chi: Shifting

- Rotations between thorax and pelvis with a wide symmetrical stance, while continuously shifting the COG in the coronal plane. The arms move asymmetrically and the eyes follow the moving hand.

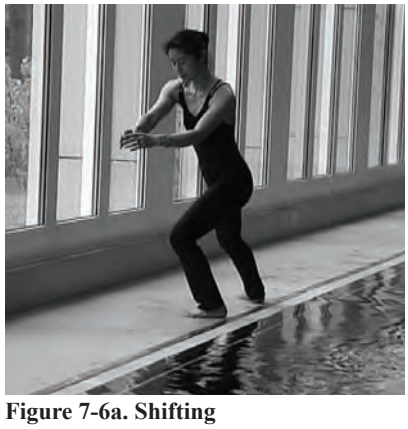

Figure 7-6a. Shifting

Figure 7-6b. Shifting

Ai Chi: Accepting

- A symmetrical trunk activity in a tandem stance, with continuous shifts of the COG in the sagittal plane. There is a visual fixation point.

Figure 7-4a. Accepting

Figure 7-4b. Accepting

Ai Chi: Accepting with Grace and Rounding.

- Symmetrical arm movements in unipedal stance where either the front leg or the hind leg is lifted during one breath cycle. There is a visual fixation point.

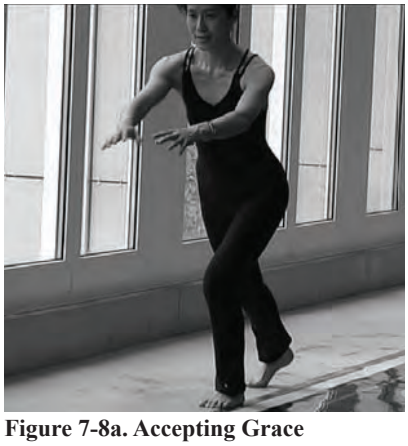

Figure 7-8a. Accepting Grace

Figure 7-8b. Accepting Grace

Figure 7-9a. Rounding

Figure 7-9b. Rounding

Ai Chi: Balancing

- Symmetrical arm movements in unipedal stance during 3 breath cycles. There is no real visual fixation point.

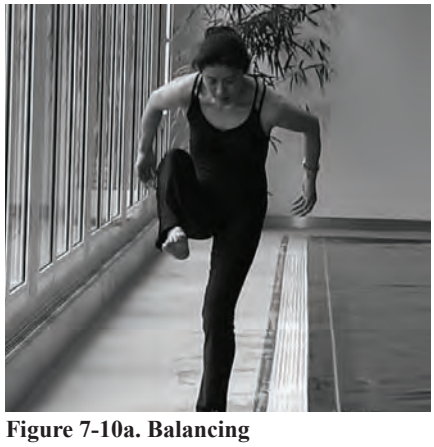

Figure 7-10a. Balancing

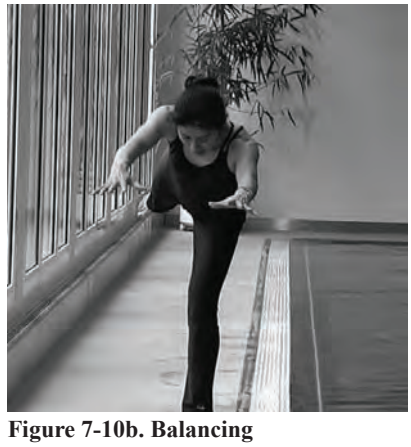

Figure 7-10b. Balancing

Ai Chi: Half Circling, Encircling, Surrounding, Nurturing.

- Symmetrical arm movements, in accordance with T'ai Chi, in a symmetrical stance with continuous movements of the COG. The eyes follow the hands.

Figure 7-11a. Half Circling

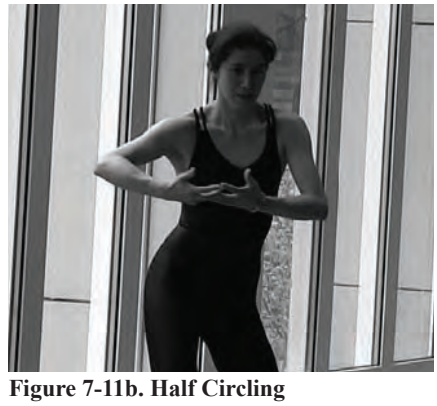

Figure 7-11b. Half Circling

Figure 7-12a. Encircling

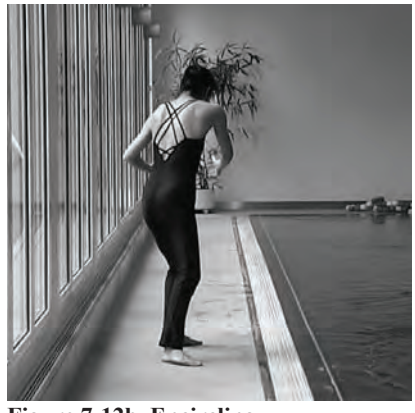

Figure 7-12b. Encircling

Ai Chi: Flowing and Reflecting

- Symmetrical arm movements occur while walking laterally, making cross-steps and pivots. A visual fixation point is possible.

Ai Chi: Suspending

- Symmetrical arm movements with a body turn and a floating phase. There are no visual fixation points.

One can define a clear sequence of increasing difficulty of the regulatory conditions:

- From a symmetrical trunk position to (rotatory) trunk movements.
- From a static to a dynamic COG.
- From a small hand movements to large reaching movements.
  From wide support to narrow bases of support.
- From visual control to non-visual / vestibular control.
- From symmetrical to asymmetrical arm movements.

Clinical Ai Chi and the ICF System

When the International Classification of Functioning, Disability and Health (ICF)[6] is used as the classification with neuromusculoskeletal and mobility reference, we can relate the following ICF subcategories to Clinical Ai Chi. (Table 7-1)

Being able to maintain an erect body position while at the same time shifting the center of gravity within the limits of stability (while using the arms for a non-supportive task) is a basic skill in postural control called balancing.[7] When a client has difficulties with this skill, the chance to lose balance increases. The characteristics of Ai Chi at the level of activity of ICF show a clear relationship with postural control. Therefore we choose to focus on this topic in relation to fall prevention.

At the level of function, prerequisites for a proper postural can be found like sufficient joint and muscle function. A connecting factor between categories like mobility, stability, muscle power and voluntary coordination is the functional and structural integrity of connective tissue. It needs a certain strength in combination with a certain length.[8,9] Ai Chi focuses on movement without force, which means that at the level of function of ICF the main focus will be mobility.

Table 7-1. ICF Subcategories Related to Clinical Ai Chi

Function level: domain b7 Neuromusculoskeletal and movement related functions	Actvity level: domain d4 Mobility
710 mobility of joint functions 715 stability of joint functions 720 mobility of bone functions (scapula) 730 muscle power 755 involuntary movement reaction functions 7602 coordination of voluntary movement 7603 supportive functions of the legs 7800 sensation of muscular stiffness 7801 sensation of muscle spasm	4106 shifting the body's the center of gravity 4154 maintaining a standing position 4452 use of arms: reaching

Objectives of Clinical Ai Chi

The therapeutic effects of Ai Chi are mostly related to the combination of diaphragmatic breathing and slow movements (as in Tai Chi). A comprehensive overview has been written by Sova R3, including psychological, neurobiological, cognitive, endocrine effects as well as effects on musculoskeletal and chronic pain.

Fall Prevention

Falls are a major problem in older (frail) adults, and in those persons with neuromusculoskeletal problems, leading not only to an increase of incapacity but also to an increase of morbidity and mortality. Falls account for 77% of all injury-related hospitalizations in Canada.[10] Complications of falls include fractures and fear of falling (FOF) with consequent activity reduction and reduced independence, among others. When training balance on land, an individual's performance may be diminished by a lack of confidence or a fear of falling. In an aquatic environment, the inherent viscosity of water serves as a postural support, promoting confidence and reducing the fear of falls. Aquatic therapy has the capacity to prevent deterioration and increase the quality of life within the elderly community as well as promoting and maintaining independence. A number of studies have investigated the efficacy of postural exercise programs in the aquatic environment, suggesting positive effects in older adults with coordination and balance deficits.[11-15] Evidence based aquatic exercise programs that focus on balance should follow evidence from both land-based and water-based research. Programmatic description in the aquatic literature is often poor and does not always follow established land-based interventions such as using an obstacle course or performing Tai Chi in falls prevention programs. Land obstacle courses and Tai Chi are used successfully to increase balance and to reduce fall risk.[16-19]

Because of the similarities between Ai Chi and Tai Chi, it is tempting to refer to the results of Tai Chi research on various health status variables (keywords: stability, balance, postural control, postural sway, fall prevention). A simple search in PubMed gave 168 hits on Tai Chi AND balance (July 2010). Research outcomes mostly are positive, although the conclusion of a

recent meta-analysis by Logghe et. al.[20] was that currently there is insufficient evidence to conclude whether TC is effective in fall prevention, decreasing fear of falling or improving balance in people over age 50 years. Nevertheless Tai Chi is (also) recommended in various guidelines as an exercise to be included in balance training.[21-25]

The Cochrane library includes[27] systematic reviews and meta-analyses with Tai Chi in the full text. A selection about neuromuscular diseases shows positive effects of Tai Chi on fall rate and risk of falling in elderly,[26, 27] increase of lower extremity range of movement in patients with rheumatoid arthritis[28] and a probable positive effect of Tai Chi on pain in patients with hip osteoarthritis.[29]

Ai Chi includes some of the variables that explain 68% of the effects of exercise on fall rate.30 The variables of the highly challenging balance exercises include movements of the centre of mass, minimized supportive use of the upper extremities and balancing with a narrow base. Also the total exercise dose should be over 50 hours of exercise. Ai Chi does not use the hands for support as long as arm movements are slow enough to not have "grip" on the water, the center of mass moves in many of the movements and also a narrow stance base is used in most of the positions. In order to make Ai Chi more challenging, the more static and stable parts could be modified or left out.

Other adaptations of Ai Chi might be included, based on falls prevention research.

Lateral stability as well as lateral stepping skills are important factors in falls prevention.[31,32] Implementing this in Ai Chi could mean:

- Working in tandem and unipedal positions, using asymmetric arm movements to prevent stabilisation through the symmetrical action of arms.
- Focusing on the cross-step movements, leaving out the pivots and asking clients to maintain a position after 2 steps
- Including side stepping without crossing feet

Being able to reach over a certain distance is well documented as a predictor for balance and for the risk to fall.[33] Originally, functional reach was tested in the anterior direction but more recent also lateral reach and multi-directional reach have been introduced.

> Ai Chi includes slow broad arm movements and potentially could yield more effect by increasing the range of movement and at various positions including a stop of some 2 seconds in order to challenge posture at the end of the reach.

The elderly can have difficulties in stepping over obstacles because of limited knee flexion and/or limited strength in plantar flexors.[34]

> Ai Chi: anterior weight shift might more actively start with plantar flexion of the hind limb ankle and the swing leg could be moved with more knee flexion

Gait variability decreases with age. One reason is the decrease of rotation in the spinal joints.[35] This leads to turning the whole body while looking around, consequently decreasing the security of foot contact with the floor.

> Ai Chi: focus on rotations in between pelvis and thorax and ask clients go more to the end of the active range of motion. In particular include movements where the eyes follow the hands in order to incorporate and increase cervical spine rotations.

Hip strategies are used when the area of support is small like on a balance beam or when the foot musculature cannot effectively stabilize the body because of a slippery surface[36] or pos-

sibly also limited contact with the floor like in water. Hip strategies are more common in elderly and clients with lower extremity involvement.

Ai Chi: focus on hip extension and hip flexion and allow lateral hip movements during the tandem stance or unipedal movements.

Mobilizing Connective Tissue

Ai Chi is known as a relaxation technique. The ICF does not define relaxation in the musculoskeletal domain, but refers to:

- Mobility of joint functions: Functions of the range and ease of movement of a joint.
- Mobility of bone functions: Functions of the range and ease of movement of the scapula, pelvis, carpal and tarsal bones.
- Muscle tone functions: Functions related to the tension present in the resting muscles and the resistance offered when trying to move the muscles passively.
- Sensation of muscle stiffness: Sensation of tightness or stiffness of muscles.
- Sensation of muscle spasm: Sensation of involuntary contraction of a muscle or a group of muscles.

These categories refer to pathological variations in the function of connective tissue (CT): abnormal shortness or diminished mobility, both from a mechanical and from a sensory point of view. The ICF mentions range and ease of movement. Clinically stiffness in an existing range of motion can be altered or the range of motion can be increased in case of a reduction of mobility.

Connective tissue is found in muscles, tendons, aponeuroses, capsules, periarticular fascia, discs and within the nervous system. Important elements of connective tissue are the collagenous fibers and the ground substance. Stiffness in muscles also includes a contractile element and will be included in this paragraph. Lengthening of connective tissue that may be abnormally restraining osteokinematic motion is an important objective in aquatic therapy, also referred to as stretching, elongation or mobilization.[37,38] Various techniques exist to address connective tissue of muscles (e.g. PNF stretches[39]), connective tissue around joints (e.g. Kaltenborn / Evjent[40]) or connective tissue of the nervous system (neurodynamics by Butler41 and Shacklock[42]). One can differentiate between addressing collagenous fibers and it's cross-links and the visco-elastic behavior of the ground substance. Mobility increase therefore can include:[9,43,44]

- breaking (excessive) cross-links between adjacent CT bundles
- achieving plastic deformation of CT fibers through tissue restoration after micro-tears
- stress-relaxation and creep of collagen fibers
- thixotropic decrease of actin-myosin cross-bridge stiffness
- restoring the interstitial fluid component to normal levels

Connective tissue has viscoelastic properties that are affected through length and through the velocity of movements. Connective tissue that is loaded more quickly will behave more stiffly (deform less) than the same tissue when loaded at a slower rate. The viscosity of the ground substance gives resistance at the beginning of an elongation. The ground substance can be altered more easily by slow movements. The ground substance has a property which is called thixotropy. This means that movement can reduce viscous stiffness (like stirring paint). The ground substance consists of a large percentage of water, bound by glycoproteins and acting like a gel. One of the functions of this gel is to stabilize and steer collagenous fibers.

Immobilization decreases the amount proteoglycans and deteriorates the function of the collagenous fibres by increasing inter-fiber friction and reducing alignment. Movement therefore is important. With a biological half time of just a few days of repetitive movement function of the ground substance can easily be improved. Repeated movements have measurable effects on stiffness or resistive torque, even decreasing during the first 3 repetitions.[45] This reduction in resistance to movement also affects hypertonic muscles in stroke patients and has been attributed to thixotropic effects.[45] Immersion is known to create a fluid shift from cellular and interstitial compartments to the vascular space.[46]

Somato-visceral reflexes can positively influence visceral activity. The sympathetic system originates from the spinal cord segments C8-L2. Afferent (mechano)sensory information through movement without pain in these segments will inhibit efferent sympathetic activity. Ai Chi focuses in trunk movements (in order to stretch meridians) in the thoracic-lumbar area and might therefore inhibit sympathetic activity. Research discussed in Chapter 2 has found a reduction in sympathetic activity during warm water immersion, which may play a role as well.

Contractile Elements

When an agonist muscle is contracting concentrically, antagonists elongate. Passive mechanical properties of the muscle play a role in the initial stiffness or tension of an elongation, like muscle filament resting tension because of actin-myosin cross-bridges[47] and the short range elastic component.[48] These properties are temporarily reduced by prior movements, but depend on the velocity of these movements as well. Tension decreases with a decrease of velocity, which is a thixotropic behavior (movement affects viscosity). This means that movements should be slow in order to decrease the force required to overcome musculotendinous stiffness.

Temperature

Viscoelastic characteristics are a temperature-dependent variable. The higher the temperature, the more pronounced the viscous properties of connective tissue reducing dominance of elastic properties with tension rapidly reducing under lengthening conditions. In vitro experiments by Lehman[49] showed progressive reduction in elastic properties as waterbath temperatures increased from 35.6ºC to 45ºC. In vivo research has shown that immersion in 40ºC increases extensibility of the hamstring muscles significantly because of changes in viscoelasticity,[50] measured with the straight leg raising test. Also immersion in 32ºC significantly increases ROM and decreases stiffness, measured with the modified Ashworth scale in children with CP compared to immersion in 29ºC.[51]

The results of effects of immersion and aquatic therapy on stiffness are mixed. Verhagen[52] and Bartels[53] did not find statistically significant differences in stiffness, measured with the Womac, in their Cochrane reviews on balneotherapy and aquatic exercise of knee and hip osteoarthritis respectively. Verhagen[52] reported the same negative outcome in their review on balneotherapy in rheumatoid arthritis.[54] Jentoft[55] however found significant stiffness changes after aquatic therapy in persons with fibromyalgia.

In order to make a mobilizing and stretching technique like contract / relax antagonist contractions effective, only 20% of the maximal voluntary contraction is necessary.[56] The mobilizing effect on connective tissue is supported by the fact that Ai Chi movements are performed with reduced force. Ai Chi includes slow movements such as Uplifting or abduction (in the scapular plane), when an arm covers 180º during a fill breath cycle. When a person is breathing 15 times per minute requires 4 seconds per cycle. This equates to an angular velocity of

45º per second. Muscular activation at these velocities is clearly reduced. Kelly and coworkers compared muscle activation of 6 rotator cuff and shoulder synergists during 3 different speeds of elevation in the scapular plane (30º/s, 45º/s and 90º/s.)[57] For all 6 muscles tested, muscle activation during the 30º/s and 45º/s test speeds was significantly less when performed in water versus when performed on land. For example, electromyographic activation of the supraspinatus muscle was 17.46% of a maximum voluntary contraction (VMC) when elevation was performed at 45º/s on dry land versus 5.71% when performed in water. Clinical Ai Chi might therefore support early active motion in postsurgical or injured shoulders.

Other kata's like Gathering include 10 to 12 seconds isometric contraction of shoulder muscles in 1 arm while the other moving (with 3 repetitions). Fujisawa et. al. electromyographically measured 9 parts of 6 shoulder girdle muscles in 9 positions and found that almost all muscle activity in water decreased remarkably in water compared to land.[58] For example, during an isometric supraspinatus activity in 90º of abduction, a remarkable reduction of electromyographic activation could be measured from 22.3% of the VMC on land to to 3.9% of the VMC in water. Although the activity of the infraspinatus muscle decreased, the authors suggested that careful attention must be paid to maximal external rotation in early rehabilitation of shoulder surgery or injury because of the relatively high resultant percentage of activity.

Research

Direct research on Ai Chi is scarce, despite its significant popularity. Published clinical trials have been listed below.

Bauer-Cunha et. al. published a report on the use of Ai Chi in 3 cases of spinal muscular atrophy.[59] The 3 clients were 15, 18 and 30 years of age and performed Ai Chi once a week, 20 minutes per session, for 1 year. The measurement was done with the Barthel index, showing an increase of 10 to 15 points in the highest quartile.

Devereux and co-workers developed an investigation based on Tai Chi exercises adapted to the aquatic environment.[60] The objective of this study was to verify the influence of a hydrotherapy program on balance, fear of falling and quality of life in community dwelling elderly female subjects with a diagnosis of osteopenia or osteoporosis. Participants had an average age of 73.3 years and were randomized to the aquatic group or a control group that continued with their usual activities of daily living. The aquatic group undertook a 10-week program twice a week in 60-minute sessions. The exercises were not described but included a variety of activities including land-based Tai Chi transferred to the water. Devereux observed significant improvements in the experimental group regarding the Step Test (ST), a test that evaluates dynamic balance. Devereux's results are in accordance with the results obtained in the study by Teixeira et. al.,[61] in respect to the dynamic balance sub-scale of the Tinetti test. The relative contribution of the aquatic Tai Chi part is unknown however.

A second research report on the use of Ai Chi was published by Ribero Queroz et al.[62] They used 9 movements in a series of 10 sessions of 30 minutes with a cohort of Parkinson patients (n=10) between 50 and 50 years. The Hoehn & Yahr stages were not given. No assessment instruments specific for Parkinson were used. They quantified observations of motor control, using video. The authors concluded that the comparative graphics showed fairly significant changes in postural tremor, dynamic balance, static balance and gait.

Noh et al. used a combination of Halliwick and Ai Chi to increase balance.63 They randomly allocated 25 chronic ambulatory stroke patients (average time of the stroke was 2.2 years) to either an aquatic group or a dry land gym exercise group. Both groups were baseline comparable in terms of gender, age and severity of stroke. Both interventions lasted for 8

weeks, 3 times per week and 60 minutes per session. The Ai Chi part of the aquatic intervention consisted of 20 minutes of two specific movements: Rounding and Balancing. Statistical and clinical significant effects were seen in the Berg Balance Scale (BBS) and in accordance with the results obtained by Teixeira et al, in respect to the static or balance sub-scale of the Tinetti test. Noh et al calculated an effect size of 1.03 in the BBS. Also weight-bearing ability, measured on a force platform showed effect sizes of 1.13 and 0.72 for forward and backward weight-shifting respectively. The authors concluded that aquatic therapy based on Halliwick and Ai Chi improves postural balance.

Teixeira et al. performed an assessor blinded randomized trial about the influence of Ai Chi on balance and fear of falling among older adults.[61] Home dwelling frail elderly (n = 30), clients of a day care centre were randomly allocated to an Ai Chi class or to a control group receiving usual care. The groups were baseline comparable with an age of 82 ± 2 years and all participants had a medium to high risk of falling (POMA / Tinetti = 14 ± 6). The intervention group received 16 Ai Chi sessions over a period of 6 weeks, according to the sequence suggested by Sova & Konno.[2] The POMA was used to evaluate static and dynamic balance and fear of falling was measured with the Falls Efficacy Scale. The time points were pre-intervention and directly post-intervention, but subsequent follow-up did not take place. Results are shown in Table 7-2.This investigation's findings suggest that an Ai Chi program leads to a clinical relevant increase of both static and dynamic balance in older people, in comparison with usual care. The Ai Chi group remained at the same level of fear of falling, while the participants of the usual care group increased their fear of falling over the research period.

Table 7-2. P-Values and Effect Sizes

	Intragroup P-Values		**Intergroup P-Values**	**Intergroup ES (d)**
	Ai Chi	Controls		
FES	0.306	0.011*	0.001*	1.5
POMA total	0.001*	0.254	0.002*	1.3
POMA balance	0.001*	0.230	0.001*	1.4
POMA gait	0.001*	0.202	0.004*	1.1

CONCLUSIONS

Anecdotally,Clinical Ai Chi is valued highly for it's relaxing and pain lessening effects, which may be attributable to changes within the autonomic nervous system, through reduction of sympathetic nervous activity allowing an increase in sympathovagal balance. Research has yet to confirm if these claims are related to the immersion effect or the specific characteristics of Ai Chi: the repetitive movements at a slowed breathing rhythm. Repetitive slow movements do have mechanical effects on connective tissue stiffness by altering thixotropic characteristics. In various clinical conditions, thixotropic stiffness has been found to be increased, such as neurological and rheumatological conditions. Research also has to verify this suggestion. The available data do support the effects on balance in neurological diseases (Parkinson and stroke), in osteoporosis and in geriatrics. In order to match Clinical Ai Chi to the core elements of fall prevention, suggestions for adaptations have been given.

CASE STUDY

History and Present State

A 59 year old woman was diagnosed with rheumatoid arthritis 7 years ago. An exacerbation caused her to be hospitalised 3 months ago. Medication was revised, the signs of acute inflammation disappeared and her sedimentation rate was normalised. She has secondary osteoarthritis of ankles, knees and hips. She is referred for an out-patient aquatic therapy program.

Subjectively, she complains about pain in the feet, ankles and knees in rest and during activity between 4/10 and 6/10 on a visual analogue scale, decreased range of motion (ROM) in ankles, knees and hips, and a general stiffness of 4/10 on a visual analogue scale (ICF function level). She lists her 3 main functional complaints (ICF activity level) as restrictions in walking long distance outside, climbing stairs and maintaining balance while doing bimanual tasks at home

Objective assessment shows decreased ROM of both hips in internal rotation, abduction, external rotation and, to a lesser degree, extension. Knees (mainly the left) show a reduced ROM with flexion more than extension. Both ankles show a reduced ROM with plantar flexion more affected than dorsiflexion. There is a general loss of muscle power in the lower extremities, especially anterior tibialis, medial vastus (left and right) and all glutei. are weak around 4 at the MRC scale.

The Womac questionnaire (LK30 version) shows 43/68 in the physical function domain, 10/20 in the pain domain and 5/8 in the stiffness domain. Clinimetric tests like the Functional Reach shows 20 cm (normal value is 34 cm) and her Timed Up and Go test revealed a time of 25 seconds. Her physical capacity is very low in comparison with age-matched women: 16 ml/kg ffm / min as opposed to the norm of 31, based on the Åstrand test.

She has an adequate coping style: she is tiring quickly, however she knows why and really hopes to increase her present condition.

Overall Clinical Assessment Summary:

Impairments of joint mobility, joint stability, sensations of stiffness and sensations of pain, reduced mm power and mm endurance.

Restrictions to maintain a steady position and to shift the COG.

Aquatic Therapy Treatment Plan

Based on the analysis of the subjective and objective impairments and restrictions, the following objectives were formulated. (In order to keep this case simple, the SMART system of goal setting, goal attainment scaling, minimal clinically important improvement and patient accepted symptom state have not been used)

Objectives:

- to increase ROM of the lower extremities
- decrease the (sensation) of stiffness and pain
- to increase general muscle power of the lower extremities
- to increase muscle endurance of the LE
- to be able to change the COG while standing increasing her supportive leg functions

- to work on balancing and stabilising reactions during gait training
- to increase aerobic capacity
- to let her enjoy achievement of pain free movements

Intervention

Amongst other aquatic therapy techniques like the Bad Ragaz Ring Method to increase muscle power, ROM and decrease stiffness, Clinical Ai Chi is used. This can be done individually, but can also be combined with attending a group, to be continued after the therapy goals have been met. The first session is partly used to introduce Clinical Ai Chi by focusing on breathing during the 5 initial katas. The sessions afterwards are focused on the objectives and therefore katas are chosen in which supportive function is exercised in standing and the trunk is in constant motion.

Gathering (Figure 7-4a and 7-4b), freeing (Figure 7-5a and 7-5b), shifting (Figure 7-6a and 7-6b), accepting (Figure 7-7a and 7-7b), accepting with grace (Figure 7-8a and 7-8b), rounding (Figure 7-9a and 7-9b), balancing (Figure 7-10a and 7-10b), halfcircling (Figure 7-11a and 7-11b), encircling (Figure 7-12a and 7-12b). The program as used by Teixeira61 is modified in order to match the chosen katas with the available time.

Table 7-3.

Week	Exercise number, according to the pictures	Minutes of Ai Chi	Repetitions per kata
1	4 - 7	8	3
2	8 - 12	8	3
3	4 - 12	15	3
4	4 - 12	20	4, with variations as suggested in the text
5	4 - 12	20	4, with variations as suggested in the text

Justification

The Clinical Ai Chi session progresses to 20 minutes as a low level fitness "workout" at 40% VO_{2max} or RPE 11/20 (some effort but not enough to speed up breathing) following the ACSM[64] guidelines for arthritic patients. Muscular endurance fits training recommendations to achieve a high amount of repetitions with a low external load. The slow movements adequately address the connective tissue stiffness. The frequent change of the COG without using hands to additionally stabilize posture along with adaptations to decrease the base of support follow recommendations on balance training.[30]

Outcome

Over the 5 week program the client progressively improved in hip, knee and ankle ROM, showed improvement of MRC muscle strength in both lower extremities to 4+/5, Her Timed Up-and-Go score improved by 7 seconds and her functional balance scores improved along with her subjective abilities to perform normal ADLs. She elected to continue with the independent group Ai Chi following formal discharge from physical therapy.

REFERENCES

1. Masunaga S. (1987). Meridian exercises. Japan Publications, Tokyo.
2. Sova R, Konno J (1999). Ai Chi, balance, harmony and healing. DSL, Port Washington.
3. Sova R. in Thein-Brody L & Richley Geigle P (2009). Aquatic Exercise for rehabilitation and training. Human Kinetics, Champaign. chapter 7 Ai Chi pp 101 – 11.
4. Gentile AM. Skill acquisition: action, movement, and neuromotor processes. In: Carr JH, Shepherd RB, editors. Movement science foundations for physical therapy in Rehabilitation. 2nd ed. Gaithersburg: Aspen, MD; 2000. p.111-187.
5. Rose DJ. (2010). Fall Proof, a comprehensive balance and mobility training program. Human Kinetics, Champaign.
6. World Health Organisation (2001). International Classification of Functoning, Disability and Health. WHO press: Geneva.
7. Bronstein AM, Brandt T, Woollacott MH, Nutt JG. (2004). Clinical disorders of balance, posture and gait. Arnold: London.
8. Mueller MJ, Maluf KS. Tissue adaptation to physical stress: a proposed "physical stress theory" to guide physical therapy practice, education, and research. Phys Ther. 2002;82(4):383-403.
9. Morree de JJ. Dynamiek van het menselijk bindweefsel. (2008). Houten: Bohn Stafleu van Loghum.
10. Arnold CM, Faulkner RA. The Effect of Aquatic Exercise and Education on Lowering Fall Risk in Older Adults With Hip Osteoarthritis. Journal of Aging & Physical Activity.18(3):245-260.
11. Arnold CM, Busch AJ, Schachter CL, Harrison EL, Olszynski WP. A Randomized Clinical Trial of Aquatic versus Land Exercise to Improve Balance, Function, and Quality of Life in Older Women with Osteoporosis. Physiother Can. 2008;60(4):296-306.
12. Dong Koog N, Jae-Young L, Hyung-Ik S, Nam-Jong P. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors - a randomized controlled pilot trial. Clinical Rehabilitation. 2008;22(10-11):966-976.
13. Lund H, Weile U, Christensen R, et al. A randomized controlled trial of aquatic and land-based exercise in patients with knee osteoarthritis. J Rehabil Med. 2008;40(2):137-144.
14. Suomi R, Koceja DM. Postural sway characteristics in women with lower extremity arthritis before and after an aquatic exercise intervention. Arch Phys Med Rehabil. 2000;81(6):780-785.
15. Tomas-Carus P, Hakkinen A, Gusi N, Leal A, Hakkinen K, Ortega-Alonso A. Aquatic training and detraining on fitness and quality of life in fibromyalgia. Med Sci Sports Exerc. Jul 2007;39(7):1044-1050.
16. Wolf SL, Barnhart HX, Kutner NG et.al. Reducing frailty and falls in older persons: an investigation of Tai Chi and computerized balance training. Atlanta FICSIT Group. Frailty and Injuries: Cooperative Studies on Intervention Techniques. . 1996;44(5):489-97
17. Rogers CE, Larkey LK, Keller C. A review of clinical trials of Tai Chi and Qigong in older adults. West J Nurs Res. 2009;31:245-279.
18. Weerdesteyn V, Nienhuis B, Duysens J. Exercise training can improve spatial characteristics of time-critical obstacle avoidance in elderly people. Hum Mov Sci. 2008;27(5):738-48.
19. Means KM, Rodell DE, O'Sullivan PS. Balance, mobility, and falls among community-dwelling elderly persons: effects of a rehabilitation exercise program. Am J Phys Med Rehabil. 2005;84(4):238-50.

20. Logghe IH, Verhagen AP, Rademaker AC, Bierma-Zeinstra SM, van Rossum E, Koes BW. The effects of Tai Chi on fall prevention, fear of falling and balance in older people: a meta-analysis. Prev Med 2010; Jun 15, Epub ahead of print.
21. Chartered Society of Physiotherapy and National Osteoporosis Society (2001). Clinical Guideline Osteoporosis.
22. Koninklijk Nederlands Genootschap Fysiotherapie. Richtlijn Ziekte van Parkinson. Nederlands Tijdschrift voor Fysiotherapie . 2004; 114(3): supp 1-88.
23. National Institute of Clinical Excellence (2004). Clinical practice guideline for the assessment and prevention of falls in older people.
24. Forwood MR & Larsen JA. Exercise recommendations for osteoporosis, a position statement of the Australian and New Zealand Bone and Mineral Society. Family Physician. 2000; 29(8): 761-764.
25. Nederlandse Vereniging voor Rheumatologie (2009). Richtlijn diagnostiek en behandeling van reumatoïde arthritis.
26. Gillespie LD, Robertson MC, Gillespie WJ, Lamb SE, Gates S, Cumming RG, Rowe BH. Interventions for preventing falls in older people living in the community. Cochrane Database of Systematic Reviews. 2009, Issue 2. Art. No.: CD007146. DOI: 10.1002/14651858.CD007146.pub2.
27. Howe TE, Rochester L, Jackson A, Banks PMH, Blair VA. Exercise for improving balance in older people. Cochrane Database of Systematic Review.s 2007, Issue 4. Art. No.: CD004963. DOI: 10.1002/14651858.CD004963.pub2.
28. Han A, Judd M, Welch V, Wu T, Tugwell P, Wells GA. Tai chi for treating rheumatoid arthritis. Cochrane Database of Systematic Reviews. 2004, Issue 3. Art. No.: CD004849. DOI: 10.1002/14651858.CD004849.
29. Fransen M, McConnell S, Hernandez-Molina G, Reichenbach S. Exercise for osteoarthritis of the hip. Cochrane Database of Systematic Reviews. 2009, Issue 3. Art. No.: CD007912. DOI: 10.1002/14651858.CD007912.
30. Sherrington C, Whitney JC, Lord SR, Herbert RD, Cumming RG, Close JCT. Effective exercise for the prevention of falls: a systematic review and meta-analysis. J Am Geriatr Soc. 2008;56:2234-2243.
31. Hilliard MJ, Martinez KM, Jansen I, Edwards B, Mille ML, Zhang Y, Rogers MW. Lateral balance factors predict future falls in community-living older adults. Arch Phs Med Rehabil. 2008;89:1708-1713.
32. King LA, Horak FB. Lateral stepping for postural correction in Parkinson's disease. Arch Phys Med Rehabil. 2008;89:492-499.
33. Duncan PW, Weiner DK, Chandler J, Studenski S. Functional reach: a new clinical measure of balance. J Gerontol. 1990;45(6):M192-197.
34. Weerdesteyn V, de Niet M,van Duijnhoven AJ, Geurts AC. Falls in individuals with stroke. J Rehabil Res Dev. 2008;25(8):1195-1213.
35. Marigold DS, Weerdesteyn V, Patla AE, Duysens J. Keep looking ahead? Re-direction of visual fixation does not always occur during an unpredictable obstacle avoidance task. Exp Brain Res. 2007 Jan;176(1):32-42.
36. Lin CF, Chang CL, Kuo LC, Lin CJ, Chen CY, Su FC. Postural control while dressing on two surfaces in the elderly. Age. 2010;Jul 15. [Epub ahead of print]
37. Geytenbeek J. Aquatic physiotherapy evidence-based practice guide. National Aquatic Physiotherapy Group, Australian Physiotherapy Association, 2008.
38. Dziedzic K, Jordan JL, Foster N. Land- and water based exercise therapies for musculoskeletal conditions. Best practice & research clinical rheumatology. 2008;22(3):407-418.

39. Sharman MJ, Cresswell AG, Riek S. Proprioceptive neuromuscular facilitation stretching, mechanisms and clinical implications. Sports Med. 2006;36(11):929-939.
40. Kaltenborn FM, Evjenth O, Baldauf Kaltenborn T, Morgan D. (2009) Manual Mobilization of the Joints: The Spine. Cambridge University Press
41. Butler D. (2000). The sensitive nervous system. Noigroup publications, Unley
42. Shacklock M (2005). Clinical neurodynamics. Elsevier, Edinburgh
43. Threikeld AJ. The effects of manual therapy on connective tissue. Physical Therapy 1992;72:893-902
44. Berg van de F. (2010). Angewandte Physiologie, das Bindegewebe des Bewegungsapparates verstehen und beeinflussen. Thieme, Stuttgart.
45. Nuyens GE, De Weerdt WJ, Spaepen AJ Jr, Kiekens C, Feys HM. Reduction of spastic hypertonia during repeated passive knee movements in stroke patients. Arch Phys Med Rehabil. 2002;83:930-935.
46. Epstein M. Renal effects of head-out water immersion in humans: a 15-year update. Physiological reviews. 1992;72(3):564-621.
47. Carey JR, Burghardt TP. Movement dusfunction following central nervous system lesions: a problem of neurologic or muscular impairment? Physical Therapy. 1993;73(8):538-547.
48. Campbell KS, Lakie M. A cross-bridge mechanism can explain the thixotropic short-range elastic component of relaxed frog skeletal muscle. J. Physiol. 1998;510;941-962.
49. Lehman JF, Masock AJ, Warren CG, Koblanski JN. Effect of therapeutic temperatures on tendon extensibility. Arch Phys Med Rehabil. 1970;51:481-487.
50. Bovy P, Foidart M, Dequinze B, Solheid M, Pirnay F. Influence des bains chauds sur les propriétés musculaires des sujets sains et spastiques. Medica Physica. 1990;13:121-124.
51. Seo S-K. Quantitative evaluation of muscle tonus by pool temperature during the aquatic therapy. 2003. Unpublished MSc-thesis, Dongshin University, Naju, South-Korea.
52. Verhagen AP, Bierma-Zeinstra SMA, Boers M, Cardoso JR, Lambeck J, de Bie RA, de Vet HCW. Balneotherapy for osteoarthritis. Cochrane Database of Systematic Reviews 2007, Issue 4. Art. No.: CD006864. DOI: 10.1002/14651858.CD006864.
53. Bartels EM, Lund H, Hagen KB, Dagfinrud H, ChristensenR, Danneskiold-Samsøe B. Aquatic exercise for the treatment of knee and hip osteoarthritis. Cochrane Database of Systematic Reviews. 2007, Issue 4.Art.No.:CD005523.DOI: 10.1002/14651858.CD005523.pub2.
54. Verhagen AP, Bierma-Zeinstra SMA, Boers M, Cardoso JR, Lambeck J, de Bie RA, de Vet HCW. Balneotherapy for rheumatoid arthritis. Cochrane Database of Systematic Reviews. 2004, Issue 1. Art. No.: CD000518. DOI: 10.1002/14651858.CD000518.
55. Jentoft ES, Kvalvik AG, Mengshoel AM. Effects of pool-based and land-based aerobic exercise on women with fibromyalgia/chronic widespread muscle pain. Arthritis Care Res. 2001;45:42–47.
56. Feland JB, Marin HN. Effect of submaximal contraction intensity in contract-relax proprioceptive neuromuscular facilitation stretching. Br J Sports Med. 2004; 38: e18
57. Kelly BT, Roskin LA, Kirkendall DT, Speer KP. Shoulder muscle activation during aquatic and dry land exercises in nonimparied subjects. J Orthop Sports Phys Ther. 2000;30(4): 204-210.
58. Fujisawa H, Suenaga N, Minami A. Electromyographic study during isometric exercise of the shoulder in head-out water immersion. J Shoulder Elbow Surg. 1998;7:491-494.
59. Bauer Cunha MC, Labronici RH, Oliveira A, Gabbai AA. Relaxamento aquático em piscina aquecida, realizado através do método Ai Chi: nova abordagem hidroterapêutica para pacientes portadores de doenças neuromusculares. Fisioterapia Brasil. 2002; 3(2): 79-84.

60. Devereux K, Robertson D, Briffa NK. Effects of a water-based program on women 65 years and over: a randomised controlled trial. Aust J Physiother. 2005;51(2):102-108.
61. Teixeira R, Lambeck J, Neto F. The influence on balance and fear of falling among older adults: a randomized clinical trial. Submitted to Clin Rehabil
62. Ribeiro Queiroz D, Oliani D, da Cruz dos Santos L, Wosniak Hunger R, Israel VL. Fisioterapia Aquática: Ai-Chi em patcientes com Doença de Parkinson. FisioBrasil. 2007; 11(82): 38-42.
63. Noh DK, Lim JY, Shin HI, Paik NJ. The effect of aquatic therapy on postural balance and muscle strength in stroke survivors – a randomized controlled trial. Clin Rehabil. 2008;22:966-976.
64. Durstine GL, Moore GE, Painter PL, Roberts SO (2009). ACSM's exercise management for persons with chronic diseases and disabilities. Human Kinetics: Champaign.

REVIEW QUESTIONS

1. Important movements to stretch meridians are:
   a. scapular retraction – trunk lateral flexion – "opening" the SI joint
   b. scapular depression – trunk lateral rotation – "opening" the SI joint
   c. scapular protraction – trunk lateral flexion – ankle dorsal flexion
   d. scapular protraction – trunk lateral rotation – 'opening" the SI joint

2. The 3 key elements of Ai Chi are:
   a. postural balancing – breath modulation – relaxation
   b. listening to inward feeling – breath modulation – relaxation
   c. rhythm – breath modulation – relaxation
   d. listening to inward feeling – meridian balancing – relaxation

3. Ai Chi is a closed skill in which regulatory conditions are changed. Which set of conditions does not belong to the ones used in Ai Chi:
   a. short leverage movements, changing to long leverage movements
   b. symmetrical arm movements , changing to asymmetrical arm movements
   c. wide stance, changing to narrow stance
   d. no COG movement, changing to COG movement

4. Ai Chi has been connected to the function level of ICF with:
   a. muscle power
   b. muscle strength
   c. muscle endurance
   d. muscle stiffness

5. Which variables explain 68% of the effects on exercise on fall rate and can also be identified in Ai Chi:
   a. movements of the COG
   b. minimize supportive use of the upper extremities
   c. balancing with a narrow base
   d. all answers are right

6. Adaptations of Ai Chi might be included, based on falls prevention research. These could be:
   a. increase the amount of pivoting movements
   b. shifting the COG outside the base of support
   c. increase the amount of cross-over steps
   d. include lateral stepping without crossing feet

7. Ai Chi includes movements that are part of corrective non-intentional strategies, which are important for elderly clients. These are:
   a. ankle strategies
   b. knee strategies
   c. hip strategies
   d. lumbar spine strategies

8. Repetitative movements affect connective tissue by:
    a. gradually lengthening the collagenous fibers
    b. reducing tone of intrafusal musce fibers
    c. reducing the elasticity of connective tissue
    d. reducing the viscosity of connective tissue

9. Electromyography research has shown that shoulder rotator muscles act:
    a. at a low % of the MVC
    b. isokinetically
    c. at a low % of the 10 repetition maximum
    d. double-concentrically

10. The "Ai" in Ai Chi stands for:
    a. empathy
    b. water
    c. slow
    d. the name of Jun Konno's daughter