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*The Immediate effect of acupuncture on
improving pain and range of motion in
patients with Shoulder Pain*

Master Thesis Dissertation in Traditional Chinese
Medicine

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**The Immediate effect of acupuncture on improving pain and
range of motion in patients with Shoulder Pain**

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DEDICATIONS AND ACKNOWLEDGEMENTS

To my parents, for all humility, example, support and hard work they transmitted me;

To my grandparents for what they represented to me and their legacy of perseverance;

To my son and daughter, for their support, sincere and unconditional love, and above all, their constant smile;

To my wife for supporting me and the family while doing this thesis;

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“Mutation is the only constant in life!”

Costa

“The natural healing force within each one of us is the greatest
force in getting well.”

Hipocrates

ABSTRACT

Title: Immediate effect of acupuncture on pain and range of motion in patients with Shoulder Pain (SP)

Background/Introduction

The shoulder pain (SP) it is a frequent condition that leads to functional impairment, as well as high individual and social costs. There is a worldwide prevalence of 7 to 25% of SP which represents 12% of chronic pain in Portugal. Acupuncture is widely used against chronic pain with low cost and little side effects. We were interested in a comparison of two acupuncture regimens in order to optimize treatment.

Objectives

The purpose of this study is to assess the immediate effect of acupuncture in the shoulder pain and range of motion.

Methodology

32 patients were divided in 2 groups by random. Subjective perception of pain was assessed by VAS and objective measurement of the amplitude of abduction was carried out before and 5 minutes after acupuncture to assess its clinical effects. Group A received acupuncture on C3 and It11 and group B on F21 and an extra point located 5 tsun above elbow. Pain reduction and ROM was assessed and statistically compared by Student's t test.

The study included male or female patients, aged between 18-85 years old, with pain in shoulder and limitation of shoulder abduction movement, diagnosed by an independent physiatrist with no previous experience of acupuncture and the TCM diagnosis of a yang maior Syndrome. Exclusion criteria involved patients with shoulder pathologies without pain in abduction, patients with neurological or oncological pathologies, pregnant and infants

Identical depth and intensity of stimulation of acupuncture were applied in both groups using Leopard-spot technique.

Results

1. Before acupuncture both groups showed similar demographic and clinical characteristics;
2. In group A pain improved 39.01%, resulting in a statistically significant pain reduction ($p < 0,001$). The amplitude improved by an average of 28,57 degrees, showing statistically significant data;
3. The comparison of group A and B revealed that pain reduction was significant in group A and has increased in group B. The ROM improvement in EG was twice the one of the CG.

Conclusion

Acupuncture according to the Heidelberg (HD) Model resulted in significantly immediate pain reduction. Also the ROM doubled in the HD model rather control group. Acupuncture is a technique with immediate effect in painful shoulder.

RESUMO

Título

Efeito imediato da acupuntura na melhoria da dor e amplitude de movimento em pacientes com dor no ombro

Introdução

A dor no ombro (DO) é uma condição frequente que leva à incapacidade funcional, com altos custos sociais e individuais. Há uma prevalência mundial de 7 a 25% e representa 12% da dor crónica em Portugal. A acupuntura é amplamente utilizada na dor crónica, com baixo custo e bons resultados. Estávamos interessados na comparação de dois regimes de acupuntura, a fim de otimizar o tratamento.

Metodologia

32 Pacientes foram divididos em dois grupos de forma aleatória. A Percepção subjetiva da dor foi avaliada pela Escala Visual Analógica (EVA) e a medida objetiva da amplitude de abdução foi realizada antes e após 5 minutos da acupuntura para avaliar os seus efeitos clínicos. O grupo A recebeu acupuntura nos pontos C3 e It11 e grupo B no F21 e num ponto extra localizado a 5 tsun acima do cotovelo. A redução da dor e amplitude de movimento (AM) foram comparadas pelo teste Student's t test (para amostras emparelhadas).

O estudo incluiu pacientes masculinos e femininos, com idades entre 18-85 anos, com dor e limitação dos movimentos de abdução do ombro, diagnosticadas por um médico da medicina convencional, não tendo tido contacto prévio com a acupuntura. A dor na abdução corresponde à patologia *Yang Maior* no diagnóstico da medicina chinesa. Os critérios de exclusão envolveram pacientes com outras patologias do ombro, sem dor em abdução, os pacientes com patologias neurológicas ou oncológicas, gestantes e bebês. A profundidade e intensidade de estimulação na acupuntura aplicada foram idênticas em ambos os grupos, utilizando a técnica "*Leopard Spot*".

Resultados

1. Antes da acupuntura, ambos os grupos apresentaram características demográficas e clínicas semelhantes;
2. No grupo **A** a dor melhorou 39,01%, o que resulta numa redução estatisticamente significativa da dor ($p < 0,001$). A amplitude melhorou numa média de 28,57°, revelando dados estatisticamente significativos;
3. No grupo **B** a acupuntura resultou numa redução da dor de 4,42%, não sendo estatisticamente significativa ($P = 0,624$);
4. A comparação dos grupos **A** e **B** revelou que a redução da dor foi significativamente melhor no grupo **A** do que no grupo **B**. A melhoria da amplitude de movimento no grupo **A** foi o dobro da do grupo **B**.

Conclusão

A acupuntura de acordo com o modelo de Heidelberg (HD) resultou na significativa redução imediata da dor. Também a AM duplicou no modelo HD face ao grupo de controlo. A acupuntura é uma técnica com efeito imediato no ombro doloroso.

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LIST OF ABBREVIATIONS

ACP	Acupuncture
TCM	Traditional Chinese Medicine
ROM	Range of Motion
SP	Shoulder Pain
EA	Electroacupuncture
TENS	Transcutaneous electric nerve stimulation
NSAIDs	Non-steroidal anti-inflammatory drugs
US	Ultrasound
VAS	Visual analogue scale
AP	Acupoints
CG	Control group
EG	Experimental group
CP	Chronic pain
SC	Sternoclavicular
GH	Glenohumeral
RC	Rotator cuff
AC	Acromioclavicular
ST	Scapulothoracic
MRI	Magnetic Resonance Imaging
IASP	International Association for the Study of Pain
TCM	Traditional Chinese Medicine
HD	Heidelberg
ALT	Algor Laedens Theory
fMRI	functional Magnetic Resonance Imaging
LST	Leopard Spot Technique
EG	Experimental Group
CG	Control Group

CHAPTER 1

Introduction

INTRODUCTION

During the various training and clinical practice as well as in our sport and personal life, we met people with shoulder pain. Sometimes well-defined cause such as trauma, sometimes insidiously cause, sometimes sudden rise, sometimes gradual. Many times the shoulder pain became chronic, compromising other structures, as well as quality of life.

The treatment of the shoulder joint is always "*a headache*" for any health care professional, much because of the time it takes to treat, the multifactorial nature and the inconstancy of the symptoms. The pain, often associated with limitation of motion, incapacitates patients and affects their professional and personal activity, which leads to some frustration, also, for the health professionals. It is also common to verify an emotional involvement in these diseases, thus making its treatment a challenging and demanding objective to fulfill.

Acupuncture (ACP) is a treatment touted as effective in reducing pain, sometimes with immediate effect.

From the foregoing, discover or test solutions that represent a good therapy for painful shoulder is always a present goal. Knowledge of Traditional Chinese Medicine (TCM), particularly ACP, is a valuable aid in the treatment of painful shoulder. So we decided to study the effect of one of his techniques on pain and Range of Motion (ROM) in the Shoulder Pain (SP). Anything that can help is welcome.

STATE OF ART

The painful shoulder as multifactorial pathology, has gathered a lot of research to achieve consensus on its evaluation and treatment. However, and often seen in review articles, still needs more evidence. Several methods for evaluation and treatment, used alone, together or comparing among them, vary their efficacy results.

ACP, although a technique that has been used for thousands of years, has been collecting more and more followers, being increasingly used to treat pain and musculoskeletal disorders [1, 2]. The analgesic effect and the rapidity with which it acts, can be used in acute and chronic pain [1, 3]. Its effect in chronic pain is best known, because it is not a first-line treatment, often a therapeutic choice only when others did not result [3, 4].

Compared with placebo groups or with other methods not always acupuncture shows positive results, revealing a need for more and better evidence. The method of evaluation and application of acupuncture and the consequent choice of points may also influence the results.

In a review for ACP and actions, Lin et al., conclude that no consensus has already been reached, but the endorphins theory is probably is the most admitting one among others. Despite no consensus, the analgesic effect of acupuncture is hypothesized to be through immune, hormonal and nervous systems. There are two different strategies of performing acupuncture therapy, manual acupuncture and Electroacupuncture (EA). Revealing the EA the advantage of combined therapeutic effects of transcutaneous electric nerve stimulation (TENS) and manual acupuncture [5].

ACP was also tested mixed with others therapies, also showing good effects. In a literature review for interventions in subacromial pain, Johansson *et al* (2002) found positive effects with acupuncture, when compared with corticosteroids, Non-steroidal anti-inflammatory drugs (NSAIDs), TENS, Ultrasound (US) therapy and strengthening exercises, even when compared with placebo, Strengthening exercises also decreased pain, increased abduction, flexion and inward rotation, and diminished functional disability. Considering US and TENS she found no differences between the two therapies, but no efficacy with those treatments. Despite the low level evidence and the lack of specification of which treatment rendered the outcome, mixed therapies, decrease pain and improve ROM and functional disability [6].

Guerra *et al* (2003) in a 201 cases observational study for five different acupuncture techniques (auriculotherapy, body acupuncture, moxibustion, cupping, EA), found that body acupuncture was the second most frequently used treatment and that altogether reached a good outcome: 59,7% were clinically resolved and 33,8% got a remarkable improvement [4].

Pirotta (2007), referring a Cochrane review in Australia, considering nine trials involving 500 patients, found no short term improvement in shoulder pain. Comparing ACP with placebo in shoulder function, also conclude that in the first 4 months there was significant differences, but after those differences were no lost their significance. This results were corroborated by Urruela *et al*. However this last author refers a German trial with statistically significant difference between acupuncture and placebo for the treatment of chronic SP (more than 4 weeks duration) [2, 7].

Doenitz *et al* (2012) found that it is possible no enhance microcirculation. Once some injuries of shoulder (like Supraspinatus tendon) may be related to a decrease of local circulation, ACP can be a good instrument no restore structures nutrition [8].

He *et al* (2005) studied intense ACP effect in 24 women with neck and SP, comparing real points with sham acupuncture, and also evaluating the social and psychological effect. The study shown good results, not only in physical symptoms but specially in the emotional and social aspects: quality of sleep, anxiety, depression and satisfaction with life [9].

Regarding the effect of ACP vs the type of technique applied to the control group, MacPherson *et al* (2014) reported the influence of control group (CG) and/or the type of needle used in the experimental group (EG). He found that acupuncture was significantly superior to all categories of control group. For trials that used penetrating needles for sham control, acupuncture had smaller effect sizes than for trials with non-penetrating sham or sham control without needles [10].

The AP have specific localizations and specific effects, not corresponding to the spinal nerve segment, but to the meridian. This specificity allows to compare the effects of the true AP with the false AP [11].

A good trust of general practitioners and physiotherapists (73%) in the short-term effect of ACP are common [12].

EPIDEMIOLOGY

Chronic SP is the third most common type of musculoskeletal pain [13].

It is consensus among several authors that the prevalence of SP is uncertain. It can fluctuate between 4 to 34%, according to different studies in different countries [2, 4, 13-16].

The SP is common in much of the world population interfering with daily life activities and with the active rehabilitation of other pathologies[17].

The SP has a direct relationship with age, increasing its prevalence with the aging, being one of the causes of chronic pain (CP). The CP and consequent dysfunctions, with heterogeneous distribution and high prevalence, is recognized as a major public health problem, with physical, psychological, family and high economic impact implications in different countries [18].

Being the SP, usually, a chronic condition, and to avoid discrepancies, we decided to focus on its prevalence in Portugal, housed in studies of chronic pain, whose include the shoulder pain. The prevalence of chronic pain in Portugal is around 34%, in which shoulder pain is present in 12% of the affected population [19, 20] (see table 1)

Pain characteristics		Subjects with chronic pain ^a (n = 2213)	Opioid analgesics use		P value ^b
			Opioid users (n = 79)	Opioid nonusers (n = 1756)	
Pain duration	Pain duration in year: M (P25–P75)	10 (4–20)	10 (4–20)	10 (5–20)	0.834
Pain-persistence pattern ^c	Noncontinuous CP: n (%)	1038 (47%)	17 (22%)	677 (39%)	0.002
	Continuous CP: n (%)	1167 (53%)	62 (78%)	1073 (61%)	
Pain intensity	Pain on average (0–10 NRS): M (P25–P75)	5 (4–6)	5 (4–6)	5 (4–6)	0.898
	Pain at its least (0–10 NRS): M (P25–P75)	3 (2–4)	3 (2–4)	3 (2–4)	0.686
	Pain at its worst (0–10 NRS): M (P25–P75)	8 (7–10)	9 (7–10)	8 (7–10)	0.232
	Pain right now (0–10 NRS): M (P25–P75)	4 (2–6)	5 (4–6)	4 (2–6)	0.036
	Mild pain intensity ^d : n (%)	685 (53%)	25 (40%)	648 (54%)	0.014
	Moderate pain intensity ^d -n (%)	287 (22%)	23 (37%)	260 (22%)	
	Severe pain intensity ^d -n (%)	322 (25%)	14 (23%)	300 (25%)	
Pain location ^e (top 10)	Lumbar region: n (%)	775 (42%)	37 (47%)	737 (42%)	0.409
	Leg: n (%)	497 (27%)	24 (30%)	470 (27%)	0.492
	Knee: n (%)	445 (24%)	19 (24%)	413 (24%)	0.929
	Cervical region:n (%)	322 (17%)	12 (15%)	301 (17%)	0.641
	Arm: n (%)	268 (15%)	11 (14%)	257 (15%)	0.828
	Hip: n (%)	239 (13%)	11 (14%)	227 (13%)	0.807
	Head: n (%)	226 (12%)	8 (10%)	218 (13%)	0.528
	Shoulder: n (%)	222 (12%)	10 (13%)	212 (12%)	0.886
	Foot: n (%)	217 (12%)	13 (17%)	204 (12%)	0.198
	Dorsal region NOS: n (%)	216 (12%)	11 (14%)	197 (11%)	0.466
	No. of concurrent painful sites: M (P25–P75)	2 (1–3)	2 (1–4)	2 (1–3)	0.745

Table 1 – pain characteristics and pain impact in subjects with chronic pain, opioid users and opioid nonusers. Adapted from Azevedo *et al* (2013) [20]

ECONOMIC IMPACT

A common worker decreases his productivity and/or probability to work when has pain in the back or articulations. Such fact impairs socio-cultural development and represents a big expense for all society, by direct and indirect costs. At a time that we all have to work hard and longer, the inability to work, as well as the need of medical care, will surely complicate the country evolution and future global needs.

In Portugal it is estimated that the indirect costs of chronic back pain and other joints (which includes the shoulder) for disability in the short and long term are of **€ 739.85 million** [19].

Also, insurers do not escape this reality, since approximately 18% of capitals payments for disability are made to patients with neck and shoulder disorders, which are often related [21].

In a large trial, ACP plus routine care was associated with marked clinical improvements at a cost of **€10,526** (approximately \$13,000) per quality-adjusted life-year (QALY), representing very good cost-effectiveness [22].

CHAPTER 2

The Western Approach of Shoulder Pain

SHOULDER ANATOMY

Talking about the shoulder we are talking about the most complex articular segment of the human body.

The human shoulder anatomy is the mechanical base for a special capacity that is the hand movement and its fine motor activity. Much of the human survival competency is based on the capability to the detail, being the hand the finest tool, to heal or to destroy.

The design of the shoulder girdle allows for mobility of all the upper extremity. As a result, the hand can be placed almost anywhere within a sphere of movement. The combined mechanics of its joints and muscles provide and control the mobility.

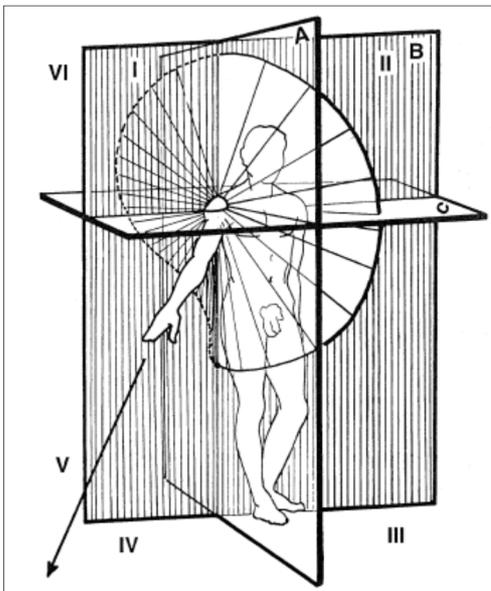


Figure 1 – Plans and axis of shoulder movements, adapted from Kapanji (2000) [23].

In the shoulder girdle complex, the only bony attachment to the axial skeleton, is made by the Sternoclavicular (SC) joint. In which the clavicle articulates with the sternum via the small SC joint. That results in a considerable mobility in the upper extremity, stabilized by an intricate balance between the scapular and glenohumeral (GH) muscles and the structures of the joints in the shoulder girdle [24, 25].

Joints of the shoulder complex

There are 5 joints that compose the shoulder girdle complex: glenohumeral, Acromioclavicular (AC), Sternoclavicular, Scapulothoracic (ST), subacromial [24].

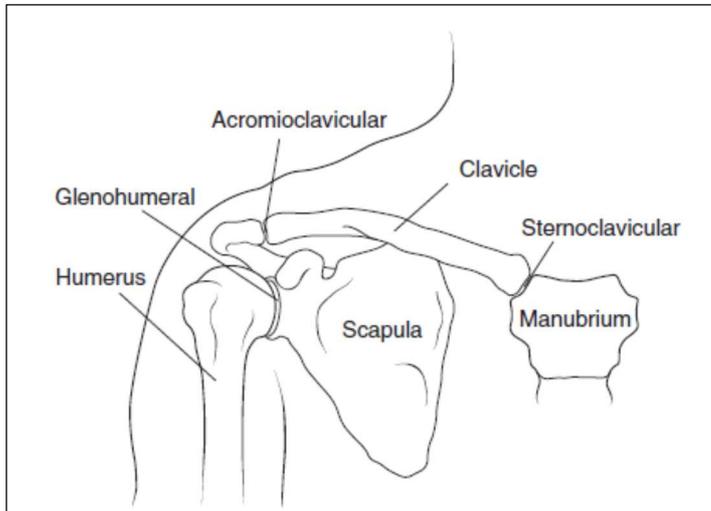


Figure 2 – Bones and joints of the shoulder girdle complex, from Kisner *et al* (2007) [24].

Glenohumeral joint

The GH joint is an incongruous, ball-and-socket (spheroidal) triaxial joint with a lax joint capsule. It is supported by the tendons of the rotator cuff (RC) and the GH (superior, middle, inferior) and coracohumeral ligaments. Some congruence is given by the concave bony partner of the glenoid fossa, by the glenoid labrum (a fibrocartilagenous lip that deepens the fossa and serves as the attachment site for the capsule), and the orientation of the glenoid fossa (that faces anteriorly, laterally, and upward). However, because of the convex bony shape of the humerus head, only a small portion of it comes in contact with the fossa at any one time, allowing for considerable humeral movement, but potential instability [24].

The structural relationship of the bony anatomy, ligaments, glenoid labrum and the adhesive and cohesive forces in the joint provide static stability. But dynamic stability is provided by the coordinated response of the muscles of the cuff and tension in the ligaments, depending on the position and motion of the humerus. Also, the long head of the biceps and the long head of the triceps brachii reinforce the capsule with their attachments. Functionally, the dynamic coordination is dependent of the neuromuscular control, including movement awareness and motor response [24] (see Fig. 3).

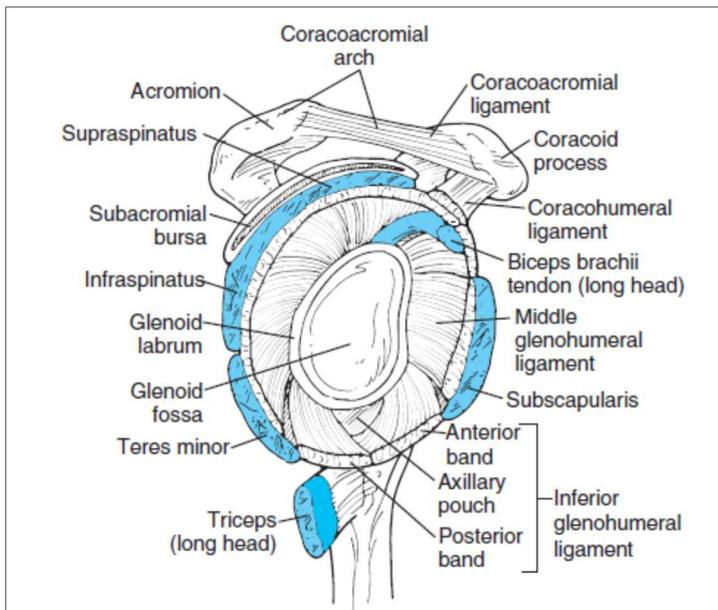


Figure 3 – Lateral aspect of the glenoid fossa, showing attachments of the glenoid labrum, capsule and their relationship to the RC and long head of the biceps brachii musculature, from Kisner *et al* (2007) [24].

Acromioclavicular joint

The AC joint is a plane, triaxial joint that may or may not have a disk. It is reinforced by the superior and inferior AC ligaments. The lateral end of the clavicle represents the convex part, and the acromion of the scapula represents the concave part.

Its movement is a slide movement, in the direction which the scapula moves.

The AC capsule, the coracoclavicular and the coracoacromial ligaments represent the static stability. Once there's no muscles crossing directly this joint, no dynamic support is given [23-25].

Sternoclavicular joint

The SC joint is an incongruent, triaxial, saddle-shaped joint with a disk that helps the congruence. The static stability is given by the interclavicular and costoclavicular ligaments. Also, once there are no muscles crossing it there's no dynamic stability. The SC moves as a result of the scapular and humerus motions, not being able to perform motion isolated [23-25].

Scapulothoracic articulation

The ST articulation it's not a pure anatomic joint, because there isn't connection between the two bone parts, but it is considered a physiologic joint. The soft tissue mobility and flexibility allows the scapula to slide along the thorax, and participate in the shoulder motions. The ST movements are: elevation/depression, protraction/retraction, up/down rotation. However, it is of extreme importance in the quality of shoulder motion, as well as in the spine posture.

The scapula is stabilized by the balance of forces. Those forces are created by the anatomical structures, as the arm weight, and by muscles (see table 2).

ST plays an important role in all arm movement, because the scapula function in synchrony to stabilize and control the position of the scapula so the scapulohumeral muscles can maintain an effective length–tension relationship as they work to stabilize and move the humerus. Without the positional control of the scapula, the efficiency of the humeral muscles decreases.

Table 2 – static and dynamic stabilizers of the scapula and GH joint, adapted from Kisner *et al* (2007) [24]

Description	Static Stabilizers	Dynamic Stabilizers
Scapula Weight of upper extremity creates downward rotation and forward tipping moment on the scapula	- Cohesive forces of the subscapular bursa	Upper trapezius and serratus anterior middle trapezius and rhomboids
Glenohumeral joint In dependent position: if scapula is in normal alignment, weight of arm creates as adduction moment on the humerus	-Superior capsule and suprahumeral ligament are taut - Adhesive and cohesive forces of synovial fluid and negative joint pressure hold surfaces together - Glenoid labrum deepens fossa and improves congruency	Rotator cuff, deltoid and long head of biceps brachy
When the humerus and the scapula is rotating upward	- Tension placed on static restraints by the rotator cuff - Glenohumeral ligaments provide interior of humeral head	Rotator cuff and deltoid, elbow action brings in two-joint muscle support - Long head of biceps stabilizes against humeral elevation - Long head of triceps stabilizes against inferior translation

Subacromial articulation

Subacromial articulation is considered another physiologic joint, composed by the acromion and coracoacromial ligament, forming the coracoacromial arch (see fig. 4). This arch overlaps the subdeltoid bursa, the supraspinatus (SE) tendon, and portion of its muscle. Important for the pathophysiology, a compromise of this space from faulty muscle function, faulty postural relationships, faulty joint mechanics, injury to the soft tissue in this region, or structural anomalies of the acromion lead to impingement syndromes and related injuries, such as RC tear [24].



Figure 4 – Left shoulder: lateral view. Detail of the acromial insertion of the coracoacromial ligament, adapted from Giacomo *et al* (2008) [26]

ACTIVE MOVEMENT OF THE SHOULDER COMPLEX

The shoulder complex in its whole, allows the following active movements, with its respective limitations: flexion/extension, abduction/adduction, external/internal rotation, horizontal flexion/extension (see fig. 5) [23-25, 27]. The showed movements respect the shoulder anatomical axis. However, the abduction movement achieves its best performance and movement quality when performed in the **scapula angle**: 30° of horizontal flexion. This angle allows the balance and uniform contraction of all deltoid and SE fibers, as well as the uniform tension in the shoulder ligaments, avoiding adverse proprioceptive actions and muscle synergies [23, 25].

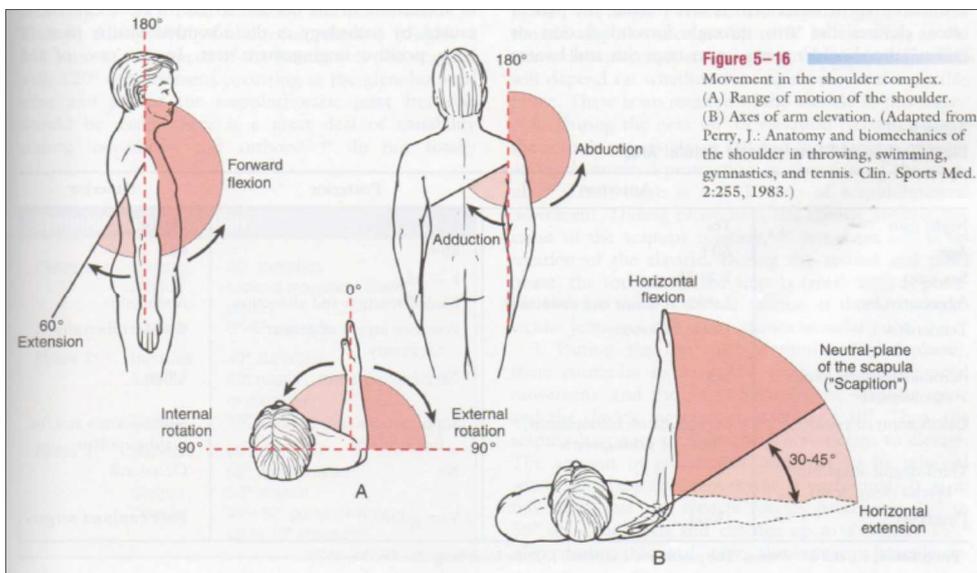


Figure 5 – movements of the shoulder complex. A – range of motion of the shoulder; B – axes of the arm, adapted from Magee (2006) [25]

SHOULDER PAIN

The SP can be defined as a pain and functional limitation due to the involvement of static and dynamic shoulder structures, as ligaments, capsule and muscles [15].

It is one of the most common complaints affecting the locomotor system, and frequently takes the patients to primary healthcare centers and specialists. The usual complications are pain, restricted movement and strength and loss of shoulder functionality [28].

It is regarded as a multifactorial pathology, whose pathophysiology is related to mechanisms of extrinsic and intrinsic order [4].

Extrinsic factors are those that result in decreased suprahumeral space and repetitive trauma (severe, or continuous as in overuse) to the soft tissues during elevation of the arm including posterior capsular tightness, poor neuromuscular control of the RC or scapular muscles, faulty ST posture with muscle imbalances, or a partial or complete tear of the tissues in the suprahumeral space (incurred during a traumatic or degenerative situation), usually the RC tear or RC tendinopathy.

Intrinsic factors include vascular changes in the RC tendons, structural variations in the acromion, hypertrophic degenerative changes of the AC joint, or other trophic changes in the coracoacromial arch or humeral head. All of these factors decrease the suprahumeral space, leading to a condition usually called Impingement [4, 24, 29, 30].

Considering the RC injury, ischemia of the less irrigated region of the tendon of the SE muscle is one of the most common causes. Overuse, and the tension overload injury of RC, subacromial inflammatory reactions and/or inability of the muscles of the RC to keep the stability of the GH joint, with consequent change of the joint dynamic, potentiate the SE injury (see fig. 6 below) [4, 21, 30].

Even when asymptomatic, the RC can be damaged, as confirms a study by Magnetic Resonance Imaging (MRI) of individuals without SP which revealed total or partial tear in 4% of the individuals <40 years old and 50% in individuals older than 60 years old [31].

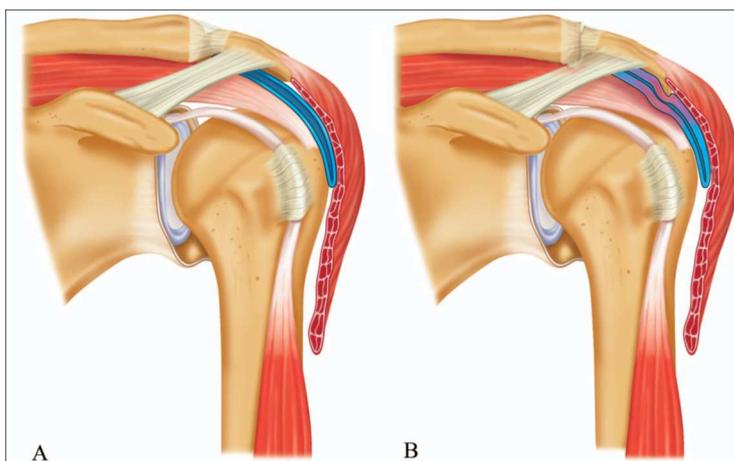


Figure 6 – A. Schematic anatomy of a healthy GH joint and subacromial space. B. Schematic anatomy of a shoulder joint with the presence of several etiologic mechanisms for Subacromial Impingement Syndrome, Witte *et al* (2011) [29].

Summary of Common Impairments with RC Disease and Impingement Syndromes

According to Kisner *et al* (2007) some, all, or none of the following impairments may be present [24]:

- Pain at the musculotendinous junction of the involved muscle with palpation, with resisted muscle contraction, and when stretched;
- Positive impingement sign (forced internal rotation at 90° of flexion) and painful arc;
- Impaired posture: thoracic kyphosis, forward head, and forward (anterior) tipped scapula with decreased thoracic mobility;
- Muscle imbalances: tense pectoralis major and minor, elevator scapulae, and internal rotators of the GH joint; weak serratus anterior and lateral rotators;
- Hypomobile posterior GH joint capsule;
- Faulty kinematics with humeral elevation: decreased posterior tipping of scapula related to weak serratus anterior, scapular elevation and overuse of upper trapezius, and uncoordinated scapulohumeral rhythm;
- With a complete RC tear, inability to abduct the humerus against gravity;
- When acute, pain referred to the C5 and C6 reference zones.

Common Functional Limitations/Disabilities [24]:

- When acute, pain may interfere with sleep, particularly when rolling onto the involved shoulder;
- Pain with overhead reaching, pushing, or pulling;
- Difficulty lifting loads;
- Inability to sustain repetitive shoulder activities (such as reaching, lifting, throwing, pushing, pulling, or swinging the arm);
- Difficulty with dressing, particularly putting a shirt on over the head.

DIAGNOSIS AND EVALUATION

When talking about the SP diagnosis, clinical history plays an important role, often representing a large part of the assessment. It should be done in a systematic and detailed manner. Patients often complain of a dull pain, many times diffuse, that worsens with movement. Have difficulty moving the shoulder close to 90 degrees or above shoulder level, as well as perform the movements behind the back (tighten the bra or apron). Are preferred activities below shoulder level and avoided above this level (extend clothing, DIY jobs) Pain is the principal complaint, which may or may not be associated with weakness or stiffness [32].

Below are some points to consider, as well as the relevant information to take from them. However, other elements can be considered when assessing the patient [33].

Table 3 – Questions to consider when collecting clinic history, *Adapted from Petty (2007) [34]*

Points assessed	Information
<i>Area of symptoms</i>	Anatomical regions or structures; Local or distal
<i>Quality of pain</i>	Arcs of pain; radiating pain
<i>Pain intensity</i>	VAS
<i>Pain Depth</i>	Deep or superficial structures
<i>Changes in sensitivity</i>	Dermatomes; cervical involvement
<i>Constant or intermittent symptoms</i>	Gravity; presence of other disease; structures involved
<i>Connexion of symptoms</i>	Relate pathologies and / or anatomical regions
<i>Factors that aggravate or alleviate symptoms</i>	Think about the causative agent of injury or therapeutic (hot / cold)
<i>Behavior of symptoms throughout the day</i>	Nature of injury
<i>Stage of the pathology</i>	Study the evolution of the lesion (better, worse, stable); relapses
<i>Recent activities</i>	Cause of injury

Observation is another point of evaluation. It should be observed posture, muscle tone, soft tissues and the movements performed by the affected limb [34].

PHYSICAL EXAMINATION

Active movements

The patient is asked to perform the shoulder's physiological movements, and comparing with the contra lateral shoulder, the following parameters are evaluated [34, 35]:

- Quality of movement;
- ROM;
- pain behavior along the amplitude;
- presence of resistance across the width and end of amplitude;
- muscle spasm provocation;

If necessary, physiological movements may be evaluated passively, as a differential diagnosis between contractile or not contractile structures [35].

When muscle weakness is observed or suspected, muscle testing can be performed. These tests evaluate selective muscle strength

Provocative Tests

Provocative tests pose, selectively, certain structures in tension or compression, in order to test their involvement in symptoms. These tests are performed by the examiner [32], and can involve passive or active movement of the patient. Attached, there's a table with the tests that can be applied (annex 1).

Diagnostic Laboratory Tests

X-Ray

The X-ray examination, often used as a routine examination or as first-line exam, can give a good help in the diagnosis. Performed in several incidences, may reveal information such as sclerosis or formation of spurs in the front edge of the acromion, AC joint osteoarthrosis, calcifying tendinitis.



Figure 7 – GH arthrosis with higher deviation of the humerus (impingement), adapted from Turtelli (2001) [36]

Ultrasound (US)

US is the primary instrument of diagnosis of SP and rupture the RC. Has advantages such as low economic cost, is a noninvasive, well tolerated by patients, rapid execution, is not contraindicated when there are implants or other artifacts, studies the dynamics of the shoulder in real time. However, it also has disadvantages, such as: depends on the ability and experience of the examiner, difficulty in observing deep tissue in obese patients and due to its location, it is difficult to observe the subscapularis muscle.

CT Scanner

CT Scanner is an exam that evaluates the joint structures and surrounding soft tissues of the shoulder with a good level of detail. Despite its high sensitivity and specificity (100%) in the identification of complete tear of RC, have limitations in tendonitis and partial tears (17-43%).

Magnetic Resonance Imaging

Allowing detailed differentiation between bone, bone marrow, tendons, muscle tissue, ligaments, capsule, synovial bags, among other elements, MRI is the goldstandart examination for complete evaluation of the shoulder. In this test, all RC pathological conditions, like tendinopathy, or total rupture can be evaluated.

Besides being very sensitive and specific in detecting partial ruptures, MRI can identify intra-tendon or synovial portion of the tendon ruptures [32].

Arthrography

The main indication for arthrography is to identify full tears of the RC and guide the infiltration of intra-articular corticosteroids. One iodinated contrast medium is introduced, and then several radiographs at different joint positions are executed. It has been replaced by MRI, but still being an alternative when the patient has contraindications to MRI.

Nuclear Medicine

Bone scintigraphy is not normally used in SP, but is a good exam when other tests are incapable of showing unclear masses. So, with avid advice you to visit or when it is not possible to determine the cause of symptoms with other tests, the use of radioisotopes can be crucial in diagnosing [33].

Conventional Treatments

Conservative treatment

The main objective in the conservative treatment of SP is pain relief. Different therapies are used: selective resting, avoiding movements that cause injury. The use of pure analgesic or NAIDs; physiotherapy (electrotherapy, ultrasounds, shock waves, kinesiotherapy, laser thermotherapy); use of sub-acromial corticosteroid injections; supra-scapular block with bupivacaine; the reestablishment of the arc of scapulohumeral motion; stretching of the capsule and GH muscles, therapy focused on cervical and dorsal column (in close relation with the shoulder) and *"wait and see"* or *"let's suspend the treatment for a while"* [4, 28, 33].

Physiotherapy

Physiotherapy and rehabilitation of the SP is divided essentially into three phases: the reduction of pain, inflammatory signs and improving range of motion of the shoulder; modifying the pattern of motion of the shoulder; strengthening the stabilizing and phasic muscles of the shoulder and proprioceptive improvement. The first step can be accomplished by taking NSAID's. The training specific movements using feedback for electromyography provides positive effects on pain and movement pattern [37].

Ultrasound Therapy [38, 39]

US are sound waves of high frequency inaudible to the human ear, a device produced by the piezoelectric effect and transmitted to the skin for a vibrating probe through which penetrate the body. Must be using a conductive product, typically a gel, but also water may be used. Can be applied in continuous or pulsed mode.

The resulting mechanism for applying a kinetic or mechanical energy that, when absorbed by the body, turns inside in a different energy.

The US manifest the following effects: improvement of ionic exchanges, increased temperature (hyperemia), improvement of cellular nutrition, improvement of cell polarization, increased activity of local metabolism, improving lymphatic circulation and decreased pain.

Besides being trusted for a large part of the clinicians, Johansson *et al* (2002) did not find significant evidence in its use [6].

Shock-wave therapy

The high energy shock wave therapy ($>0.28\text{mJ/mm}^2$) is effective (moderate to strong evidence) in the treatment of calcified tendinopathy of the RC in the medium and long term. However, in non-calcified tendinopathy the effect is not so evident. Focusing of shock waves in the deposits of calcium is more effective (moderate evidence) than focus on large humeral tuberosity.

Laser Therapy [38, 39]

The laser (*Light Amplification Stimulated Emission Radiation*) comprises applying energy to the body of the electromagnetic spectrum, in the form of light, to facilitate their biochemical activity. This light is applied to the body in a modified and controlled way, well measured so as not to cause cellular damage manner. Typically, a monochrome light is used, composed of a single wavelength, thereby controlling and isolating the light which is intended to emit.

Its application is made directly to the affected region is very well tolerated and has immediate effects. The effects are: improvement of protein synthesis, increased ion exchange, enhance the generation of new organic molecules used in the regeneration

and energy intake. Fundamentally, the laser favors the intercellular environment and facilitates assisted exchanges between the active cells and their extracellular environment.

Massage

Massage is the manipulation of soft body tissues and is usually carried out manually. With benefits like, improvement of large and micro circulation, improvement of lymphatic flow, improvement of interstitial permeability, control of scar tissue formation, release of adhesions and fibrous tissue, improve the muscle flexibility, action in nervous tissues (special in pain peripheral terminations) it releases pain [40].

The massage can be very important not only in the injured tissue, but in the surrounding tissues, like muscles, improving mobility and range of motion, as well as releasing muscle tension.

According to *Cyriax* (2001) deep transverse massage, breaks down scar tissue adhesions created by successive tendon injuries, relieving symptoms and preventing relapses. The therapist performs a digital friction on the exact site of the lesion and transversely to the direction of the affected fibers [35].

Administration of Sub-acromial corticosteroid.

Consists of a suprascapular nerve block with *bupivacaína*. Well tolerated, sees its best effects in arthritis and/or degenerative joint disease [33].

Suprascapular nerve block may be more effective than placebo at reducing pain in people with frozen shoulder, but not in improving shoulder function (measured by Simple Shoulder Test) or ROM. However, it improves pain, disability, and ROM in people with rheumatoid arthritis, degenerative disease, or both [21].

NSAIDs

Murphy et al (2009) in his revision, found that oral NSAIDs compared with placebo in people with RC disease Oral NSAIDs may be more effective than placebo at reducing pain at 7 to 14 days in people with acute-onset shoulder tendonitis, subacromial bursitis, or both, and at reducing pain at 14 days in people with acute shoulder pain of less than 96 hours' duration. But he couldn't find if oral NSAIDs are more effective than placebo at improving pain or abduction at 4 weeks in people with RC tendinitis of more than 72 hours' duration [21].

Corticosteroids

The infiltrations of corticosteroids to reduce inflammation and pain may have a significant therapeutic effect and facilitate mobility and function [41].

However, the adverse effects of oral corticosteroids are well documented and include a wide array of problems affecting many body systems. Common or serious adverse effects include: osteoporosis, diabetes, dyspepsia, weight gain, and impaired healing. These effects can be minimized by using the lowest effective dose for the minimum period possible [21].

Both these chemical treatments gather the highest preference of clinicians (89-94%). However, due to their side effects and sometimes the constraints of some patients to take them, they cannot be always used.

Surgical Treatment

While responding positively to the conservative treatment, there are cases where surgery may be considered as a solution.

The timing for surgery is often difficult for the practitioner. So, it must be taken into account the desired performance for the joint, the state of injury, the age and comorbidities of the patient. If in a young patient, the main goal is to maximize strength and function in an older, the main purpose is pain relief.

In general, the absolute surgical indications are acute loss of strength, posttraumatic, in young and active without previous dysfunction of the RC. The surgical indications are relative refractory pain or muscle weakness for adequate conservative therapy for 3-6 months [33].

THE PAIN

According to the *International Association for the Study of Pain* (IASP), pain is defined as "*an unpleasant experience multi-dimensional, involving not only a sensory component but also an emotional component and which is associated with a real or potential tissue damage, or is described in terms of such damage*". By current knowledge, pain does not generate any measurable biological indicator, whereby the intensity of pain becomes the one that the patient relates, and thus a subjective data [42].

CHAPTER 3

Traditional Chinese Medicine

The Heidelberg Model

TRADICIONAL CHINESE MEDICINE (TCM)

TCM is a system of diagnosis and health care that has evolved over the last three thousand years. The first records found report for the year 1000 BC the *Chang Dynasty*, which at the time already addressed sophisticated problems of medicine [43].

The first known book on the subject of Chinese Medicine, the *Huangdi Neijing* - the *Yellow Emperor Cannon of Internal Medicine* - dates back to the years 475–22 BC and documents human structure and physiology as well as disease pathophysiology and treatment procedures.

TCM is recognized by the World Health Organization (WHO) (2010) as variety of therapies and medicinal practices employed in China for the last two millennia, developed from clinical experience and recorded in classical ancient scripts.

The TCM is based on a holistic and systematic theoretical structure of a philosophical nature, focusing his study and action in respect of the yin/yang, the five elements theory and in the circulation system of energy through the meridians of the human body.

There are seven main treatment methods of TCM [44]:

- Tui Na ou Tuiná (推拿) (massage);
- Acupuncture (針灸);
- Moxibustion (艾炙);
- Vacuotherapy (拔罐);
- Fitotherapy (中藥);
- Dietetics/Nutrition (食療);
- Physical Practices: integrated meditation exercises, breathing and circulation of energy, such as *Qi gong* (氣功) or *Tai ji quan* (太極拳).

Under the upgrade, systematization and universalization of concepts, practices and teaching, in the 1950's, these principles were modernized in order to integrate many anatomical and pathological notions with modern scientific medicine.

In the *I Ging* (“The Book of Changes”, the oldest book of mankind), the *yin* and *yang* signs are presented as a mathematical expression of numbers. This binary numbering system developed by Leibniz enables to describe circular processes, the monad, bigram and trigram [45].

Following this new approach, a new system began to be studied and developed: the Heidelberg (HD) Model.

In this model, homeostasis and their regulation, plays a key role in the understanding and balance of the human body. Thus the functioning of the human body and its physiological adjustment processes derive from the fact that state of balance is a constantly changing process and not a stationary process. If this balance is disturbed, symptoms are developed.

THE HEIDELBERG MODEL OF TCM

According to the HD School of Chinese Medicine (Greten 2011), TCM is a system of findings and sensations, designed to evaluate the functional vegetative state of the body, further treated by a set of tools such as Chinese dietetics, TCM psychotherapy, TuiNa massage technique, Chinese phytopharmacology, QiGong and ACP [46].

Being a scientific model, the HD Model explains TCM in a logical and systematic manner. Based on the work of Leibniz, who decoded the *I Ging* (the mutations book) in a binary language, the human physiology can be described as a **circular process**. Like in mathematics and physics, the human body can be analyzed using the trigonometric measurements and respective force and direction vectors.

Body homeostasis or regulation, may best be understood through the thermodynamic study of the water when heated. Imagining a water container, a heat source, and a controller (thermostat), and establishing a standard temperature like 37°C (**target value**), we can recognize the processes of homeostasis. Water as our internal environment, the heat source as the different stimuli to which the body is subjected and the thermostat as the monitoring mechanisms and regulation.

The analogy with this system tells us that our body does not hold our target value as we expected. For when we cut the supply of heat to the water, this takes a while to cool down until it reaches the target value. The same happens when we supply heat to the water, it does not heat up immediately. That makes our regulation system working in an up and down movement forming a **sinus wave** (see fig. 8).

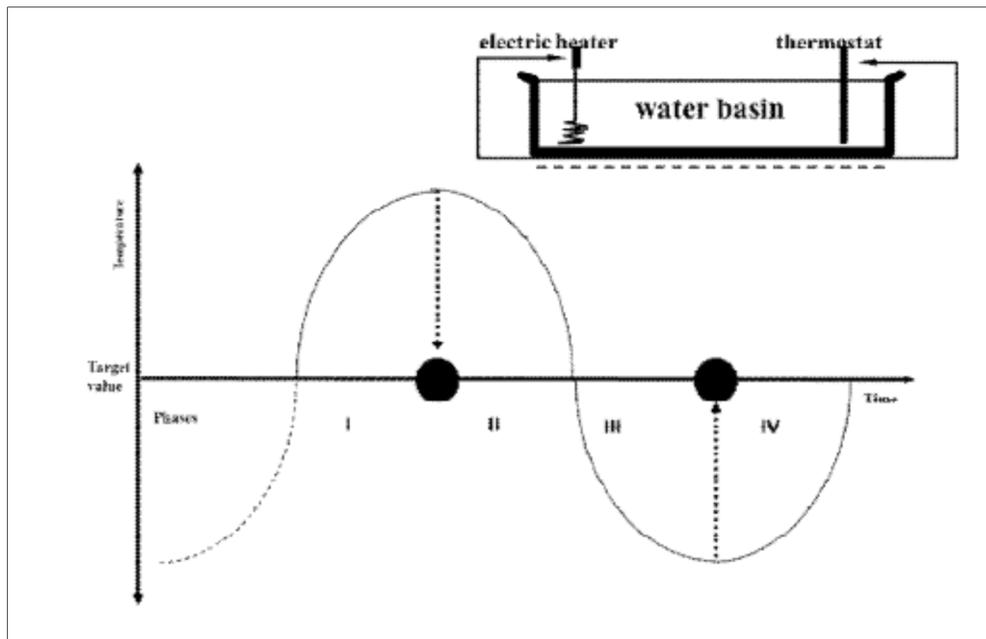


Figure 8 – Model of the “Water basin”, adapted from (Greten, 2011) [46]

Phases as a circular process of vegetative functions

TCM considers a parallel between living organisms and their surroundings, the Nature. Thus, for example, the environment is divided into four seasons, the functioning of the human body is also divided in cyclic processes, the **vegetative functions**.

Given the circular and chained character of regulatory processes, HD designates as **phases** the following commonly called elements: **Wood** (related to spring); **Fire** (related to summer); **Metal** (related to autumn); **Water** (related to winter) and fifth the **Earth**.

Defining *phase* as: a cybernetic or regulatory term, part of a circular process, a vegetative functional tendency which is manifested in a specific body part by means of clinically relevant signs and symptoms named **orbs**.

An orb, according to HD model, may be considered as:

- “clinical manifestation of a phase, named after a region of the body (body island)”;
- “a group of diagnostically relevant signs indicating the functional state of a body island (body region), which correlates with the functional properties of a conduit”.

Although it may show similarities with the designation of human organs according to Western medicine, an orb is an organ pattern or the signs manifested by that organ.

The Scientific HD model of Chinese Medicine is based on a simplified model of **body regulation**. In this model, the vegetative functions are expressed cyclically, resulting in a sinusoidal curve whose vectors have reference to a baseline value, which represents the homeostasis (horizontal line).

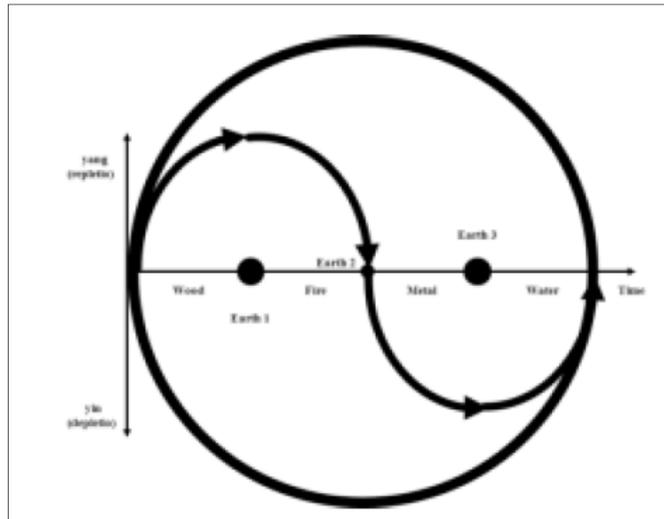


Figure 9 – Sinusoidal curve representing the circular process of phases, adapted from *Greten* (2012) [47]

The regulatory model leads us to understand better how to express phases. Just as one season comes threaded in before, with new features, temperature, color, influence on the planet; phases arise in a regular thread, manifesting vegetative functional tendencies. Thus the phase transitions give the following sequence: **wood-fire-earth-metal-water**. Here, the phase earth has a role of up-regulation or down-regulation, working as a vector which supports the transitions between phases.

As Greten's (2011) advocates that below the base line, are the yin phases in which parasympathetic stimuli is more expressed. On the other and, above the base line are the yang phases, where the sympathetic nervous system prevails. Phases Wood and Fire are characterized by a hyper-tone and hyper-dynamic **vegetative state**, when compared to Metal and Water, that are respectively more hypotonic and hypo dynamic [46] (see fig. 10).

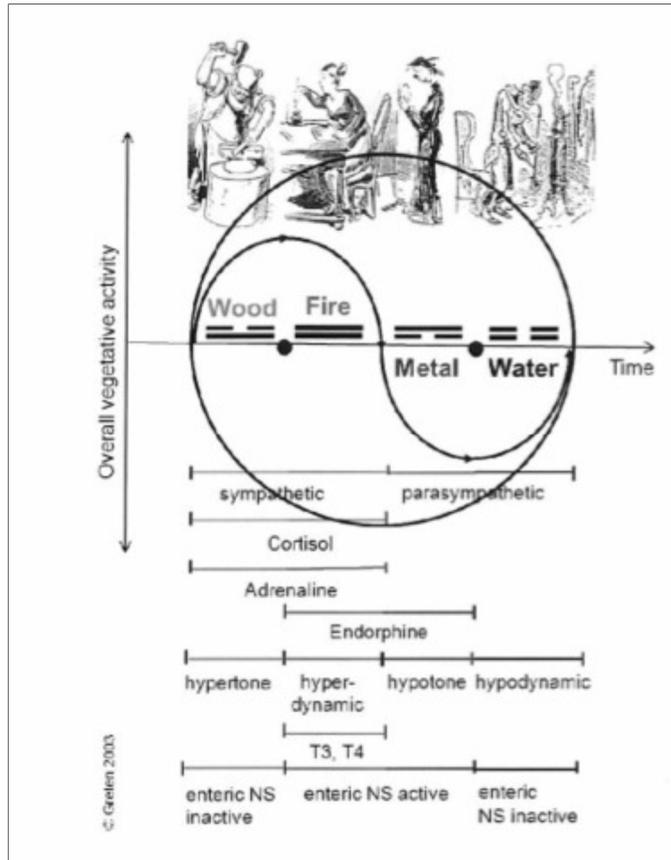


Figure 10 – the phases with respective Western medicine features, adapted from Greten (2012) [47]

Yin, Yang and The three treasures of TCM: Qi, Xue and Shen

Yin and Yang

Yin and yang are probably the most familiar words of TCM. In fact they are the basis of his understanding.

Are fundamental principles and complementary opposites that interact with each other and help the perception and understanding of various contradictions in anatomy and physiology of the human body, as well as diagnosis and treatment.

Having been first time reported in the *I Ging*, in the form of continuous and broken lines, forming the trigrams and hexagrams also formed a possibility encoding and systematization of philosophical concepts.

The Yin is defined according to Porkert (1999), as the structural part, something static, the physiological somatization, and the Yang is action, is alterations, modifications and can disappear or destroy, or even emerge as something dispersed [48].

According to Greten (2011), they are a pair of terms to describe functional relations in Chinese culture and language.

Philosophically they derive from the simple observation of nature, showing an interdependence between all that exists. For example, when the sun lays his sun-rays over a mountain, defines one sunnier side and one shadow side. However, if on the sunnier side we put a house, it will have a bright and shady side, thus creating shade in the light, creating yin within yang. So everything that happens in the Universe has two opposite and interdependent aspects and yin and yang is a way to express that thought.

For Jia J. (2004), yin and yang are relative terms to express the polarity and not static, but dynamic, constantly changing, meaning that there is only cold and heat, but heat becoming cold and cold transforming into heat [49].

According to HD and framing the yin and yang in a regulatory context of homeostasis, they may have the following meanings:

<i>Yin</i>	<i>Yang</i>
Below target value	Above target value
Descending values, such as in downregulation	Rising values, such as in upregulation
Lack of substrate causing instable regulation	Functional, primarily regulatory problem

Adapted from Greten 2012 [47]

If we put these terms in the medical context, we identify them with the following main meanings:

<i>Yin</i>	<i>Yang</i>
Less vivid, less qi	More vivid, more qi
Colder	Warmer
Outside, exterior	Inside, interior
Function	structure

Adapted from Greten (2012) [47]

Qi, Xue and *Shen* are the three kinds of functional capacity within human beings.

The Qi

There is something powerful in the Universe that is sometimes called the vital force that forms and animates us.

In China, the *qi* is metaphorically represented by a pot of boiling rice with the lid open through which the steam escapes. *Qi* can then be immaterial as steam or dense like rice.

Qi is energy and as such can take various forms and states. Every moment that condenses *qi* assumes a material form and when dispersed the *qi* assumes a more tenuous form. *Qi* is a continuous formation of matter and energy that continuity can be seen by the principle that energy is unique, not lost, not destroys, not creates, and the total amount of matter and energy is not variable. When an amount of energy seems to have been destroyed, it was actually processed.

No match for western medicine *qi*, which makes it often difficult to understand. *Qi* is difficult to be observed, measured or weighed. To understand it you must believe that it exists. Not being visible *qi* is observed through the activities that it manifests.

Porkert (1999) postulates the *qi* is an immaterial energy with a qualification and direction [48].

With base in this designation, the HD model defines *qi* as the individual vegetative **capacity of an organ or tissue to function, which may cause a sensation of tearing, pressure or flow**. The *qi* has 3 subdivisions:

- Qi originale, original *qi*: *qi* directly originating from the yin. Original *qi* is the power to create the vectors of the phases and is then processed to form further functions of the orbs such as their diagnostically relevant signs;
- Qi defensivum, defensive *qi*: form of *qi* located outside of the conduits within the tissue. Predominantly residing within the surface. Its distribution is believed to be dependent of a good breathing. Considered to ward off exogenous pathogenic influences;
- Qi nutritivum, or nutritive *qi*: *qi* originating from food.

The Xue

Many times translated as blood, in TCM understanding it is more than what Western medicine comprises as blood functions.

The HD designs **Xue** as being a “*fluid that regenerates, restores, moistures and energizes the functional tissues of the body*”. Besides the functions assigned to the blood by Western medicine, such as heating, transport of oxygen, hormones and nutrients, TCM emphasizes the emotional effects of a balanced fluid and microcirculation.

The Shen

In TCM **Shen** is the “*functional capacity to bring order into the emotional processes and order into associations*”. In other words, emotional and associative confusion come by a lack of Shen, resulting in a lack of stage presence, incoherence of speech and lack of motor coordination (specially fine-motoric).

In a Western vision, we can see the *Shen* as our concentration, our motor coordination and other skills that depend of the cognition aspect. Summing it up, is our presence of mind.

The channels of Qi circulation: the conduits

The qi flows in the body thru specific pathways usually called meridians (much due to the meridians of the Earth's topography).

For Jia (2004) a meridian is a "zone of influence". Meridians are no channels or imaginary lines that run through the body, but areas where there are higher concentrations of qi, and greater ability to influence certain physiological function [49].

Similarly, Greten (2011), by the HD, defines a meridian as a “*connection of a group of points with effect on the clinical signs of an orb, believed to serve as a conduit for the flow of Qi and Xue*”, renaming it as a **Conduit** [46].

The qi circulates through ducts covering the whole body. If balance exists in the circulation of qi, all conduits are strong and well-energized and all body tissues are properly nourished, resulting in a healthy organism. Imbalances on qi flow, might result in a

pathological imbalance, therefore, ACP is used as a means to correct them by specific AP's within these conduits that in turn will develop specific regulatory actions.

There are twelve main conduits, also called “Cardinal Conduits”. There are 6 yin conduits and 6 yang conduits. They are symmetrical conduits, in other words they extend in mirrored symmetry over the right and left halves of the body: 3 of them leading from the hand to the chest, and 3 from the foot to the upper body.

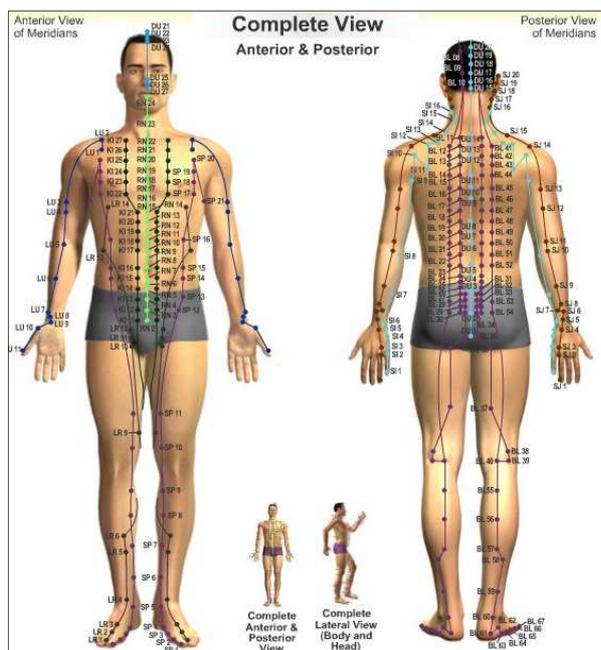


Figure 11 – Cardinal conduits of the body, taken from: <http://piramidal.net/2012/01/26/mapa-de-meridianos-de-acordo-com-a-acupuntura/> in 29/09/2014

Despite of, more conduits were added to the twelve principal: twelve paracardinal conduits (*sinarteriae paracardinales, jingbie*); eight odd cardinal conduits (*cardinales impares, qijing bamo*, abbreviated to “Odd Conduits”); fifteen reticular conduits (*sinarteriae reticulares, luomo*); parareticular conduits (“Reticular Branch Conduits”, *sinarteriae parareticulares, bieluo*) and reticulars of the third generation (*reticulares parvulae, sunluo*) [50].

According to TCM each conduit connects to a particular “inner organ”, all conduits, are considered to extend on the surface of the body (also known as *extima*) within the skin and to communicate with inner parts of the body also known as the *intima*. Considering this communication between surface and intima, we might explain the disturbances that arise to the surface, and why they can be diagnosed and influenced by therapeutic manipulation [51, 52].

Each phase contains two conduits with the exception of phase fire that contains 4.

For the same reasons listed before, for the HD of TCM, the conduits are also designed in a specific way. These are the phases with the respective conduits, with HD designations, between closing parenthesis are the common names [46]:

- Phase Wood: *Hepatic* (Liver) and *Felleal* (Gall bladder);
- Phase Fire: *Cardiac* (Heart), *Tenuintestinal* (Small intestine), *Pericardial* (Pericardium) and *Tricaloric* (Triple burner);
- Phase Earth: *Stomach* and *Lienal* (Spleen);
- Phase Metal: *Pulmonal* (Lung) and *Crassintestinal* (Large intestine);
- Phase Water: *Vesical* (Urinary bladder) and *Renal* (Kidney).

DIAGNOSE

According to HD of TCM, the most important element of the all model is the **diagnosis**. If we take a major indication of the large difference in HD model from other models, is that he bets at all the time in the diagnosis in all cases.

How balance can be affected: “how to become sick”

According to the model of Heidelberg, there are four mechanisms how the diseases happen, that create imbalances, and they are:

- Excess of an agent, the pathogenic factor causing the imbalance;
- Problems of transition, a phase transforms in the next phase as a functional vegetative regulation occurs in a cyclic way, if the natural transition between phases doesn't occur, a dysregulation takes place and a disease might be manifested;
- Imbalance of antagonizing phases, as the phases are upward and downward “vectors”, outlined in a compassed rose, it can be imbalances between phases that are not consecutive, but are in opposite positions in the already described sinusoidal curve;
- Yin deficiency, if there is a Yin deficiency, this means that there is a structural problem. In Western terms, there is not enough cell apparatus to oppose the disease

The agents

There are three kinds of agents: the **exterior agents** (described as an analogy of the patient's exposure to the environmental conditions), the **interior agents** (the emotional conditions) and the **neutral agents** (as the risk factors and lifestyle to which the patient is exposed).

The exterior agents are:

- *Algor* – as if the body has been exposed to cold;
- *Calor* – as if the body has been exposed to heat;
- *Humor* – as if the body has been exposed to damp environment;
- *Ariditas* – as if the body has been exposed to dry environment;
- *Ventus* – as if the body has been exposed to a draught of air.

The interior agents are:

- *Ira* – over expression of anger;
- *Voluptas* – expression of uncontrollable over excitement;
- *Cogitatio* – feeling of over thinking;
- *Maeror* – feeling of grief and sadness;
- *Timor* – expression of anxiety.

The neutral agents are:

- Overwork;
- Malnutrition;
- Trauma;
- Infections;
- Toxic substances;
- Others.

Based on HD model, functional diagnosis is composed of four main steps described below (see fig. 12):

1. The **constitution**: tendency of an individual to express predominantly an “*orb* pattern”;
2. The **agent** (pathogenic factor): is considered as a functional power or a “vector” that has the capacity to change the individual functional properties, producing clinical signs;
3. The “**orb**”, are group of diagnostically relevant signs that indicate the functional state of a body island, which correlates with the functional properties of a conduit;
4. The **guiding criteria (GC)**, is regarded as directional standard conventions of physiology, permit the interpretation of the actual symptoms that are a manifestation of the overall body regulation.

This fourth step, the guiding criteria, is divided into 4 different kinds of information that helps to characterize the disease. Those guiding criteria are described below:

GUIDING CRITERIA	<i>Repletio / Depletion</i>	<i>Calor / Algor</i>	<i>Extima / Intima</i>	<i>Yin / Yang</i>
RELATED PHYSIOLOGICAL MECHANISM	Neurovegetative	Humoro-vegetative	Neuro-immunological	Structural or Regulatory
SIGNS/INFORMATION	More energy or less energy; more qi or less qi	Related with microcirculation; signs and body reaction to heat or cold	Exterior or interior; is related to theory of the 6 stages of energy - <i>ALT</i> ; indicates how depth did the agent Algor has invaded the body	Distinguish between primary dysregulation (yang), or Secondary dysregulation due to a structural deficiency

Table 4 – The guiding criteria by the HD model of TCM [46]

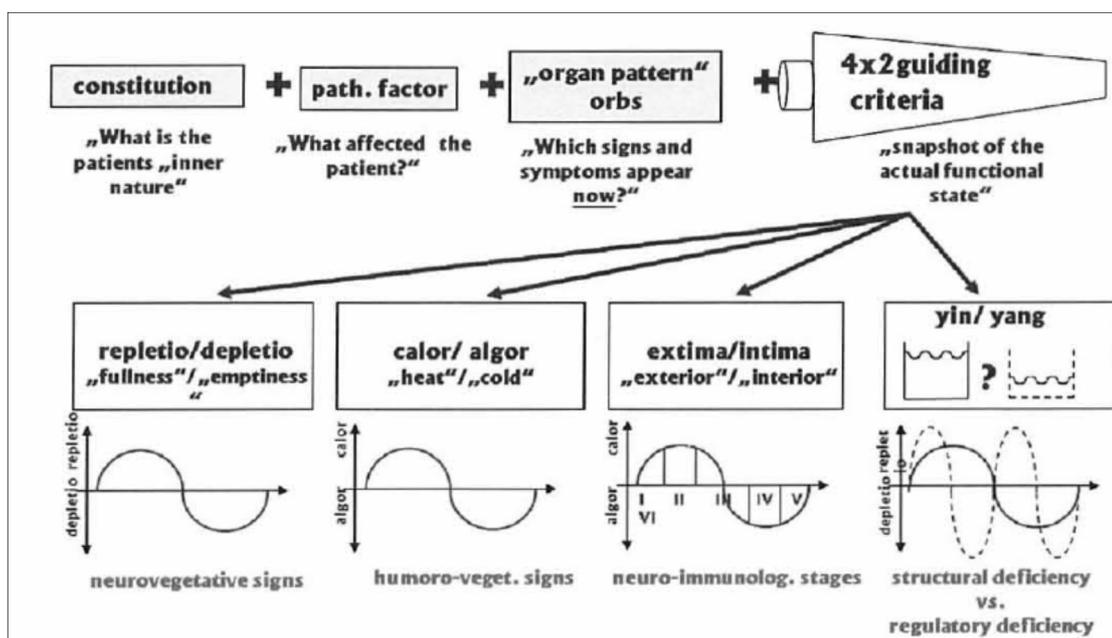


Figure 12 – the four components of TCM diagnosis, by HD model, Greten (2011) [46]

The Algor Laedens Theory (ALT) as a diagnostic system for immune-vegetative mechanism (3rd)

The ALT, also known as "Shang Han Lun", the model of six stages, also known as the theory of six layers of energy, describes the processes by which the agent cold can affect the body and the counter-action of the body to this agent. It is a prerequisite for the application of the ALT theory is that you need to have the signs of *algor* (tearing pain, hyaline coating of the tongue, pulse diagnosis, among others). The TCM calls these mechanisms of counter-action the reactive *calor*, a general increase in microcirculation that is itself a regulatory process. If in each stage, the mechanisms of counter-action fail, the *algor* invades the body.

The six stages can be divided in [47]:

- Three extimal stages, Yang
- Three intimal stages, Yin.

The *algor* in Western terms, might be translated like a lack of circulation, or decreased regional microcirculation that affect primarily the conduit that contains more *xue* than *qi*,

and may be caused by defensive reflexes to cold or virus (adhesion molecules, complement system, coagulation).

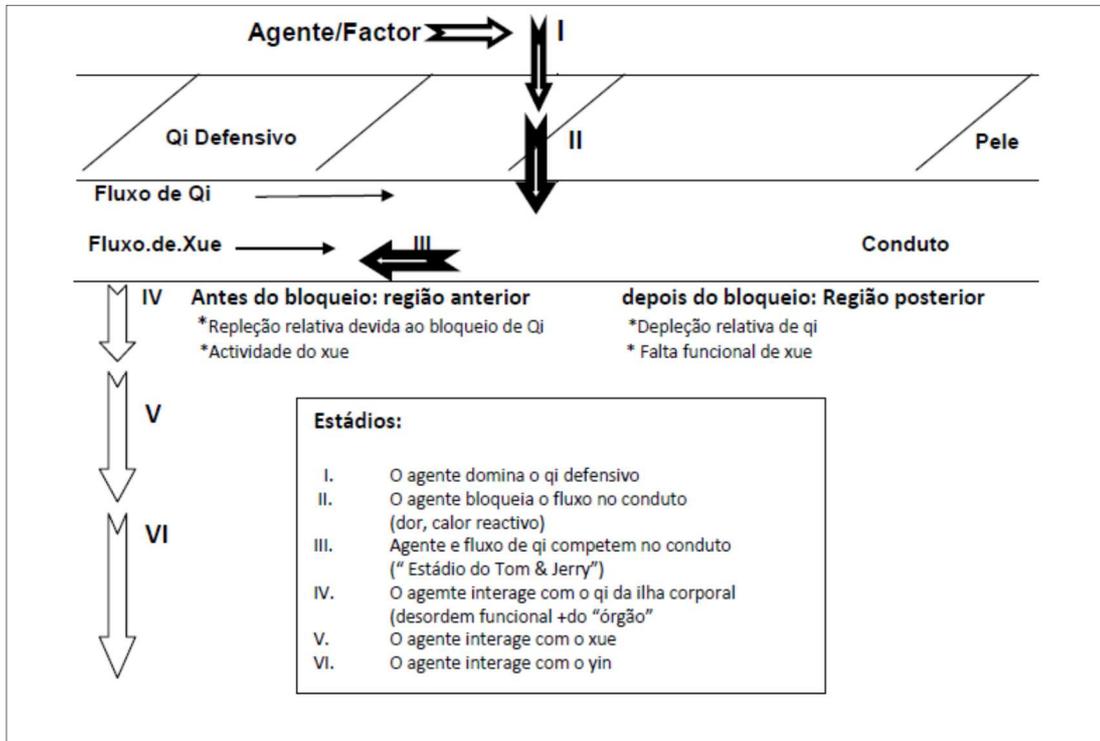


Figure 13 – scheme of the six stages with the corresponding forms of energy, adapted from Greten (2011) [47]

Each layer has a specific functional power that, when attacked by *algor*, produces the characteristic signs and symptoms. The six energy layers comprise six different forms of energy which technically are [47]:

- I. **Defensive qi** (or *Wei Qi*), resides within the *extima*, outside the conduits and creates a first defensive barrier against external attacks;
- II. **Qi of the conduit**, is the *qi* within main conduits (the "*cardinal conduits*"). If the agent blocks the *qi* flow, primarily may result in pain and secondarily in dysfunction of the respective orb.
- III. **Xue of the conduit**, driven by the conduit *qi*, it warms the conduits, while nourishes and moisturizes the tissues. This heat banishes the agent *algor*.
- IV. **Qi of the body island**, is the *qi* in the *intima* (whole body's interior), where the functions of the orbs are generated in their respective parts of the body "*islands*";

- V. **Xue of the body island**, is a substantial part of the of the body islands with body heat, thus activating and enhancing functional properties;
- VI. **Yin**, which is the functional tissue, like a subpopulation of cells, the substrate from which the functions (*yang*) develop.

The *Algor* is a Yin agent with functional properties of deprivation.

The *Algor*-induced signs and symptoms of orbs involved are categorized into 6 stages of clinical signs:

- I. **Yang major**, when the agent invades the skin, “attacks” the *defensive qi*. The defensive qi does not remain in the conduits but in the skin surrounding the conduits and in all other tissues. Symptoms may vary, but the clinically most decisive symptom, may be a general feeling of chills. The Orbs that are affect are the **Vesical** and the **Tenuintestinal**;
- II. **Splendor Yang**, when the agent *algor* enters the conduits, it creates a regional block of the flow of *qi* and *Xue*. Once flow of *qi* is more easily blocked than the flow of *Xue* as the *qi* is what moves the *Xue*, the phases and orbs that more depend on *qi*, are those more prone to this problem. In this stage the affected Orbs are the **Stomachal** and the **Crassintestinal**;
- III. **Yang minor**, if the agent *algor* dominates the flow of *Xue* in the conduit, this may lead to a reverse flow of *Xue* to the interior, leading the *algor* to the interior, causing a feeling of internal cold. Often, the inside *Xue* (yin) will be mobilized against the agent causing the sensation of internal heat again, or if the *Algor* is expelled out, even heat temporarily abroad. The struggle *algor vs xue*, expelling each other repeatedly is called the “*Tom and Jerry*” stage. Here **Felleal** and **Tricalorical** Orbs are involved;
- IV. **Yin major**, from this stage forward, the main symptoms do not come from the conduits, but more frequently from the interior (the *intima*), the “*body island*” and it respective functions. When an agent affects the *qi* of the “*body island*”, *Earth* and the *Metal* (as phases) are sensitive to the decrease of the *qi* activity, the **Lienal** and the **Pulmonary** Orbs are the most affect;
- V. **Yin flectens**, when the *Algor* affects *Xue* in the inside, the functions of the Orbs which depend on *Xue* are more easily affected than the others. By their straight

relation with the xue, signs and symptoms of **Hepatic** and **Pericardial** orbs may appear;

- VI. Yin minor**, the Yin is the structural condition to the yang development. Consequently, also the yin (functional tissue) is a technical form of energy. When this energy is affected by *Algor*, **Renal** symptoms are more likely to develop. As the *Yang* drift from the *Yin*, a similar process is the development of the Ascending Yang Qi which is in connection with the **Cardial** Qi.

CHAPTER 4

Acupuncture

The Acupuncture Physiology

ACP is one of the main forms of treatment in TCM. It involves the use of sharp, thin needles that are inserted in the body at very specific points. This process is believed to adjust and alter the body's energy flow into healthier patterns, and is used to treat a wide variety of illnesses and health conditions. The beneficial effects are created by the needles itself, without injection of any kind of drug.

In 1972, the National Institutes of Health gave its first grant to study acupuncture. The study reported that ACP was not hypnosis [53].

In 1997, a conference organized by the National Institutes of Health in the USA, a Consensus Panel reported that there was "*clear evidence for acupuncture's*". Also, ACP efficacy was evaluated as being suitable for a certain number nominations. The WHO (2002), indicates ACP for several medical conditions, specially involving pain [53, 54].

In countries like Germany, the investment in TCM is increasingly with a growth rate estimated between 20 and 22%. There is a socioeconomic element between users of TCM because it finds most fans among the wealthier layers, with more training and conservative than among the poor and who have less training (Greten, 2006).

In Portugal, ACP is recognized by the Medical Council as a "*Medical Competency*" as a result of reflections of the *Portuguese Society of Medical Acupuncture* and the approval of the National Executive Council on 14/05/2002. Nevertheless, recent legislation allows other Health Professionals to practice ACP, since they gather the conditions to obtain a professional certificate.

Regarding the eastern definition of how ACP works, using specific points connected, forming a Channel (conduit) with specific effect in the body, Western medicine has tried hard to find anatomical, histological or electrophysiological evidence to support it. However, so far, in contrast to the points, there has been no identification of anatomical basis. Nevertheless, certain findings allow the Western medicine observer to assume with great probability that the postulation of channels might be correct [55]:

1. Needles can induce sensations in the patients at sites very distant from the site of insertion. The sensations described, for example, starting in the hand and rising along the arm and up to the face, often corresponding to the description of a traditional channel. The Chinese doctors call it a "propagated sensation along the channel";

2. Considerable dermatology literature describes different eczemas, atopic dermatitis, or similar complains which correspond exactly to the path of traditional described channels;
3. TCM movement therapies and meditation, like *qi gong*, produce sensations in many patients, in pathways corresponding to the energy-flow channels;
4. In a French study, a radioactive tracer ^{99m}Tc was injected into particular acupuncture points on the leg and its spread was followed by a gamma-ray camera. Remarkably, after hours, the spread was observed to occur thru the paths of the channels.

Despite this facts, Western investigations have proposed different theories on the mechanism of ACP [5, 53, 55-57].

a) **Neurotransmitter Theory** – ACP effects higher brain areas, stimulating the secretion of β -endorphins and enkephalin in the brain and spinal cord, which influences the immune system and the anti-nociceptive system;

b) **Autonomic Nervous System Theory** – ACP stimulates the release of several types of opioids like norepinephrine and acetylcholine. That affects changes in their turnover rate, normalizing the autonomic nervous system and reducing pain;

c) **Gate Control Theory** – ACP activates no nociceptive receptors that inhibit the transmission of nociceptive signals in the dorsal horn, “*gating out*” painful stimuli;

d) **Vascular-interstitial Theory** – ACP manipulates the electrical system of the body by creating or enhancing closed circuit transport in tissues. This facilitates healing by allowing the transfer of material and electrical energy between normal and injured tissues;

e) **Blood Chemistry Theory** – ACP affects the blood concentrations of triglycerides, cholesterol and phospholipids suggesting that ACP can both rise and diminish peripheral blood components, thereby regulating the body toward homeostasis;

Nevertheless, a good explanation based on the neurophysiologic studies of the analgesic effect of ACP, is given by Hempen *et al* (2012) referring (Pomeranz *et al*) in the following steps [55]:

- I. Peripheral stimulation with as ACP needle stimulates afferent nerve cells of type 2 and 3. A real stimulation only takes place when the *qi* sensation generated is

accompanied by sensations such as numbness, dull pain, and feelings of pressure or distension;

- II. The stimulation at the periphery transmits impulses to the spinal cord;
- III. Peripheral pains (skin, joints, organs) are directly linked to the spinal cord;
- IV. In the posterior horn area of the spinal cord, the switch is made to a second neuron, which transmits the stimulation on to the thalamus and the cerebral cortex;
- V. In the spinal cord, ACP stimulation causes the release of enkephalin or dynorphins (but endorphins are not released here). The substances released cause a blockage of the pain transmission in the spinal cord and thus produce an analgesic effect. Various peptides are involved in this process: cholecystokinin, somatostatin, neurotensin, calcitonin, and angiotensin;
- VI. Impulses are transmitted from the area of the spinal cord to the cerebellum. Here, as the result of the influence of enkephalin, there is a release of monoamines. Being serotonin and norepinephrine as the most important, which are capable of having a feedback influence on the cells of the spinal cord and of preventing further transmission of pain.
- VII. In the hypothalamus, beta-endorphin and adrenocorticotrophic hormone are released. That hormone stimulates the effect on the adrenal cortex and leads to the release of cortisol. As all cells producing beta-endorphins are located in the hypothalamus, the substances are then distributed via the vascular system, producing a systemic effect.

Western neurophysiology plays an important role explaining analgesia as well as one of many effects of ACP. Obviously the release of endorphins, monoamines, and cortisone has a special feature in some ACP treatments. However, this cannot in any way explain the range and immense variability of the effects of ACP. Furthermore, this approach to finding an explanation would suggest that the precisely differentiated localization of AP would not be necessary, which contradicts the specificity of ACP appliance.

Why use Acupuncture?

For its analgesia, ACP is a very popular treatment, with results sometimes surprising in acute and chronic pain. It is shown as a reference for the treatment of chronic pain, since in many studies, the results obtained were more effective than in the placebo and treatment with false ACP (sham ACP) [1, 3, 4].

ACP treatment is low cost and highly effective in the treatment of pain. By previous studies and by clinical experience acupuncture's efficacy proved to be immediate with a medium and long term effect. Address the concerns and objectives of the WHO and the "National Strategic Plan for Prevention and Control of Pain" of the Direção-Geral da Saúde ACP is a therapeutic tool of great usefulness and should be placed at the disposal of the population [58, 59].

Specificity of Acupoints

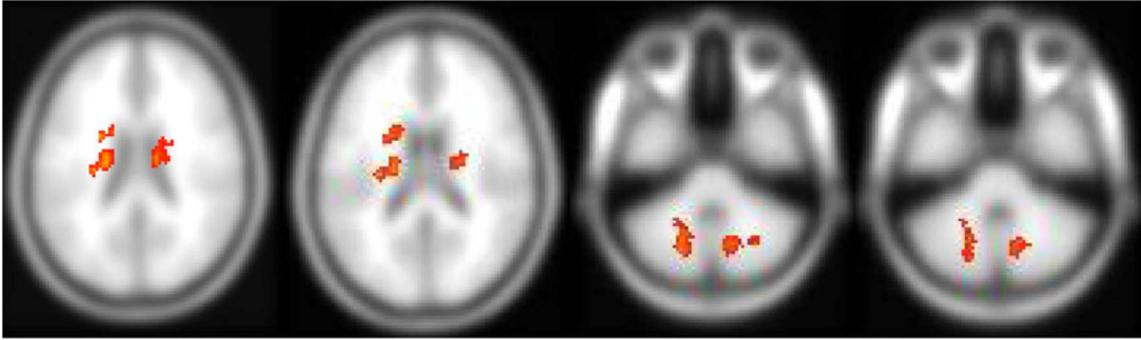
The Western theories proposed to explain the workings of ACP rely on spinal nerve segments and the reflex action of the nervous system. However, the conduits do not always correspond to nerve or dermatome pathways. We also know that the AP's, albeit close, have specific locations and different effects.

One question that can be raised is whether using a false point near the genuine, even if outside the conduit it will have the same effects. Studies using functional Magnetic Resonance Imaging (fMRI) shows that does not.

Byung *et al* (2009) studied the effect of point *F34* and a false point situated 2 inches from this point, but out of *felleal* conduit, using EA as a stimulus and fMRI as evaluation. The fMRI allowed to observe that the regions activated by EA at the point *F34* were different from those activated with the sham point.

In addition, the results demonstrated that real EA at *F34* had a greater effect and broad neuromatrix responses that involved limbic-related brain structures (see fig. 13).

(a) Activation by EAS at GB34



(b) Activation by EAS at the sham point of GB34

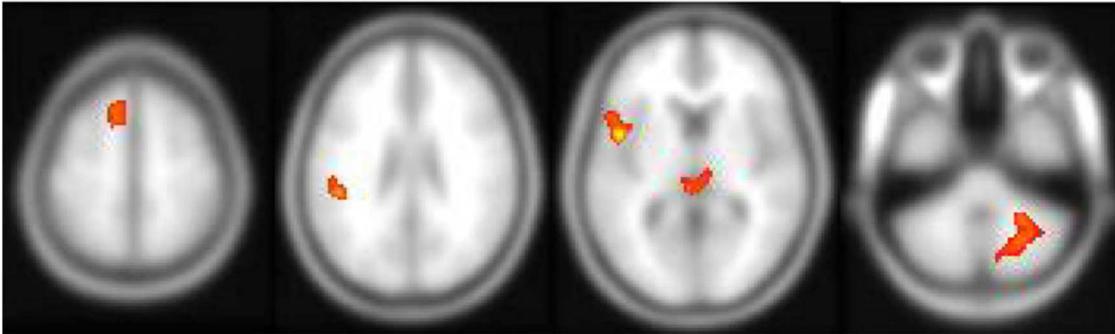


Figure 14 – fMRI images from the regions activated by acupoint F34 and by its sham point. Adapted from Byung *et al* (2009) [11]

In conclusion, we may say that EA at an AP and in its sham point, in the same spinal segment, induced specific cerebral response patterns, which provides evidence for neuronal specificity of an AP. It has also been showed that EA at F34 may be more related to motor function than EA at its sham point, which is correlated with the clinical indications for acupoint F34.

Leopard Spot Technique (LST)

The LST is as a special technique to influence *qi* and *xue*.

Due to the lack of evidence, this technique is difficult to explain in modern terms. However, many acupuncturists have informally stated that they get dramatic results from this treatment method.

In the ancient times, the first applications of ACP consisted of bleeding, as a method to make out the "*bad blood*" as well as the perverse *qi*, especially in lesions and fevers. Only later the needles were used as a way of regulating *qi*, abolishing the need of "*releasing*" something from the body.

He (1987) states that, “for excess type syndromes, bleeding is recommended because it can drain the excess, alleviate congestion and stasis, and remove the pathogens. The function of this therapy is “to drain calor or “quicken” the xue and qi and relieve local congestion” [60, 61].

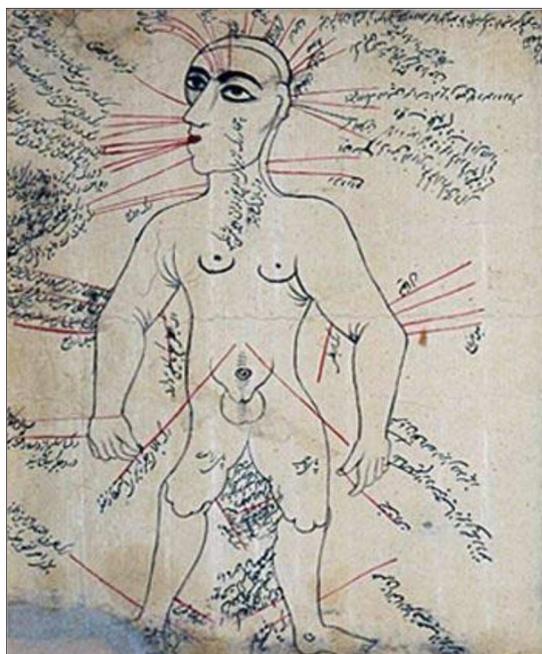


Figure 15 – old picture of Leopard-spot technique [62].

Western acupuncturists often use bleeding techniques in ear ACP in order to rapidly decrease blood pressure, and other acute symptoms [63].

Even considering standard ACP is presented as being effective by the stimuli of several substances release (i.e., endorphins), stimulating local blood flow (i.e., by dilating vessels), producing brain changes what may have both systemic and highly specific effects; letting out a small amount of blood (usually just a few drops) remains without a suitable explanation for the potent effects claimed.

The LST is applied by causing an output of a few drops of blood, by a quick and light pricking to pierce the skin and vein, very similar to what happens when evaluating the levels of blood glucose. Four major therapeutic aims must be considered to apply this technique [64]:

- I. It can invigorate the smooth flow of *qi* and *xue*. For example, when a patient has a wiry pulse and other signs of *qi* and *xue* stagnation;

- II. It disperses *qi* and *xue* stasis, as in cases of backache or spider veins;
- III. It can drain excess, *calor* and *ardor*. For example, in excess that includes pathogenic factors as in an invasion of *Calor-Venti* in the Pulmonary conduit resulting in a fever and extremely sore throat;
- IV. Bleeding can bring down yang rising, for example, in the varieties of high blood pressure due to *Hepatic Yang rising*.

THE SP BY THE HD MODEL AND THE POINTS SELECTION

The Shoulder complex is crossed by six conduits. For functional purposes it is possible to group them into three axes:

- **anterior axis**, with conduits of Metal phase Pulmonal (P) and Crassintestinal (Ic);
- **middle axis**, with the conduits of Fire phase, Tricaloric (Tk) and Pericardial (Pc);
- **external axis**, with conduits of Fire phase, Cardial (C) and Tenuintestinal (It).

By the clinical experience of the HD model, the most common shoulder pain occurs by the commitment of the Fire axis, and by so, involving C and It *orbs*. The first is more symptomatic when the patient tries to take his hand behind his back (internal rotation movement); the second is more symptomatic in anterior movements and above shoulder level (elevation and/or abduction) [46]. These two movements are often involved in SP, particularly when the Supraspinatus muscle is involved (either by its contraction, either by its stretch).

The phase Fire (involving the fire axis) is a *Yang* phase, therefore, more subject to over-activity. The phase Fire has a function of transforming potential into function, so a blockage of this phase, makes its function impaired [47].

Despite the anatomical lesions that painful shoulder involves, what TCM considers as an affection of *Yin* (because there is a lesion of the structure), the SP is not just the physical component, but also encompasses the emotional component. HD gives particular emphasis to the emotional component in SP.

The major function of the *cardial orb* is the "*control of emotionality and mental associations*", being a function overly challenged in lifestyle that we take these days. By its connection with the emotional sphere, the *cardial orb* often gets depleted [47].

Its correspondent conduit, the *Tenuintestinal*, is characterized by "*ear and shoulder pain*" and enteric reflexes that emotional changes may give sensations in the abdominal region, known as "*emotional abdomen*". We've all had that experience in stressful situations, like when you fall in love or at an important time of evaluation, when we feel our belly "*working*" abnormally, feeling of "*butterflies in the stomach*". So, the cognitive and emotional demands of nowadays leads to complications of *Cardial* and *Tenuintestinal orbs*.

A *Cardial* feature is the movement of the arms as a mimic representation of the emotional and cognitive activity. This movement represents the activity of the *cardial orb*, and by the other hand, when shoulder (and arm) movement is impaired it may represent the blockage or depletion of *cardial orb* [47].

The ALT might help in the SP diagnose, as well as choosing a therapeutic approach.

The *Xue* is controlled and moved by the *cardiac orb*. The corresponding exterior orb is the *Tenuintestinal orb* and therefore prone to be affected by *algor* as an exterior agent, causing symptoms such as [47]:

- Pain in shoulder
- Pain in shoulder blade

The arch pain felt in abduction, corresponds to the ALT stage I – *Yang maior* – with particular involvement of *Tenuintestinal orb*.

In ALT, a mechanism called the “*outside-inside hopping*” explains an alternative pathway for the invasion of an agent. As all conduits are coupled with a second conduit of the same phase. The connections between the *extimal* and *intimal* conduits of one *phase* are present between all points of a conduit with the respective point on the other side. If the heat and the functional powers of the *intima* are strong, the agent cannot invade the *intima* directly. Alternatively, it may pass from an *extima* conduit via these connections to the coupled conduit of the same phase. Like this, Tenuintestinal complaints, can change to cardiac complaints [47].

According to the Heidelberg Model of Traditional Chinese Medicine (TCM), in agreement with other authors, the exhibit symptoms in SP indicate congestion (stasis) *Xue* (Blood) and *Qi* (energy). Thereby, the chosen acupuncture technique and AP, must have its action over *xue* and *qi*. One of the most ancient techniques of ACP with these effects is the “*LST*” [22, 46, 65]. Accordingly, the tearing feature of the pain often seen in SP, may lead us to consider *algor* as the provoking agent, and help us in therapeutic guidance.

The points

By its effect on the conduits of the fire axis of the shoulder as well as their combination via ALT, the working group of HD model choose the points **C3** and **It11** as the intervention in experimental group through the “*LST*” [47, 48, 58].

C3 *mare minus*, (*Shao hai*) is located in a muscle recess midway between medial distal condyle of the humerus and the medial end of the elbow crease and **It11** *genus caelestre* (Tian Zong) is located in the center of the infra-spinous fossa of the scapula [48, 55, 66]

The **C3** also belongs to a category of AP's, called "*the five antique points*". Under this category, the **C3** is the conjuncture of the *cardial orb* and therefore is allocated to the Water phase. It is used in labile *cardial qi*. By strengthening the *cardial* Yin, this point has a sedative effect, it disperses the wind (a *Yang* agent) and also acts in the conduit course disorders. It is used in labile *cardial qi*. Labile *cardial qi* can manifest as *shen* problems in *cardial* constitutional types with phases of high on-stage presence followed by sudden failure in the control of everyday procedures like forgetfulness, uncontrolled fine motoric or sudden changes in emotionality [46].

On the external counter-orb we see reactive repletion of the Tenuintestinal orb caused by relative depletion in the *cardial orb*. This is frequent and may lead to Tenuintestinal shoulder/neck pain as a loss of control over the movement of *Xue*.

The point **It11** is the source of the *qi* to the arm [46].

By Hempen *et al* (2012), the point **C3** expels wind and wind-damp, calms the spirit and activates the *luo* channels. It is indicated, for paresis, **stiffness of the arm**, stiff neck, numbness of the arm, trembling hands, among others indications. And the point **It11** expels wind-damp, and is indicated for **pain in shoulder and upper arm**, pain extending from the elbow along the dorsum of the upper arm to the shoulder, among others indications [55].

CHAPTER 5

Methodology

STUDY OBJECTIVE

Facts to consider

The pathologies of the shoulder beyond its impact on patient's life can trigger other conditions, such as neck pain.

ACP has proven to be an effective therapeutic tool in SP.

The model of HD has their own vision of TCM, particularly in the diagnosis and choice of points.

The LST is a technique rarely used in research, although widely used in clinical practice.

The immediate effect of ACP can be very helpful to achieve good therapeutic intervention.

Objectives

- To study is to access the immediate effect of ACP in the shoulder pain and range of motion;
- To assess the viability and effectiveness of the research protocol for a future clinical trial.

RESEARCH TEAM

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SETTING

Pre Experimental Procedure - Recruitment and Design

Sample and Recruitment

This study was focused on Portuguese patients, aged between 18 and 85, diagnosed with Painful Shoulder Syndrome by a Conventional Medicine Doctor.

Patients were provided by the Department of Physical Medicine and Rehabilitation of Hospital da Prelada, da Santa Casa da Misericórdia, located in Porto.

A previous, non-definitive convenience sample was selected based on the patient's clinical file and eligibility criteria (refer to table 5).

Inclusion Criteria

Exclusion Criteria

<p>I. Male or female patients aged between 18-85 years old, with pain in shoulder and limitation of shoulder abduction movement, diagnosed by a doctor of conventional medicine*;</p> <p>II. Have no previous experience with acupuncture.</p> <p>* which corresponds to ALT stage I – Yang minor in the TCM diagnose</p>	<p>I. Patients with shoulder pathologies without pain in abduction;</p> <p>II. Patients with neurological or oncological pathologies;</p> <p>III. Pregnant and infants;</p>
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Table 5 – Eligibility criteria

After the initial screening, potential participants were contacted, or when necessary, their families. After explained the study by the telephone, an interview was scheduled at a day and time to better explain the procedure and when understood and granted, proceed with it. Before positive feedback, informed consents were presented and their agreement was asked.

Sample randomization

After recruitment, a serial number was attributed to each participant. The sample was then randomly divided into two groups using the method of papers on a bag. The two groups created were: Experimental Group (EG) and Control Group (CG).

Outcome assessment

Initially for each patient, will be verified if abduction movement is painful and/or limited.

By our clinical experience we have observed, as some authors argue that the most committed and painful shoulder movement is abduction. Such a movement happens to be involved in most activities of daily living (particularly those involving raising the arm), is also the main movement of the most frequently affected muscle, the supraspinatus. Nevertheless, the remaining muscles of the RC are involved in the abduction, sometimes directly in their implementation, even partially by some of its beams, either by its stabilizing component and/or holding the GH joint during abduction. For this reason, the abduction movement in the plane of the scapula (30 following a bending axis perpendicular to the plane of the blade) was chosen as the test movement [4, 23, 24, 27].

To evaluate the pain it was used the Visual Analogic Scale (VAS), because it has been shown to be a relevant tool for measuring pain, particularly in SP [14].

For this purpose, a line of 10 cm, with the numbers 0 and 10 drawn on opposite ends was used, meaning, respectively, the minimum and the maximum pain ever felt. In this scale, the participants drew a line where they considered that their pain was located [42].

For the assessment of ROM, it was used the manual goniometer as a measuring device. The goniometer was chosen because it is an instrument easy to use and their low economic cost as a measuring device. Despite, it still is considered a good and reliable method for amplitudes evaluation, especially when the same physical therapist takes these measurements [67-69].

Study design

The study was designed as a prospective, controlled, non-blinded, preliminary trial.

Collected patients data

At Baseline (T0)

After confirm patient personal data, shoulder involved, inclusion and exclusion criteria, patients were asked to execute the movement of abduction in the plane of the scapula, until pain or movement limitation prevent further movement of the shoulder. The maximum amplitude attained was measured by the investigator.

Immediately following ROM measure, patients were asked to register the pain felt in the VAS.

After intervention (T2)

After 5 minutes of the acupuncture intervention, the same procedures as in T0 were performed, concerning to ROM and VAS.

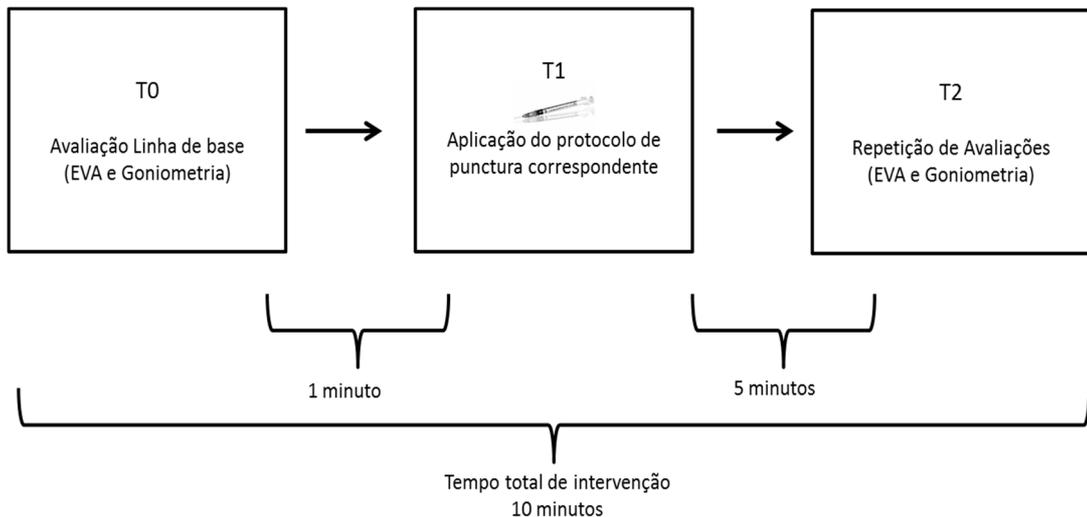


Figure 16 – flowchart of research

Experimental procedure – Intervention

The experimental protocol was based on the clinical experience from the HD.

Clinic of Chinese Medicine workgroup.

With the patient seated, the acupoints were located and the area of intervention has been disinfected, using for the purpose gloves, sterile gauze and ethyl alcohol.

Then, LST of ACP, known as ancestral ACP technique that is characterized by rapid insertion of the needle 5 times, from the point has been applied, causing its dispersion through bleeding very slight (1 to 5 small drops of blood), was applied to both groups. A mesotherapy needle 27G ½ "0,4x13mm, brand *BD Microlance™* 3, sterile single-use was used.

True ACP protocol, consisting of the points C3, (*Shao hai*) located in a recessed muscle midway between epitróclea the humerus and the medial end of the elbow crease and It 11 (*Tian Zong*) located in the center of the infra-spinous fossa of the scapula, was applied to the EG.

"False" points of ACP (for this clinical picture) were applied to the CG. We used the points F21 (*Jian jing*), located in the suprascapular region, midway between the tip of the acromion process and below the spinous process of the seventh cervical vertebra (C7), and an extra false point, located 5 cun above the elbow crease between the *Crassintestinal* conduit and the *Pulmonal* conduit. (Figures 16 and 17) [11, 48, 66].

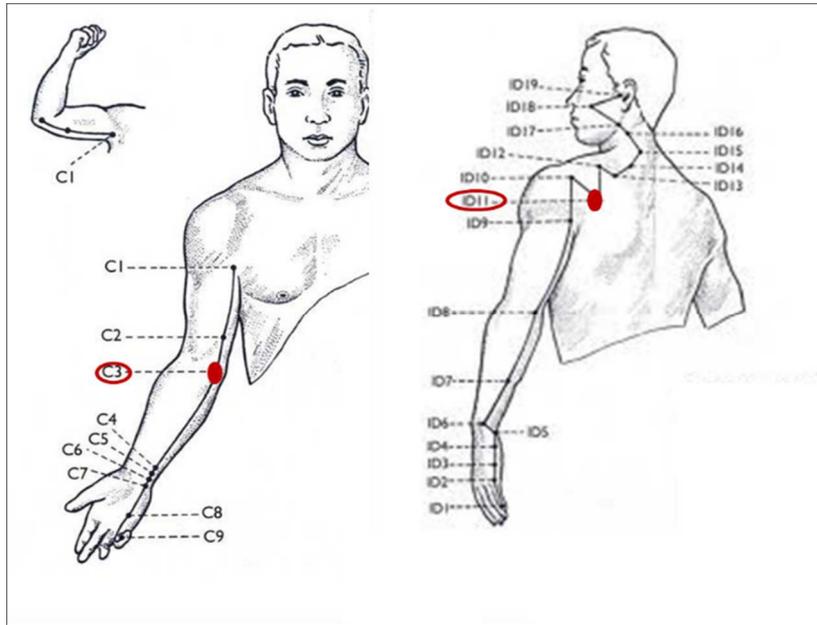


Figure 17 – points used in experimental group

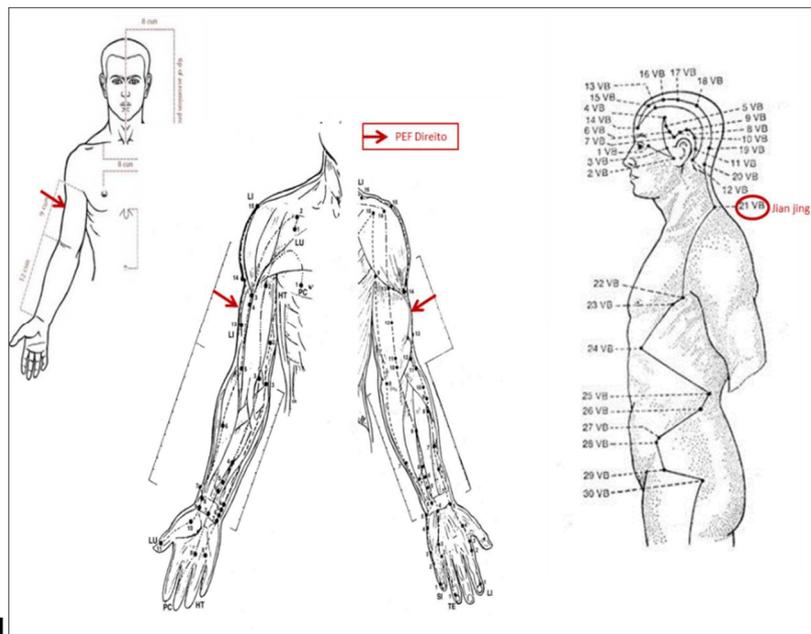


Figure 18 – points used in control group

The targeted areas were again disinfected and placed a sterile dressing for protection.

Ethical considerations, protection of human rights and safety issues

All patients voluntarily decided to be a part of the present study. Participants were not given or promised any warranties regarding their health after or during the study.

The study was conducted in accordance to the 1964 Helsinki Declaration and international standards of Good Clinical Practice requirements and it was granted approval from the Ethical Committee (EC) of the Hospital da Prelada, Santa Casa da Misericórdia do Porto.

All subjects were provided a consent form describing the study with precise information, in order to exert an informed decision about their participation in the investigation (see attached annex 2).

Subjects and/or families were briefed about the goals, methods, expected benefits, and potential risks or discomforts, as well as it was their right to decide to withdraw or discontinue the experiment at any moment during his/her participation. They were also notified that no prejudice would result in cases of refusal to participate or withdrawal from the study.

The trial would stop if the investigators believed that there was an unacceptable risk of serious adverse events.

Confidentiality

All data collected in the scope of the present study is confidential, and identification of participants was preserved at all moments. Data was only maintained during the necessary time to produce the present paper.

Participants Exemption

No pre-established agreement existed that obliges participants to take part in the study. Both patients and other participants were free, at any given moment, to abandon the investigation if this was their desire.

Financing and Conditions

This study is independent and as such, not financed by any institution. Participants were voluntarily a part of it, without any promise of financial or other form of compensation. The resulting costs of investigation were fully supported by the investigator.

Conflicts of Interest

None of the individuals that were part of the present study is involved in any conflicting activity.

Research Supervisor Feedback

The present study started after receiving positive feedback from Prof. Henry J. Greten and from Dr. Gonçalo Borges.

Study Location

The study was carried out in: Hospital da Prelada, Santa Casa da Misericórdia do Porto.

RESULTS

At baseline, the patients and the controls shared similar demographic and clinical characteristics. The *Kolmogorov Smirnov test* was performed, which confirmed the normal distribution of data, ($p=0,881$) for goniometry and ($p=0,558$) for VAS.

Our study included 32 patients; 25 females and 4 males with a mean age of 64.33 years (min 44, max 80). Four of these patients were excluded for a diagnosis of oncological diseases, resulting in a 29 participants sample.

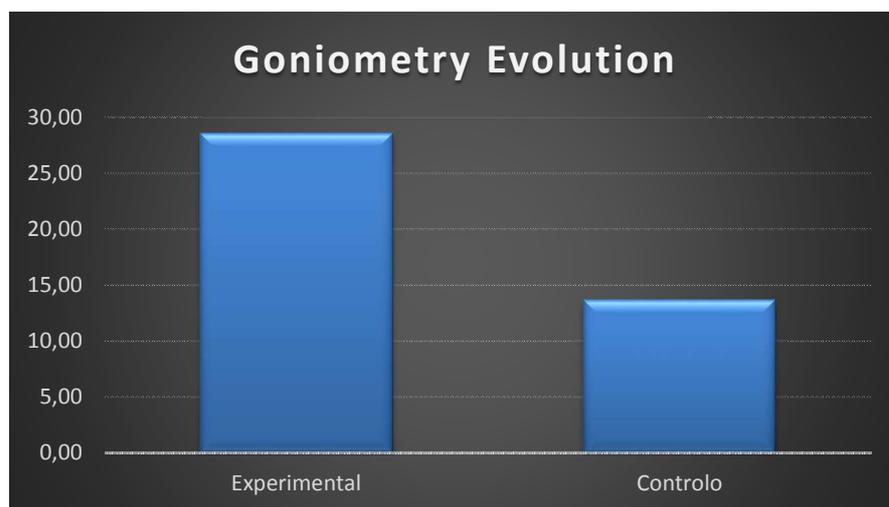
To assess the ROM and the VAS we choose the *Student's t test* (For paired samples). This test is commonly used to compare two small sets of quantitative data when data in each sample set are related.

The EG had highly statistically significant results ($p<0.001$) for the two dependent variables (Goniometry and VAS). The CG although the applied ACP protocol has had statistical significance ($p=0.033$) in the goniometer, it was less than the significance of the EG. Since the VAS parameter of the CG had no significant difference ($p=0.624$) between the application of corresponding acupuncture protocol and the baseline. In terms of mean

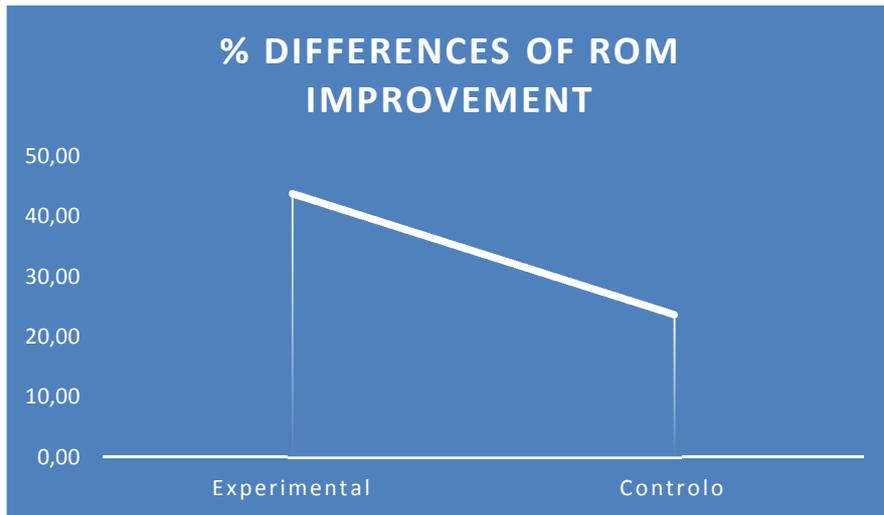
percent improvement, the EG achieved an improvement percent of 43.70% in the goniometer, while the CG got a mean percent improvement of 23.71%. In the VAS parameter, the EG achieved percentage improvement of 39.01%.

Table 6 – percentage of ROM and VAS improvement

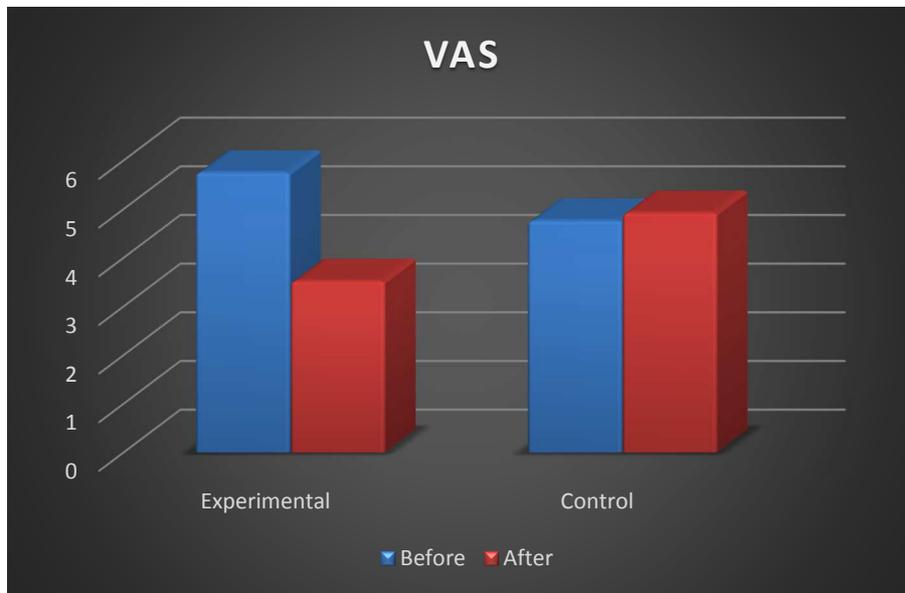
	Goniometry		VAS	
	Experimental	Control	Experimental	Control
<i>Mean %</i>	43,70	23,71	-39,01	-4,42
<i>Median %</i>	42,02	9,09	-42,86	0,00
<i>Min %</i>	0,00	-4,76	-16,67	0,00
<i>Max %</i>	100,00	100,00	-33,33	100,00



Graphic 1 – degrees representation of goniometry evolution, between experimental and control group



Graphic 2 – percentage representation goniometry evolution, between experimental and control group



Graphic 3 – VAS evolution in experimental and control group

CHAPTER 6

Discussion

Limitations & Future Directions

Conclusion

References & Appendixes

DISCUSSION

The painful shoulder is one of the most common and disabling complaints of the musculoskeletal system for a good part of the population, compromising their quality of life and their contribution to society, resulting in significant economic and socio-cultural impact. It is a condition that gives pain and functional limitation resulting from impairment of static and dynamic structures of the shoulder, such as ligaments, capsule and muscles [15, 24].

The sample was predominantly female, presenting a high age average, thus following the trend in the literature, which evidence that the pain is more common after 45 years [4, 20, 24, 28, 65, 70, 71].

For example Guerra *et al* (2003) used a sample of 201 cases and saw their split in 68% women to 32% men, standing the highest incidence of SP between 40 and 79 years [4]. Naturally, with age, use, and/or misuse of the shoulder and structures that influence it (such as the cervical spine), are becoming more marked increasing the intensity of the lesions. Although the sample was not characterized due to his professional activity or sport, because it was not the purpose of the study, we know that this variable has an important contribution in the emergence of SP. Azevedo *et al* (2012) used a Portuguese sample of 5094 respondents and found that 222 (12%) had chronic SP [20].

In this study the application of ACP had a significant and immediate effect on pain and ROM, compared with the CG, which is consistent with the results of several studies[3]. Kajsa *et al* (2002), in a review article, found decreased pain and restored function in comparison with placebo, in several studies with good evidence [12, 22]. Vickers *et al* (2012) in his systematic review of 31 studies comprehending 17922 patients, verified effectiveness of acupuncture in chronic pain of back, neck, osteoarthritis, headache and shoulder pain. The differences between true and sham acupuncture indicated that acupuncture is more than a placebo. Must be pointed that, the differences are relatively modest, suggesting that factors in addition to the specific effects of needling are important contributors to the therapeutic effects of acupuncture [3]. Sun *et al.* studied the effect of a group of exercises face the same exercises plus acupuncture in 35 patients with frozen shoulder, he only found statistically significant difference between the groups after 20 weeks of treatment. In his review, Lee *et al.* also conclude that acupuncture combined with exercise is effective for shoulder pain after stroke[1]. Gladys *et al.* studding the difference between effect of exercises plus EA and exercises plus interferential electrotherapy in frozen shoulder, found an increase of the *Constant Murley Assessment*

and a decrease in the VAS. In the other hand, found no significant difference between the 2 intervention groups [16]. For Kelly (2009), chronic pain syndromes affecting the neck and shoulder are commonly treated with ACP, reporting significant and sometimes long-lasting effectiveness of acupuncture for these conditions [22].

Nevertheless, other authors show there are little evidence or low, little significance effects and other failures in the investigation of this matter. A common finding, evidenced by Kelly (2009), has been that both sham and actual ACP improve pain, and the differences between the treatments do not reach statistical significance. Sham treatments often have been criticized as being too similar to actual treatment, especially if a needle is inserted into tissue; in the case of ACP, this suggests the possibility of a nonspecific needling effect [22].

A Cochrane review, produced by an Australian team, referenced by Pirotta (2007), examined the evidence for ACP in treatment of shoulder pain. In their search, the authors concluded that ACP provided no short term improvement in SP. However, they also pointed out that as only small numbers of people had been included in the trials, there was a possibility that no difference between ACP and other treatments or placebo was detected where one might actually exist (type II error) [7].

In this study, we used a CG, to which has been applied false ACP (for this condition). The literature reveals favorable data for its use as control. The use, in the CG, of a true and a false AP, is a favorable fact that AP's have a specific location and effect, going beyond their influence on the spinal segment in which they are located. The point F21 (applied to CG) located in a region whose dermatome (root of C3) involves the shoulder in a usually painful area, had no significant effect on pain. The sham chosen point, located in the same spinal segment of one of the true used points, also had no significant effect on pain. These findings agree with the work of Byung *et al* (2009) in his analysis of the specificity of an acupoint by fMRI [2, 3, 11, 22].

The application of LST, proved to be a simple, rapid technique that besides a small painless erythema or hematoma, caused no side effects or undesirable effects, even in patients with decreased coagulation. However, in traditional ACP, there are many reports of side effects such as trauma (being pneumothorax the most common); infection, and even including death cases [2, 22, 72].

Wagn (2013) obtained significant effects on pain and function in periartthritis of the shoulder, with a similar technique used in this study, causing a small controlled bleeding for symptom relief [73].

According to HD of TCM, the emotional component has a great influence on SP and any ACP model can and should take this into account when electing AP's to use. The influence of emotional component on SP and the emotional effect of the treatment of SP are two things that should not be separated, as some authors confirm [46].

Dong *et al* (2005) studied the social and psychological effects of ACP in women with chronic neck and SP, and found that ACP had a significant effect on pain, anxiety, depression, and sleep quality and life satisfaction. Improving relevant social and psychological variables, during at least three years [9].

These findings emphasize the importance of observing a patient holistically, framing all parts of his body, mind and social relationship, because the treatment of these elements help to achieve better results. This has been considered in the choice of protocol used, for example in the choice of point C3, which has special emotional and mental effect, besides its action on the shoulder.

Although the IT11 point is a point used by most authors [58, 74], the C3 point was not found in any study in the treatment of painful shoulder, stressing the authenticity of the HD method. However, Greten (2011) argues that when the fire axis is affected, the C3 point should be used to improve the results, especially with LST.

ACP is a treatment with a good cost-benefit ratio. Kelly (2009) describes a cost value for money for the treatment of shoulder and neck pain in the United States of America (€12.469 per QALY) [22]. The protocol used in this study, considering the equipment used and the duration of application (including the presence of a professional and the occupation of the space) can be presented as an instrument with a good cost-benefit ratio equal or better than the referenced.

The primary conservative treatment for SP is physical therapy, and pain reduction is a very common goal. Treatment options may include exercise, reeducation of movement control, manual or manipulative therapy, education about self-management, graded exposure to problematic activities and pacing of activity level [24, 58].

SP may improve with physical therapy. Passive and active mobilization, strengthening exercises and proprioceptive training improves the functioning of the shoulder complex joint, reducing pain and improving ROM. The rehabilitation of muscular synergies improves the functioning of the shoulder and prevents the onset of injury and/or recurrence.

Several studies using ACP comparisons with other physical therapy techniques such as electrotherapy and US show positive effects when ACP is added to these techniques, rather than the techniques performed isolated [16, 75].

Lee et al (2012), studying SP after stroke, concluded from this systematic review that ACP combined with exercise is effective for SP after stroke [1].

Thirty five patients with a diagnosis of frozen shoulder were randomly allocated to an exercise group or an exercise plus ACP group and treated for a period of 6 weeks. Compared with the exercise group, the exercise plus ACP group experienced significantly greater improvement with treatment. In that study, Sun et al (2001) concluded that the combination of ACP with shoulder exercise may offer effective treatment for frozen shoulder [65].

Such findings show that ACP does not have to be used as a single therapy, but must be combined with other Western approaches such as physiotherapy. We know that a very painful shoulder, does not allow much movement, and as a consequence the maintenance of inflammatory signs (such as edema) and / or muscle atrophy. For example, the LST can be used to immediately reduce pain, to allow application of other techniques (mobilization proprioceptive training) in the same session. It's easy and fast application, proves to be a very useful tool that can be applied by many health professionals in different fields (clinical, infirmary).

LIMITATIONS AND FUTURE DIRECTIONS

This study has some limitations that could be improved in future studies.

The used sample is small (although studies with similar samples have been found), so we recommend some caution in considering the results. Besides higher, the sample may be better characterized, eg considering its professional or sporting activity, or even be selected within these specific groups. Also, in the framework of TCM, the diagnosis for the purpose of sample selection, may include other parameters, such as diagnosis of tongue or wrist. To improve reliability, the study should have been double-blinded, in order to eliminate any suggestion or interference from the researcher. In the future, other methods may be applied safeguarding this element.

EG was compared with a single CG and with the same technique. In the future, more than one group and/or techniques (moxibustion, ear ACP, classical ACP, EA) may be used. In this field there already exist special fake needles that mimic the sensation of the real needles, but without any effect on the body, that might eliminate the effect of suggestion. Thus represent a good chance to be used in the CG's [76].

Other variables, as well as other assessment tools are likely to be used. The goniometer, although intra-observer may include measurement errors. The VAS, although widely used, is always a subjective measurement. The duration of pain was not considered.

In future works other instruments may be adopted for evaluation. The isokinetic dynamometer or digital image, in the measurement of amplitude, allow more accurate data. Questionnaires to assess the function of the shoulder and its interference on life quality may also be used. The duration of pain is also a variable to consider in improving the specificity of the results. Strength is also a variable to be used as well as the muscular synergy, using for this purpose a feedback system or electromyography.

The aim of this study was to assess the immediate effect, however, future works may establish other protocols and longer follow-ups to evaluate the effect in the medium and long term.

CONCLUSION

Current literature data supports a plausible effect of ACP in SP.

The used protocol, via HD model of diagnose, had a significant effect in immediate pain and ROM of painful shoulder.

By its simplicity, in implementation and evaluation, the protocol might be a therapeutic tool to consider in SP, supposedly allowing the application of other therapeutic techniques.

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APPENDIXES

Annex 1 - Table with tests for the shoulder pain, adapted from [32, 77, 78]

TEST	DESCRIPTION	RESULT (positive test if)	Sensitivity
IMPINGEMENT TESTS (do not localize the injury)			
Neer's test	The examiner stands behind the sitting patient. With one hand prevents rotation of the scapula, and the other executes a shoulder front elevation of the patient. This movement causes the decrease of the interval between the greater tuberosity of the humerus and the anterior-inferior portion of the acromion	Pain and suggests an anterosuperior compression	89%
Hawkins-Kennedy test	Behind the patient, the examiner performs passive shoulder flexion at 90°, followed by repeated movements of internal rotation	Pain resulting from contact between the RC (on the side of the synovial pouch) and coraco-acromial ligament and/or the articular surface of the tendon and the anterior superior edge of the glenoid cavity. The contact between the tendon and sub-scapular muscle and the coracoid apophysis can also occur.	87%
Yocum test	The patient places a hand on the contralateral shoulder and is asked to raise the elbow without raising the shoulder	Pain caused by contact of the tendon of the RC and the coraco-acromial ligament and possibly the lower surface of the acromion-clavicular joint, suggesting an anterior-superior or anterior-internal PSS	78%
The sensitivity of this three tests listed above, when combined, is 100%, showing the relevance of their systematic execution			
Posterior impingement test	Patient in the supine position. The examiner makes 90-100° abduction together with maximum external rotation.	Posterior pain caused by compression of the articular side of the tendon of the RC between the greater tuberosity of the humerus and the posterior superior margin of the glenoid cavity/joint capsule	90%
TESTS THAT ALLOW TO LOCATE THE INJURY			
SE impingement test	Shoulder and elbow at 90° of flexion, while palpating the supraspinatus tendon, the examiner makes internal rotation	Pain is caused	86%
Empty can test	Shoulder in the plane of the scapula (90° of abduction and 30° of horizontal adduction) and maximum internal rotation: thumb	Pain is caused	Unknown

	pointing down. Examiner pushes downwards and the patient must resist the force.		
Test for isolation of infraspinatus	0° shoulder elevation, elbow at 90° of flexion and 45° of internal rotation, leaning against the hip. Patient performs external rotation against resistance	Pain is caused	Unknown
Patte's test	The examiner holds the patient's shoulder at 90° of anterior elevation while he is asked to perform external rotation against resistance.	Pain is caused	92%
Gerber's test	Patient places his hand on his back, with 90° of elbow flexion. The examiner's move's the hand about 5-10 cm away from the back, keeping the angle of the elbow. The patient must maintain position without examiner's help	If the patient is unable to maintain position, the subscapularis is involved	100% if there is rupture of the subscapularis
Gerber's resisted test	Same as above, but the patient must perform internal rotation against resistance		

TEST FOR THE BICEPS LONG PORTION

Speed test	Shoulder at 90° of flexion, full extension and supination of the elbow. Perform arm flexion against resistance	Pain reveals involvement of the long head of the biceps	63%
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Annex 2 – consent form

CONSENTIMENTO INFORMADO, LIVRE E ESCLARECIDO PARA PARTICIPAÇÃO EM PROJETOS DE DOCÊNCIA E/OU INVESTIGAÇÃO

de acordo com a Declaração de Helsínquia¹ e a Convenção de Oviedo²

Por favor, leia com atenção a seguinte informação. Se achar que algo está incorreto ou que não está claro, não hesite em solicitar mais informações. Se concorda com a proposta que lhe foi feita, queira assinar este documento.

Título do estudo: Efeito imediato da acupuntura na melhoria da dor e amplitude de movimento em pacientes com dor no ombro

Enquadramento: No âmbito da tese de Mestrado de Medicina Tradicional Chinesa do Instituto de Ciências Biomédicas Abel Salazar

Explicação do estudo: este estudo visa estudar o efeito da acupuntura na dor e na limitação da amplitude da articulação do ombro. Será escolhida uma amostra de indivíduos de ambos os géneros, com idades entre os 18 e os 85 anos, com as condições clínicas bem específicas, descritas e diagnosticadas por um médico de medicina convencional. Da amostra serão excluídos os indivíduos com todas as outras patologias que não a do estudo, as grávidas ou lactentes, e patologias do foro neurológico e oncológico. A amostra será dividida em 2 grupos: o de teste e o de controlo. No grupo de teste será aplicada uma técnica de acupuntura (*Leopard-spot*) em pontos verdadeiros definidos para a patologia, no grupo de controlo será aplicada a mesma técnica em pontos de acupuntura não indicados para essa condição clínica (*sham acupuncture*). No primeiro momento (T0 – avaliação de linha de base) a amostra será avaliada quanto à dor e a amplitude, usando para o efeito, respetivamente, a Escala Visual Analógica e o Goniómetro. No mesmo momento, será aplicada a acupuntura, usando uma agulha de mesoterapia 27G ½” 0,4x13mm, da marca BD Microlance™ 3, esterilizadas de uso único, e nova avaliação (T1) logo após a intervenção.

Os dados recolhidos serão tratados estatisticamente.

Esperam-se como resultados, que a acupuntura reduza a dor e melhore a amplitude do ombro, apresentando resultados estatisticamente significativos na dor e amplitude do ombro com patologia

Note que não se espera que a acupuntura prejudique o tratamento convencional a que será sujeito nem haverá qualquer interferência no seu plano de tratamento habitual.

Todas as agulhas de acupuntura são esterilizadas e descartáveis (ou seja, de uso único). Antes da inserção das agulhas, a pele será desinfetada com uma solução antisséptica alcoólica.

Os riscos associados a acupuntura são mínimos. Poderá sentir algum grau de dor ou desconforto e formigueiros no local das picadas com as agulhas de acupuntura. Mais raramente, poderá sentir tonturas, ansiedade ou náuseas. É possível que após o tratamento possam surgir ligeiros sangramentos, em particular se estiver a tomar a tomar medicamentos anti-agregantes (ex.: Aspirina, ácido acetilsalicílico) ou hipocoagulantes (ex.: Varfine ® (varfarina); Sintrom ®, acenocumarol) e/ou aparecerem ligeiros hematomas num local onde foram inseridas as agulhas que se resolverá espontaneamente. Caso esteja a tomar a medicação acima referida deverá informar a equipa de investigação.

Condições e financiamento: O presente estudo será realizado sem qualquer custo para o paciente. Todos os custos serão suportados pelo Instituto de Ciências Biomédicas Abel Salazar da

¹ http://portal.arsnorte.min-saude.pt/portal/page/portal/ARSNorte/Comiss%C3%A3o%20de%20C3%89tica/Ficheiros/Declaracao_Helsinquia_2008.pdf

² <http://dre.pt/pdf1sdip/2001/01/002A00/00140036.pdf>

Universidade do Porto (ICBAS-UP). A sua participação é voluntária e terá o tempo que necessitar para ponderar sobre a sua participação neste estudo. É livre de consultar a opinião dos seus familiares ou amigos. Caso decida aceitar, poderá posteriormente a qualquer momento recusar continuar no estudo, sem quaisquer tipos de prejuízos assistenciais ou outros, caso não queira continuar a participar.

Confidencialidade e anonimato: Todos os dados recolhidos para o presente estudo asseguram uma total confidencialidade e anonimato dos participantes, os seus nomes nunca serão tornados públicos. Todos os resultados obtidos serão devidamente codificados; os dados serão apenas do conhecimento do investigador principal e dos orientadores do estudo.

Agradecimentos e identificação do/a investigador/a e da pessoa que pede o consentimento, se for diferente: Mário Francisco Barbosa Costa, Fisioterapeuta, trabalha em unidade privada de Fisioterapia.

Assinatura(s):

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*Declaro ter lido e compreendido este documento, bem como as informações verbais que me foram fornecidas pela/s pessoas/s que acima assina/m e que considero suficientes. Foi-me garantida a possibilidade de, em qualquer altura, recusar participar neste estudo sem qualquer tipo de consequências. Desta forma, aceito participar neste estudo e permito a utilização dos dados que de forma voluntária forneço, confiando em que apenas serão utilizados para esta investigação e nas garantias de confidencialidade e anonimato que me são dadas pelo/a investigador/a.*

Nome: \_\_\_\_\_

Assinatura:  
/\_\_\_\_\_

Data: \_\_ / \_\_

**ESTE DOCUMENTO, COMPOSTO DE 2 PÁGINA/S, É FEITO EM DUPLICADO:  
UMA VIA PARA O/A INVESTIGADOR/A, OUTRA PARA A PESSOA QUE CONSENTE**