USING SILVER SPIKE POINT NEEDLE-FREE ELECTRO-ACUPUNCTURE FOR POSTOPERATIVE PAIN MANAGEMENT

Daniel C. C. Lee

VICTORIA UNIVERSITY

December, 2008

USING SILVER SPIKE POINT NEEDLE-FREE ELECTRO-ACUPUNCTURE FOR POSTOPERATIVE PAIN MANAGEMENT

A Thesis Presented for the Master by Research

By

Daniel C. C. Lee

School of Biomedical and Health Sciences

Faculty of Health, Engineering and Sciences

VICTORIA UNIVERSITY

December, 2008

Declaration

I, Daniel C. C. Lee, delare that the Master by Research thesis entitled *Using silver spike point needle-free electro-acupuncture for postoperative pain management* is no more than 60,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, referencec and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, the thesis is my own work.

Signature Date

Acknowledgements

I wish to thank my supervisors, Associate Professor Hong Xu and Dr Kerry Watson of Victoria University for the enormous amount of patient, support and professional guidance through the period of my candidature. Without this kindly instruction and broad academic experience, the project would not have been possible.

I wish to express my many thanks to Professor Colin Torrance and Professor Allan Pearson of La Trobe University Melbourne, supervised the proposal stage of this study.

Many thanks are extended to China Medical University, Taiwan. The project would not have been possible without their support. The treatment component of this project was supported and undertaken in Taiwan at the China Medical University Hospital (CMUH), under the principal supervision and support of Professor Lin Jaung-Geng – Director of the China Medical University. Dr. Rick Wu, Department Head of Anesthesia, CMUH and Dr. Chen, Kuen Bao, Director of Anesthesia, CMUH supervised and conducted the anesthetic and analgetic procedures.

I would also like to thank the participants for their involvement in this research.

Contents

List of Figures

List of Tables

Abstract

The severity of postoperative pain is affected by many factors including the patient’s age, sex, personality, knowledge of and confidence in the procedure, attitude of the staff, and the individual's physiological condition. The same procedure can produce different degrees of postoperative pain in different patients. Even though, in most cases, upper abdominal or thoracic surgery causes severe postoperative pain, superficial operations still cause mild postoperative pain. Patients usually feel the most pain in the first few hours after surgery. Postoperative pain can result in irritability, insomnia, increased heart rate, hypertension, excessive perspiration, overactive metabolism, tachycardia, diaphoresis, mydriasis, pallor and increased myocardial oxygen consumption. In patients with coronary artery disease, postoperative pain can result in myocardial ischemia and possible infarction that in turn may delay postoperative recovery.

Intravenous patient-controlled analgesia (PCA) is an accepted method to relieve postoperative pain. Opioids are often used as an analgesic for severe pain management. Possible adverse effects are respiratory depression, constipation, vomiting, gastroparesis, and central nervous system depression including somnolence and consciousness disturbance. Opioid-related side effects often occur post-operatively, and are related to the total dosage of opioid medication. Non-pharmaceutical products can be an alternative in the treatment of post-operative pain and produce less adverse effects. Acupuncture’s ability to control pain has been documented for thousands of years and has become well-accepted in modern Western medicine. Electro-stimulation has a postoperative pain relieving effect when applied as either electro-acupuncture (EA), transcutaneous nerve stimulation (TENS) or Silver Spike Point (SSP) therapy. SSP as needle-free EA and has been shown to have a similar analgesic effect to standard EA, where electrical stimulation is applied to needles that have been inserted into acupuncture points, and a superior effect than TENS. The acupuncture analgesic mechanism remains unclear in spite of successful clinical applications and recognition by WHO. This study investigated SSP needle-free EA's role in managing of postoperative pain and in reducing the adverse side effects of opioids.

Acupuncture has generated much interest in western countries like Australia, and is considered a rather safe clinical treatment method for a wide range of disorders. However, in clinical applications, there are some contraindications and complications with using needles. SSP needle-free EA offers many benefits over standard acupuncture treatment such as: reduced hazardous waste, no skin penetration and therefore a reduced risk of infection. SSP EA provides a range of stimulation types that are particularly suitable for sensitive patients including young children and the elderly. A particular advantage of SSP EA is that it can be safely used on acupuncture points all over the body, whereas incorrect acupuncture needling over major organs and the spinal cord can cause serious problems.

In this study, we examined the effects of Silver Spike Point (SSP) therapy, also known as needle-free electro-acupuncture (EA), at the classical bilateral acupuncture point Zusanli (ST36) on postoperative pain and opioid-related side effects following hysterectomy. Based on a double blind, sham and different intervention controlled clinical experimental design, four groups of randomised patients were enrolled into the study as subjects. Group 1 was assigned as the control group; Subjects in group 2 were applied SSP electrode at a sham acupuncture point; Group 3 received SSP stimulation at 100 Hz and Group 4 received SSP stimulation by a mixture of at 3 Hz, 10 Hz, and 20 Hz on Zusanli (ST36). It was planned that each group was to consist of 25 women who had undergone hysterectomy. The research evaluated the analgesic effect of SSP needle-free EA for post-operative pain relief of women who had been given a hysterectomy, and comparing the difference between high frequency and low frequency stimulation. The hypothesis was that the groups that received the double treatment of SSP needle-free EA (both pre- and post-surgery) at acupuncture point Zusanli (ST36) would demonstrate increased analgesic relief over a longer period of time, i.e. longer duration before requiring the first PCA dose, fewer PCA doses required, and fewer opioid related side effects compared to the sham and control groups. In addition, the group that received the low frequency treatment would achieve better analgesic relief compared to the high frequency treatment, the sham, and the control groups.

The Results were analyzed using a One-way analysis of variance (ANOVA) for Visual Analogue Scale (VAS) of Patient Controlled Analgesia (PCA) doses delivered, and PCA doses demanded by the patients. This method is for testing the differences between means of

independent samples. In this case, using SPSS and Student-Newman-Keuls (SNK) and Tukey post-hoc analysis performed a One-way ANOVA. F-tests were also carried out to determine significance between means of the variables, time of first ambulation, bowel movement, total PCA demand and total PCA doses. Statistical significance is based on P value with $P < 0.05$; clinical beneficial is based on $P < 0.10$. The results indicated that the means and standard deviations of the four groups were within a close range.

Forty-seven women who had hysterectomies met the criteria. The women were randomly allocated to four different groups. Except for those in the control group, treatment was given by an acupuncturist preoperatively and consisted of a course of either sham, low or high frequency stimulation. All groups were assessed during the postoperative period for 24 hours.

The Visual Analogue Scale (VAS) was used to determine the amount of perceived pain felt by each subject. It was a 0-10 scale with 0 being no pain and 10 being most severe pain. The data was collected over a 24-hour period commencing post operatively. The significant differences between the groups at each specific time interval were examined. Results showed a clearly decreasing trend in the amount of pain felt over the 24-hour period for all the four groups with respect to the PCA and time. Significant differences or clinical benefits were found between the means at two hours post-operatively with $F(3,42) = 2.66$ at $p<0.10$; three hours post-operatively, $F(3,42) = 3.68$; $p<0.05$, four hours post-operatively, $F(3,42) = 4.33$, $p<0.05$; eight hours post-op, $F(3,42) = 3.33$, $p<0.05$; sixteen hours post-op, $F(3,42) = 4.25$, $p<0.05$; and twenty-four hours, $F(3,42) = 4.67$, $p<0.01$. Further post-hoc analysis showed that at one hour post-operatively, groups one and four were different to each other at the $p<0.10$ level. At three hours, group 1 ($M=6.05$) was significantly higher, at the $p<0.05$ level, than group 4 ($M=3.00$). This difference was also found at four hours, group 1 ($M=5.65$) and group four ($M=2.71$); eight hours, group 1 ($M=4.808$) and group four ($M=2.57$); sixteen hours, group 1 ($M=4.46$) and group 4 ($M=2.0$); and twenty - four hours, group1 ($M= 3.50$) and group 4 ($M=1.21$). Both post-hoc comparison tests indicate that group 4 was significantly different from groups 1, 2, and 3 at twenty-four hours.

Differences between the means (M) over the four time intervals for Patient Controlled Analgesia (PCA) doses requirement were also examined. Significant differences were found

with $F(3,43) = 3.69$ at $p<0.05$, in the Post Operative Room (POR) between the groups. Post-hoc analysis confirmed that group 4 (M=2.30) was significantly lower than groups 2 (M=5.17), and 3 (M=4.58). Post-hoc comparison tests indicate that mean PCA doses in the POR, for group 4 was significantly different from group 2 and 3. Mean PCA doses between groups 1 and 4 have no differences. Differences between the groups between one and eight hours post-operatively were also found with $F(3,43)=2.33$ at $p<0.10$. However, post-hoc analysis did not confirm this finding between any of the four groups.

To compare the mean amount of Patient Controlled Analgesia (PCA) demands of the four groups over the 24 hours post-operative, a one-way ANOVA with S.N.K and Tukey-HSD post-hoc tests were applied. The results showed that the four groups had a similar trend within 24 hours postoperatively. However, significant differences were found between the means at the Post Operating room with $F(3,43) = 4.80$ at $p<0.01$, and 1 to 8 hours postoperative with $F(3,43) = 3.49$ at $p<0.05$. Post-hoc analysis confirmed the significant difference between the means at 1 to 8 hours postoperative as group 2 (M=55.75) was significantly higher than group 4 (M=22.30). Post-hoc analysis also confirmed that group 2 (M=30.83) was significantly higher than group 3 (M=13.00) and group 4 (M=5.90) at the POR. No other significance was found between means.

The results of PCA doses demanded by subjects indicated that there was no significant difference between the total PCA doses given for the four groups over twenty-four hour period post-operatively. However, a one way ANOVA was applied to compare the groups for total PCA doses demanded and significant differences were found between the groups with $F(3,42) = 3.59$ at $p<0.05$. Post-hoc analysis confirmed the difference between groups 1 (M=84.54) and 4 (M=41.60). Moreover, differences were found between the four groups for the amount of analgesia delivered in mg, $F(3,43)=2.45$, $p<0.10$. Post-hoc analysis confirmed this finding between group one (M=38.63) and four (M=29.29).

The thesis concludes with a discussion of methodological issues related to conducting randomized, placebo-controlled trials of electro-acupuncture and goals for future research in this area of pain management. Treatment outcome of SSP needless electro-acupuncture

showed an improvement of the time of first bowel movement and ambulation, opioid related side effects, total amount of PCA demand, and total amount of PCA doses.

The clinical significance of this particular study is of great interest, especially for those patients who wish for a non-pharmacological analgesia without side effects. Although further study is needed to ultimately determine whether SSP needle-free electro-acupuncture (EA) has a place in postoperative pain treatment, this study has suggested that SSP needle-free EA does have a place as an adjunct to standard medical care for post-operative surgical pain. Arguably this 'needle free approach' has benefits for patients who have difficulties with traditional acupuncture needling and at the same time are interested in a non-pharmacological approach to treating pain.

Key words: Silver Spike Point (SSP) therapy, needle-free electro-acupuncture (EA), hysterectomy, postoperative pain management, Zusanli (ST36).

Definitions and Abbreviations

Qi - Translates as vital activity of life energy. In Traditional Chinese Medicine (TCM), health is considered to be a function of the smooth flow of qi, through a series of pathways or meridians, which link and unite all parts of the body into a single integrated whole. Disease is defined as an imbalance of, or disruption to the movement of qi (Liu, 1998).

Xue (blood and its functions) - In Traditional Chinese Medicine (TCM), blood is formed from food essence produced by the pi (spleen meridian system) and the wei (stomach meridian system). The blood then circulates throughout the body providing nourishment and moisture to all the organs and tissues. The deficiency of blood affects the normal functioning of the body. Blood also provides nourishment for mental activities. A sufficient blood supply ensures clear consciousness and a vigorous spirit (Liu, 1998).

Yin and Yang Theory - Yin and yang theory is based on the philosophical construct of two polar complements. These complementary opposites are neither forces nor material entities, but are concepts used to explain the continuous process of natural change. Yin and yang are not only a set of correspondences; they also represent a way of thinking. In this system of thought, all things are seen as a part of an integrated whole. The yin-yang nature of a phenomenon is not absolute, but relative. Yin and yang exist in everything in nature. The theory of yin-yang permeates all aspects of the theoretical system of TCM. It serves to explain the organic structure, physiological functions and pathological changes of the human body. In brief, health is considered a balance of the yin-yang aspects of the whole person and disease is defined as an imbalance of the yin and yang. To adjust the balance of yin and yang is an important principle in TCM in the prevention and treatment of illness (Liu, 1998).

Real Acupuncture Points - acupuncture at classical points on the body. In this study, subjects in Groups 111 and 1V received SSP needle-free EA to real acupuncture points.

Sham Acupuncture Points - acupuncture at non-classical points on the body. In this study, an attempt was made to reduce the placebo effect of acupuncture treatment by placing SSP

electrodes at points (without electrical stimulation) on the body which did not correspond to classical acupuncture points. This procedure attempts to minimise the medical effects of acupuncture, while maintaining the its psychological effect. Needling sham points (sites) is the most accepted control for the clinical evaluation of acupuncture, as it goes closest to addressing the placebo effect.

SSP - The SSP therapy is a recognised form of needle-free electroacupuncture (EA) and has been shown to have similar analgesic effects to needle EA. SSP is an advanced form of low-frequency electrical therapy that was developed in 1976 in Japan as a joint academic industrial study between Osaka Medical College (Department of Anaesthesiology) and Nihon Medix Company Limited. SSP therapy stimulates the analgesic effect of needle electroacupuncture, without using needles. Low-frequency treatment, using SSP therapy has been found to provide effective pain relief.

Chapter 1

Introduction

At some point in life, everyone experiences pain. Pain is the most common complaint physicians see in their practices. "*Despite modern surgery and anaesthesia, patients continue to associate surgery with severe pain; postoperative pain for which they will receive inadequate analgesia*" (Editorial: Postoperative pain. Anaesthesia and Intensive Care, Vol 4 p95-96, 1976).

Effective treatment of severe pain has been one of the great challenges of medicine. Besides experiencing pain, most of us have also taken a wide range of pain medications, from over-the-counter medicine like aspirin to stronger prescription drugs; and we are aware that these medications can have unpleasant and unwanted side effects. Would so many of us continue to take these modern pharmaceuticals if we knew about other options that are time-tested, safe, natural and effective?

Acupuncture is an essential part of Traditional Chinese Medicine (TCM), a comprehensive system of medicine with a continuous clinical history over thousands of years. TCM includes a variety of techniques in addition to acupuncture such as herbal prescription, dietary therapy, Tai Chi (Tai Ji) exercise, electrostimulation, cupping (suction), moxibustion (burning herbs), gua sha (scraping) and massage (Yang, 1997).

Liu and Gong, 2007 indicated that: In China, not many modern synthetic analgesics are used. Doctors are not often prescribing pain medications. Whether a Chinese doctor has trained primarily in Western or TCM, acupuncture and patent herbal medicines are seen as the first treatment option for pain. TCM is a relatively safe, effective and natural healing modality that has been used by a quarter of the world continuously for several thousand years to deal with a variety of pain issues.

Although TCM had long been available in Asian-American communities, broader awareness of acupuncture came to the United States in 1972, when *New York Times* journalist James Reston went on a ground-breaking trip to China with the Nixon entourage. Once there, he suffered a severe appendicitis attack and underwent emergency surgery. During his post-operative recovery, Chinese medical doctors offered acupuncture to relieve his pain and promote healing. Mr. Reston had wonderful results and was so impressed by this ancient healing technique that when he returned to America, he wrote a front- page article for the *New York Times* entitled, "I saw the past, and it works." Since then, acupuncture has become increasingly popular in the United States, especially for pain-related problems. It is widely accepted by more and more people for pain reduction. Both ancient wisdom and modern scientific research reveal that acupuncture really works - it is not just a matter of belief. Many people become convinced of this when they see their cats or dogs get better after having acupuncture treatments (Liu and Gong, 2007). In California, where the practice of acupuncture has been independently licensed since 1976, acupuncture is:

> *"the insertion of needles to prevent or modify the perception of pain or to normalize physiological functions, including pain control, for the treatment of certain diseases and dysfunctions of the body and includes the techniques of electro-acupuncture, cupping, and moxibustion."[(State of California, Business and Professions Code, Section 4927 (e)]*

Some researchers feel that acupuncture works primarily because of its interaction with the spinal afferent processing system, involving somatic nociceptive (pain), proprioceptive (muscle static load, length and position), and autonomic fibers, as well as other nerves of the body that provoke local, spinal, and centrally mediated control. The principal effect of this descending control is to restore autonomic balance and to reduce pain (Kendall, 1989, 2002). Acupuncture and electro-acupuncture are commonly used to treat chronic or post-operative pain, nausea, and other pain conditions:

> *"Acupuncture, in combination with pharmacological interventions, may lower the need for medication and reduce the risk for side effects from these drugs." (*National Institutes of Health, National Center for Complementary and Alternative Medicine. Acupuncture Information and Recourses, 2001*).*

The severity of postoperative pain is affected by many factors including age, sex, personality, knowledge of and confidence with the procedure, attitude of the staff, and the individual's

physiological condition. The same procedure can produce different degrees of postoperative pain in different patients. Even though, in most cases, upper abdominal or thoracic surgery causes severe postoperative pain, superficial operations still cause mild postoperative pain. Patients usually feel the most pain in the first few hours after surgery. Postoperative pain can result in irritability, insomnia, increased heart rate, hypertension, excessive perspiration, overactive metabolism, tachycardia, diaphoresis, mydriasis, pallor and increased myocardial oxygen consumption. In patients with coronary artery disease postoperative pain can result in myocardial ischemia and possible infarction that in turn may delay postoperative recovery. (Lo, 1998).

Intravenous patient-controlled analgesia (PCA) is an accepted method to relieve postoperative pain (McQuay, 1992; Galloway, Boyle, Burns, Davidson and George, 1984). Opioids have been used as an analgesic for most postoperative pain management (Barratt, 1997; Moote, 1994). Possible adverse effects are respiratory depression, constipation, vomiting, gastroparesis, and central nervous system depression including somnolence and conscious disturbance, (Tobias, 1997; Follin and Charland, 1997). However, opioid-related side effects often occur post-operatively, and are related to the total dosage of opioid medication (McQuay, Bullingham, Moore, Evans and Lloyd, 1982). The ideal analgesic should fulfill the following conditions: elevated analgesic potency, fast action, long lasting analgesic effect, without risk of addiction and tolerability, low risk of adverse reactions and comfortable to administer (McGurk and Robinson, 1998; Meredith, 1986).

In the 1970s, extensive research was carried out in Japan into acupuncture analgesia and anesthesia. Since its analgesic effect was unstable and it required quite some time to obtain the effect, and as new pharmaceutical methods for analgesia and anesthesia were developed, the investigation into acupuncture analgesia and anesthesia was not continue. However, analgesia and anesthesia by acupuncture is applicable under appropriate conditions for the management of postoperative pain, where PC06, BL24, GV06, GB34, ST25, ST36 and SP6 are applied to produce analgesia (Washisu, 2006).

Electro-stimulation has a postoperative pain relieving effect when applied as either electro-acupuncture (EA) transcutaneous nerve stimulation (TENS) (Christensen, Rotne, Vedesdal,

Jensen, Jacobsen and Husted, 1993; Stanley, Cazallaa, Atinault, Coeytaux, Limoge, Louville, 1982; Lu, 1993) or Silver Spike Point (SSP) therapy. SSP is needle-free EA and has been shown to have a similar analgesic effect to standard EA, where electrical stimulation is applied to needles that have been inserted into acupuncture points, and a superior effect than TENS (Ishimaru, 1989; Umeki N, Iwa M, Ishimaru K, Shinohara S, Kitade T, Hata K, 1990; Ishimaru, Shinohara and Kitade, 1990). The acupuncture analgesic mechanism remains unclear in spite of successful clinical applications and recognition by WHO (Christensen, Rotne, Vedelsdal, Jensen, Jacobsen and Husted, 1993; Stanley, 1982; Lu, 1993). This study will investigate SSP needle-free EA's role in managing postoperative pain and in reducing the adverse side effects of opioids.

Acupuncture has generated much interest in western countries like Australia, and is considered a rather safe clinical treatment method for a wide range of disorders. However, in clinical applications, there are some contraindications and complications with using needles such as:

a) Fear of needles especially among young children.
b) Patients who bleed easily.
c) The risk of puncturing vital organs.
d) The risk of fainting due to the patient's nervous disposition, weak constitution, hunger, fatigue, improper positioning or overstimulation of needles.
e) Needles getting stuck due to the patient's anxiety and tension, muscle spasm, or change of position after needle insertion.
f) Bent needles due to the patient's sudden change of position, practitioner's poor skill, or inadequate management of a 'stuck' needle.
g) Broken needles due to poor quality, over manipulation, muscle spasm, sudden movement or change in posture, or forcefully withdrawing of a 'stuck' needle.
h) Haematoma due to damage the blood vessels, or failing to add pressure to the needled point after withdrawal of the needle.
i) Discomfort or pain from needling.
j) Risk of infection or cross infection.

Besides these contraindications and complications, used needles have the potential of being an environmental hazard.

SSP needle-free EA offers many benefits such as:

a) Reduction of hazardous waste.
b) Minimization of the contraindications or complications of standard acupuncture.
c) No skin penetration and a reduced risk of infection.
d) SSP EA provides a range of stimulation types that are particularly suitable for sensitive patients including young children and the elderly.

A particular advantage of SSP EA is that it can be safely used on acupuncture points all over the body, whereas incorrect acupuncture needling over major organs and the spinal cord can cause serious problems.

Contraindications of SSP EA treatment include:

a) Patients who have an internal electronic device (e.g. pacemaker).
b) Patients recovered from cerebral hemorrhage.
c) Patients who have acute spinal cord disease, epilepsy, infectious hypertension, tuberculosis, heart disease (especially miocartosis or valvular disease), and extreme asthenia.
d) Pregnancy (especially first trimester).
e) Care must also be taken with patients who suffer from cutaneous erethism, contagious skin diseases, allergies or wounds (the affected areas should be avoided) and on sensitive areas (e.g. the face where visible marks can be seen after a short period of treatment), with patients who have just eaten, who have weak skin, sharply fluctuating blood pressure, high fever and on infants (Nihon Medix, SSP Operation Manual).

Lo (1998) investigated the effect of pre-operative EA treatment on hysterectomy patients as a pain control method in conjunction with the use of PCA. He found that the first postoperative requirements for narcotics was prolonged, PCA demands decreased, and the opioid-related side effects were reduced in the first 24 hours post-operatively after preoperative EA

treatment. He demonstrated that the opioid sparing effects of EA depends on its stimulation frequency. The results were varied suggesting that further investigations in this area are required.

In 1989, an experimental study designed to increase the analgesic effect for pain following abdominal surgery using SSP needle-free EA, was undertaken by Ishimaru and Shinohara, who found that that SSP Therapy can increase the pain threshold. These results varied however, according to the differing stimulation frequencies (Ishimaru, Shinohara and Kitade, 1990).

Lundeberg (2002) indicated that acupuncture is a system with an empirical basis that has been used in the treatment of pain for centuries. Its use for pain relief is supported by clinical trials and this has facilitated its acceptance in pain clinics in most countries. Acupuncture effects on pain must devolve from physiological and/or psychological mechanisms with biological foundations. Acupuncture and some other forms of sensory stimulation elicit similar effects in man and other mammals, suggesting that they bring about fundamental physiological changes. Acupuncture excites receptors or nerve fibres in the stimulated tissue which are also physiologically activated by strong muscle contractions and the effects on certain organ functions are similar to those obtained by protracted exercise. Both exercise and acupuncture produce rhythmic discharges in nerve fibres, and cause the release of endogenous neurotransmitters including opioids, monoamines, oxytocin and other neuropeptides (SP, CGRP, GAL, CRF, NPY), which are important in the control of both sensory, affective and cognitive elements of pain.

Over the past ten years there has been a growing awareness that pain is due not simply to the activation of peripheral nociceptors, as in nociceptive pain, but to multiple factors, and is therefore susceptible to various modes of acupuncture treatments. Depending on the aetiology, pain may be classified into several categories, such as nociceptive, neurogenic, chronic pain syndrome and psychogenic pain (Lundeberg, 2002).

Musculoskeletal and visceral pain states, both being nociceptive pain, are characterised by hyperalgesia. However, despite belonging to a similar category, the pain is triggered by

different mechanisms. Neurogenic pain is caused by injury or dysfunction in the nervous system and is often severe and intractable and may not respond to even powerful opioids. Recent studies suggest that there is a third pain category, distinct from the neurogenic and nociceptive, where pain is related to a sickness response that occurs with exposure to chemical compounds and infectious agents the associated central changes produce heightened pain sensitivity (‘hurting all over’), termed chronic pain syndrome. In clinical trials acupuncture or low frequency electro-acupuncture have been shown to be effective in some nociceptive pain states, whereas high frequency stimulation is more effective in neurogenic pain. In chronic pain syndrome patients with high anxiety, acupuncture is generally inefficient. It is possible that part of the lack of effect in chronic pain syndromes can be attributed to high levels of the opioid-antagonist cholecystokinin in the brain (Lundeberg, 2002).

Acupuncture may be effective in some categories of pain but the mode of stimulation should be adjusted to the aetiology of pain. Also, patients are likely to respond better if they are not stressed and anxious.

Saso (2002) discussed acupuncture and Neuroimmunomodulation:

> The immune system represents a multisystem comprised of components derived from central nervous (CNS), endocrine (ES) and immune system (IS) (Jankovic, 1979). A term neuroimmunomodulation (NIM) was coined to describe the permanent intercommunication between these systems. They exchange information on the basis of shared receptors and biochemical substances (Blalock, 1992). By modulation of their production it is possible to affect the function of the immune system. The immunointervention could be achieved by direct influence on the immune system or indirectly by modulating activity of the CNS or Endocrine System (ES).
>
> Evidence has been accumulated in recent years on the underlying pathophysiological mechanism of the acupuncture (Bossy, 1990). Stimulation of different acupuncture points could produce a certain amount of neurotransmitters, neuromodulators, neurohormones and cytokines (Lundeberg and Eriksson, 1991). They can either directly affect the components of the immune system or indirectly by activating the

neuroendocrine axis. The main neuroimmunomodulators released after acupuncture stimulation are opioid peptides: the enkephalins, endorphins and dynorphins. (Fujiwara, Tong, Matsuoka, Shibata, Iwamoto and Yokoyama, 1991; Sakic, Kojic, Jankovic and Skokljev, 1989). The experimental results suggest a bi-modal, dose dependent effect of the opioid peptides on the immune system, met-enkephalin (Met-Enk) and leu-enkephalin (Leu-Enk) being the most extensively studied opioid peptides (Jankovic, 1994).

It is now clear that Met-Enk and Leu-Enk are not equipotent since the former has been more active in modulating the immune response. Met-Enk injected peripherally in high doses suppresses, whereas in low doses enhances, immune reactions. Injection of Met-Enk into the cerebral cavity (ICV) of the rat sensitised with bovine albumin could modulate cutaneous delayed hypersensitivity to the antigen more effectively than when injected peripherally. So, delayed cutaneous reactions were increased after small dose intraventricular injection of Met-Enk, whereas the large dose of the same enkephalin induced decreased skin reactions (Jankovic and Maric, 1987; Maric and Jankovic, 1987).

At a certain dose Met-Enk could be a potent anti-inflammatory agent, or may even prevent anaphylactic shock (Jankovic and Maric, 1987). Enkephalins are able to prolong survival time of mice inoculated with tumour cells. In vivo treatment of cancer patients could also result in immunomodulation. Of great interest are the results that showed, *in vitro* as well as *in vivo*, that the enkephalins can enhance NK and T cell activity. Therefore by increasing activity of NK cells it would be possible to enhance host resistance to viral and tumour challenge (Plotnikoff, 1988).

The rapidly expanding area of NIM has become an unlimited source of data that has enabled us to understand and scientifically explain the ancient skill of acupuncture.

Zieglgansberger (2002) pointed out the future directions for acupuncture research:

Excitation following nociceptor activation or paroxysmal activity in afferent nerves triggers sets of neuronal events which extend over a time frame ranging from

milliseconds to hours, days or weeks. In addition to traditional treatments, new regimes to prevent or trigger activity-dependent long-term changes in transducing and suppressive systems for pain are emerging.

In recent years traditional pain treatments such as acupuncture became accessible to the analytical power of modern electrophysiological, molecular and cellular biological techniques. These recent advances in pain research underline the importance of multireceptive neurones in the establishment of hyperalgesia and allodynia, which are under the control of inhibitory interneurons on various stages in the neuraxis. The first stage of sensory integration in the dorsal horn of the spinal cord reflects the earliest short-term responses such as neuronal discharge activity as well as the long-term changes that most commonly require alterations in gene expression. In general, activity-dependent gene expression and the transient modulation of synaptic transmission by, for example, phosphorylation of ion channels, greatly expands the capacity of highly integrated systems, such as the pain matrix, to react in a more plastic manner to environmental stimuli. Acupuncture stimuli may interact with neuronal circuits on various levels of the neuraxis. It is feasible to assume that this treatment evokes neuroplastic changes and alters gene expression in various components of the pain matrix, for example, in cortical and subcortical areas integrating pain threshold and intensity. Enhanced neuronal excitability is the therapeutic target of acupuncture. Imaging techniques can now be used to relate peripheral stimulation of traditional and nontraditional acupuncture points and pain perception. Animal experiments suggest that numerous neurons in pain related structures lower their excitability under such a treatment. An enhancement of the discharge rate of such tonically active inhibitory interneurons would finally lower the activity in neurons involved in pain processing. Under physiological conditions their activity probably prevents acute pain signals from triggering long-lasting excitability increases in projection neurons.

This study was intended to determine the effect of pre- and post-operative SSP treatment on post-operative pain following hysterectomy. Based on clinical experimental design, four groups of randomised subjects were enrolled. Group 1 was assigned as the control group;

Subjects in Group 2 were applied SSP electrode at a sham acupuncture point, a point not usually regarded as a classical acupuncture point; Group 3 received SSP stimulation at 100 Hz and Group 4 received SSP stimulation by a mixture of at 3Hz, 10Hz, and 20Hz. It was proposed that each group consist of 25 women who had undergone hysterectomy. The research evaluated the analgesic effect of SSP needle-free EA for post-operative pain relief and comparing the difference between high frequency and low frequency stimulation.

Chapter 2

Literature Review

Acupuncture and related techniques are increasingly used for analgesia and anaesthesia. This chapter reviews the theory, current evidence and applicability of acupuncture (with needles or without needles) and related techniques for anaesthetic procedures and postoperative related symptoms.

Recent evidence suggests that manual acupuncture (as distinct from electro-acupuncture) is effective for reducing preoperative anxiety and for postoperative pain. Current available data does not support the use of acupuncture as an adjunct to the general anaesthetic in the intra-operative setting. A number of acupuncture points including ST36 have been reported to have beneficial effects on post-operative pain. Lee and Chan (2006) found that there are extensive and good quality evidence to support the use of P6 acupuncture point stimulation techniques for preventing postoperative nausea and vomiting in combination with, or as an alternative to, conventional anti-emetics. The use of acupuncture for labour pain management appears promising but requires further research. Subject selection, acupuncture point selection, needling techniques, and the mode of acupuncture need to be considered when applying acupuncture and related techniques in the peri-operative setting. There are guidelines for the conduct and reporting of acupuncture research, and these should be followed to improve the quality of studies.

Pain management is usually applied to the patient post-operatively; however, this is often difficult to manage due to individual's pain thresholds. The medical profession has also employed the concept of "pre-emptive analgesia" (McQuay, 1992). Adequate pain management then, can be applied pre-, intra-, and post-operatively. Modern pain control utilizes many comprehensive treatments and medications, such as patient controlled analgesia (PCA) (Tamsen, Hartvig, Dahlstrom, Lindstrom, Holmdahl, 1979; Burns, Hodsman, McLintock, Gillies, Kenny and McArdle, 1989; Notcutt, and Morgan, 1990; Kluger and

Owen, 1990), intrapleural regional analgesia (Cronin and Davies, 1976; Murphy, 1983; Rawal, Sjostrand, Dahlstrom, Nydahl, and Ostelius, 1982; Moore, 1975), spinal analgesia, peripheral nerve block, opioids, local anesthetics, and non-steroid anti-inflammatory drug (NSAID). Non-pharmaceutical methods include TENS, EA analgesia and SSP needle-free EA provide other alternatives for pain control. Following are the regimens that have been applied to postoperative pain control.

2.1 Pain Perception

The problem of pain has been a wellspring for much of mankind's religious and medical thinking. Pain is one of the most powerful and insistent sensations and a force behind much of man's behaviour in the physical world. It has also been a fertile ground for a plethora of religious interpretations and a focal point around which some of the philosophical thinking of a culture has crystallized (Rudolph, 1995). The section below gives a very brief overview of the history of pain interpretation in the West, based on Jaros' summary (1991) and Rudolph's (1995) view.

It is thought that ancient civilizations, such as the Egyptians and Assyro-Babylonians, ascribed pain caused by disease to intrusive forces such as spirits or magical fluids. One of the roles of the shaman or priest was to facilitate the release of the destructive elements in the afflicted's body. This release could take the form of vomiting, sweating, blood letting or a variety of other means. The concept of pain in western thought has evolved from roots in the ancient Greek, Roman and Hebrew civilizations. The Greeks believed that enduring great physical or psychological pain would enable one to achieve a greater measure of courage and nobility, while Plato thought the sensations of pleasure and pain distracted the soul from knowing what was real.

With the ascent of the Church in Western Europe, Greek teachings were repudiated and found their way into Persia and influenced a variety of Arabic scholars and physicians. The Arab physician Avicenna (AD 980-1036) developed a theory of pain based on the four temperaments of heat, cold, dryness and moistness, an imbalance of which gave rise to 15

different types of pain. It is interesting to note that the Chinese use the same four temperaments with the addition of wind as a fifth temperament (Kenyon 1983).

After the collapse of the Roman Empire, the church of the Middle Ages gained in power and from Judaism adopted the connection of sin with punishment and punishment with pain. The English word pain is derived from the Latin word poena meaning punishment. The otherworldly outlook of the Medieval Church placed little emphasis on worldly comforts and held that the suffering and pain of the human condition was a result of Original Sin and thus just punishment. Disease was seen as punishment which also cleansed in a purgative sense and to expend too much effort in the alleviation of suffering could even be seen as transgressing against God's divine order.

With the Renaissance came a renewed interest in man, nature and the scientific method. The belief of Original Sin was gradually replaced by a belief in the original purity of human beings, who then became corrupted by the effects of disease, poverty and injustice. Manipulating the natural order to minimise these negative influences was seen as a legitimate way to improve the physical and spiritual condition of mankind. This was a time of intense study of the human body through dissection and experimentation. However the acceptance of analgesia met with considerable resistance on moral grounds as recently as the late nineteenth century and in the Catholic Church required formal approval from Pope Pius XII.

Rodolph (1995) stated that western civilization has almost completely secularized pain. Through the use of over-the-counter analgesics, biofeedback and patient-controlled analgesia, the locus of control has shifted more from external deities to the individual. Thus, PCA can be seen as part of a progression towards greater self-responsibility of the individual. This is a theme found not only in the area of pain relief, but in the changing western health profession in which the onus for health is gradually being placed more on the individual.

The origin and nature of pain, whilst researched and studied extensively by modern science is still a mystery. As more is known about the mechanisms of pain it becomes apparent that pain is not a function of one particular body system and cannot be removed from human experience. While research has opened a more comprehensive view of the mechanisms of

pain, that view has not become simpler but rather more complex. As the individual struggles to assume increased responsibility for his or her health and pain, this complexity may indeed lead to either the external deities becoming resurrected in a contemporary form or replaced by the individual divinity of each person. In terms of psychology, the shift from external deities to individual responsibility can be viewed as a move of the locus of control from a powerful outside centre to the individual self (Rodolph, 1995).

The physiological nature of pain is still poorly understood at present. As far as PCA is concerned, the working definition used here is: pain is whatever the experiencing person says it is, existing whenever the experiencing person says it does (Roop, 1991). A definition of pain adopted in 1986 by the Subcommittee on Taxonomy of the International Association for the Study of Pain (IASP) is pain is an unpleasant experience associated with actual or potential tissue damage, or described in terms of such damage. (Drasner Katz and Schapera. 1992; Merskey, 1979). It can be seen that by definition pain is subjective and cannot be measured directly as such. Pain is simultaneously a physiological and a psychological experience. The physiological effects of pain are quite well known and include increased oxygen consumption, decreased lung volume, immobility and a variety of hormonal and metabolic responses.

Pain itself also tends to vary over time and this would ideally require a constant adjustment of the analgesic level. In oncology pain and in post-operative pain, the phenomenon of breakthrough pain has been observed. Breakthrough pain is a period of severe pain over and above the chronic temporal components and can be difficult to control (Citron and Kalra. 1985).

Nocioceptive pain has responded better to opioid analgesic treatment than neuropathic pain which has been thought to respond only minimally. Recent research using PCA has however shown some success in treating neuropathic pain using morphine (Jadad et al. 1992).

The psychological impact of pain is just as real as the physiological component and consists of emotional and socio-cultural factors and the patient’s general psychological disposition. The integration of psychologic principles with pharmacologic treatment has been discussed

by Chapman (1992). A general overview of the psychological aspects of pain can be found in Melzack (1988).

It is generally accepted that a positive relationship exists between anxiety and experienced pain (Christoph 1991; Lange, Dahn and Jacobs, 1988; Gill, et al. 1992; Melzack 1988). Fear of pain can in turn heighten anxiety. Possible lack of control over severe pain can significantly increase patients' anxiety levels. Christoph (1991) points out that unmanaged pain contributes to the development of critical care psychosis and personality disorders. This view is also echoed by Drasner et al. (1992). It should be borne in mind that the pain under discussion here is of perceived levels of pain that cannot be readily controlled by orally or rectally administered analgesics. PCA has often been credited with reducing anxiety by giving patients control over their environment and reducing the time to administer pain relief (Lange 1988; Drasner, et al. 1992).

PCA has gradually become a more popular pain management modality both with patients and clinical staff. The thrust behind the development of PCA has been an increasing awareness from as early as 1952 of the inadequacy of the conventional methods of administering pain relief (Papper 1952; Tamsen, 1986; Lubenow and Ivankovich, 1991; Marks and Sachar, 1973).

A major turning point was reached with a publication by Marks and Sachar in 1973, which placed the percentage of patients experiencing inadequate analgesia as high as 73% (Marks and Sachar 1973; Ferrante and Covino, 1990). A steady stream of articles have echoed these findings since then, variously quoting figures for insufficient analgesia of at least 50 % (Ferrante and Covino, 1990), one of the major reasons for inadequate analgesia is the method of analgesic administration, in particular the practice of pro re nata (p.r.n.) and scheduled intramuscular (IM) injections at three or four hourly intervals. The patient experiences very large swings in blood concentration over the four hourly bolus intervals, with attendant large changes in analgesia. The range in which analgesia is experienced is relatively small, and as the plasma concentration varies the patient receives satisfactory analgesia only for a relatively short time.

Rudolph (1995) indicated that the advantages of PCA are perhaps best understood by describing the difficulties encountered in pain relief and how they are dealt with in conventional intramuscular regimens. The problems in pain relief are discussed below and can best be subdivided into four groups: pharmacology, method of administration, the nature of pain itself, and patient variation.

2.2 Postoperative Pain and Related Symptoms

Although the currently available armamentarium of analgesic and antiemetic drugs is impressive, management of acute postoperative pain, as well as nausea and vomiting, poses some unique challenges to ambulatory surgery. White (1995) indicated the increasing number and complexity of operations being performed on an outpatient basis present the practitioners of ambulatory anaesthesia with many unique challenges. Outpatients undergoing day-case procedures require an analgesic technique that is effective, has minimal side effects and can be easily managed away from the hospital.

Patient Controlled Analgesia is a pain control treatment developed in the late 1970s (48). Its advantage is that patients can self-administer opioids intravenously, according to their individual demands, by pressing a button. In 1982, Bennett's experimental results indicated that PCA is preferable to IM (intra-muscular injection) because it can meet individual pain requirements.

The disadvantage of PCA for postoperative pain relief is its related adverse effects. These include nausea, vomiting, dizziness, tiredness, respiratory depression, lack of concentration, and lethargy (White, 1988; Parker, Holtman and White, 1991).

With PCA, opioids can be administered by a nurse under the physician’s order at the patient’s request. Opioids have been used as an analgesic for most postoperative pain management (Barratt, 1997; Moote, 1994). Possible adverse effects are respiratory depression, constipation, vomiting, gastroparesis, and central nervous system depression including somnolence and conscious disturbance (Tortora, 1989; Follin, and Charland, 1997).

White (1995) also indicated that the control of postoperative pain and emesis is the most important factor in determining when a patient can be safely discharged from an outpatient facility. Since inadequately treated pain and emesis are among the most common problems after ambulatory surgery, the ability to provide adequate pain relief without exacerbating post-operative nausea and vomiting (PONV) remains one of the major challenges for providers of outpatient anaesthesia and surgery. Although peri-operative analgesia has traditionally been provided by opioid analgesics, aggressive use of opioids can be associated with sedation and an increased incidence of PONV, which, in turn, contributes to a delayed discharge from the day-care facility.

Non-Steroid Anti - Inflammatory Drug (NSAIDs) have shown a morphine-sparing effect when administered as postoperative pain control. Associated side effects include headache, drowsiness, vomiting, peptic ulcers, gastrointestinal irritation/bleeding, platelet dysfunction, and bronchospasm (d'Amours and Ferrante, 1996; Follin and Charland, 1997; Barratt, 1997; Tobias, 1997).

Local anesthetics can be administered by epidural, subarachnoid routes, or as a peripheral nerve block. Successful use of opioids can reduce side effects, such as vomiting and respiratory depression (Barratt, 1997; Follin and Charland, 1997).

Pharmacologically, the ideal analgesic would have quick onset of action, no unwanted effects, no ceiling effects and no tolerance. No drug meets all these requirements, but morphine and pethidine (meperidine) present the best compromise and are the most frequently used (Lubenow and Ivankovich, 1991).

In practice, the unwanted effects of opioid analgesics are varied. The extent and the type of unwanted effects which appear at various concentrations depend on each individual patient. A balance between analgesic effects and unwanted effects must be found for each individual. PCA is uniquely suited for this task, as it allows each patient to find his or her own balance between some of the unpleasant unwanted effects and analgesia. The following is a list of

common systemic effects of opioid agonists used in PCA (Mather and Owen, 1990, Eige 1992).

- Central nervous system effects usually consist of diminished responsiveness to nociceptive stimuli, mood elevation and sedation. In addition, further effects may include mental clouding, dizziness, dysphoria and hallucinations.
- Respiratory system effects are primarily reduced ventilatory response to CO2 (and to hypoxia) with the potential for respiratory depression. Unfortunately, potency of analgesia parallels the respiratory depressant action, so that as a patient receives more analgesic the risk of respiratory depression also increases. Respiratory depression is the most serious of the acute unwanted effects of opioids.
- Effects on the gastrointestinal system especially ileus include nausea and vomiting as well as uncoordinated gut activity, often resulting in constipation.
- Circulatory system effects are minimal at standard post-operative doses. Morphine and pethidine can sometimes cause hypotension.
- Other effects of morphine include generalized itching, disrupted sleep and nightmares (Fulton and Johnson, 1993).

It should be noted that the proposed PCA system features safety monitoring devices to monitor respiration rate, arterial oxygen saturation (SpO2) and end-tidal carbon dioxide concentration (ETCO2), primarily with the aim of detecting respiratory depression due to over sedation from analgesics. Respiratory depression resulting in apnoea is the most serious of the unwanted effects, although less severe effects are also of concern and may be the reason for discontinuation of PCA therapy (Rudolph, 1995).

The ratio of efficacy to toxicity is referred to as the therapeutic index and is traditionally defined in the literature as the ratio of the amount producing the adverse effect in 50 percent of the test population to the amount producing the desired effect in 50 percent of the test population. A high therapeutic index indicates a drug in which the unwanted effects are minor and the desired effects dominate. For PCA, a drug with a high therapeutic index would be particularly important because of the large differences, in between patients in amounts required for efficacy. However, the commonly used drugs in acute pain relief have a small therapeutic index relative to the range of effective dosages required by patients. This is one of

the reasons which makes a generalised approach to acute pain relief difficult, particularly as there are no suitably objective parameters of a patient's analgesic requirements (Rudolph, 1995).

Adverse effects are associated with high systemic concentrations caused by over dose or accidental intravascular injection, resulting in central nervous system reactions like dizziness, visual and auditory disturbances. In extreme cases cardiovascular toxicity caused death (Follin and Charland, 1997). Other effects include hypotension, hypertension, numbness, motor block or loss of motor power and neurological injury (Gissen, Covino and Gregus, 1982; d'Amours, and Ferrante, 1996; Tobias and Thomas, 1995).

In order to minimize these opioid-related adverse effects, "balanced" analgesia techniques involving the use of opioid and non-opioid analgesic drugs (local anaesthetics and non-steroidal anti-inflammatory drugs (NSAIDs) are becoming increasingly popular. Local anaesthetic techniques, peripheral nerve blocks and wound infiltration with local anaesthetics are becoming increasingly popular adjuncts to general anaesthesia because they can provide considerable intra-operative and post-operative analgesia. These techniques decrease the incidence of pain and reduce the requirements for narcotic analgesics in the peri-operative period. Effective pain relief in the early post-operative period provides for rapid and smooth recovery, enabling earlier ambulation and discharge from the ambulatory surgery unit. The use of local anaesthetic techniques for postoperative pain control can also decrease the incidence of PONV and, thereby, potentially lower the incidence of unanticipated hospital admission after ambulatory surgery (White, 1988).

White (1988) also indicated that non-pharmacological techniques Transcutaneous electric nerve stimulation (TENS) or acupuncture-like transcutaneous electrical nerve stimulation (ALIENS), as well as peri-cutaneous electrical nerve stimulation (PENS), have been utilized in the treatment of both acute and chronic pain in the ambulatory setting. Given the inherent side effects produced by both opioid and non-opioid analgesics, as well as the local anaesthetics, it is not surprising that nonpharmacological approaches to managing acute postoperative pain are increasingly popular in the outpatient setting. The mechanisms by which TENS, ALIENS, and PENS exert their analgesic action have not been completely

elucidated. However, possible mechanisms include: (1) stimulation of descending pain inhibitory pathways, (2) an inhibition of substance-P release in central nervous system (CNS) structures, and (3) the release of endogenous opioid substances within the CNS.

Postoperative nausea, retching and vomiting are among the most common postoperative complaints which occur after general, regional and local anaesthesia. Although much less problematic in patients receiving local anaesthesia as part of a monitored anaesthetic care technique, the incidence of postoperative emesis in recent large studies has been reported to be in the 20-30% range, which is consistently lower than the 75-80% incidence reported during the "ether" era. Nevertheless, persistent nausea and vomiting may result in dehydration, electrolyte imbalance, and delayed discharge after outpatient surgery. Persistent retching or vomiting can cause tension on suture lines, venous hypertension and increased bleeding under skin flaps, as well as exposing the patient to an increased risk of pulmonary aspiration of vomitus (if the airway reflexes are depressed from the residual effects of anaesthetic and analgesic drugs). Although frequently described as a "minor" postoperative complication, the incidence of severe (intractable) nausea and vomiting has been reported to be 1 in 1000 (0.1%). Factors affecting post-operative nausea and emesis include the patient's demographic characteristics, the nature of the underlying disease for which the surgery is being performed, the type of operation, and the anaesthetic drugs and techniques (White, 1988).

In conclusion, White indicated that as a result of enhanced understanding of the mechanisms of acute pain and the physiological basis of nociception, the provision of "stress free" anaesthesia with minimal postoperative discomfort is now possible for most patients undergoing ambulatory surgical procedures. The aim of any analgesic technique should not only be to lower the pain scores but also to facilitate earlier mobilization and to reduce peri-operative complications, in particular PONV. In future, clinicians should be able to effectively treat postoperative pain using a combination of "balanced," "preemptive," and "peripheral" analgesia techniques without producing emetic sequelae.

2.3 Acupuncture and Postoperative Pain Management

Acupuncture has been practiced empirically in China for several millennia. The existence of acupuncture is believed to have been around for at least 4000 years, although its precise origin is not clear. The 'sharp stone needle', the earliest form of acupuncture needle made in stone, was discovered in the New Stone Age ruins in China. The systemic theory of acupuncture meridians was established about 2000 years ago in the Huang Di Nei Jing (Yellow Emperor's Inner Classic, a medical textbook, C. 300 BCE) (Anderson and Lundeberg, 1995).

Acupuncture is one of major practices of TCM, which is a distinctive heritage of Chinese culture. In TCM, the human body is considered as a dynamic organism composed of internal and external organs, connected by channels called meridians, through which 'qi' is circulates. When the human body is in balance, there is an unobstructed flow of 'qi', which is the vital energy, required for the maintenance and nourishment of the organs and associated tissues (Yang, 1997).

The Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines (Brian and Richard, 2004) states that:

> *"The Western interpretation of the Chinese concept of pathways in the body called channels, pathways, vessels, or conduits, through which a vital force (Qi) circulates, has been largely misunderstood as being esoteric, paranormal, and unscientific. However, further inspection has demonstrated that many of the pathways and points mapped by the early Chinese physicians actually correspond to blood and lymph vessels, central and peripheral nervous systems, myofascial distributions, neurovascular nodes, neuromuscular attachments, and motor points. "*

Scientific studies on acupuncture along with recent advances in neuroscience are providing a physiological basis for explaining the mechanisms involved. Some researchers now feel that acupuncture works primarily through interaction with the spinal afferent processing system, involving somatic nociceptive (pain), proprioceptive (muscle static load, length and position), and autonomic fibers, as well as other nerves of the body that provoke local, spinal, and centrally mediated control. The principal effect of this descending control is to restore autonomic balance (homeostasis), restore blood flow, resolve spasms, and to reduce pain (Kendall, 2002; Filshie, Jacqueline and Adrian White, 1998; Pomeranz, Bruce and Gabriel Stux, 1989).

Acupuncture needles most commonly in use are stainless steel, pre-sterilized, and pre-packaged for safety and convenient use. Acupuncture involves the insertion of fine sterilized needles through the skin at specific points (called acupuncture points) and is one of the key practices of TCM. In addition to selecting the proper needle insertion locations, the specific technique used to insert and stimulate the needle has an influence on the desired outcome of the treatment. There is commonly a sensation of numbness, tingling, electrical sensation, fullness, heaviness, distension, soreness, warmth, or itching that may be felt around an acupuncture needle - a sign that nerve fibers are being activated (Yang, 1997).

Various alternative methods have been tried to simulate acupuncture needles. When an electrical current was first added to the inserted needles, peri-cutaneous electrical nerve stimulation (PENS) or electro-acupuncture (EA) was created (Kendall, 2002). Low-level (cool) lasers have been tried to stimulate acupuncture points. Acupressure, which uses simple manual pressure or mechanical vibrating devices has been applied to simulate acupuncture, or substitute for it. Infrared heat lamps, ultrasound, electrical heating pads, diathermy, and other devices have been used as a substitute for moxibustion. Acupuncture, electro-acupuncture, and moxibustion have many variations (The Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines 2004).

In this ancient system, maintaining human health is considered achievable via a delicate balance between two opposing, but inseparable, principle elements, “yin” and “yang”. Yin represents “cold, slow, and passive elements,” whereas yang represents “hot, exciting, and active elements.” Accordingly, the internal organs in humans are also divided into the yin and yang system. Thus, this ancient theory of TCM suggests that health can be achieved by maintaining yin and yang in a balanced state in the human body and that an internal imbalance between these 2 elements is responsible for a state of disease (Chen, 2005).

Furthermore, TCM states that “qi” (ie, vital energy) is the life force or energy that influences health. In this regard, maintaining a balance between the opposing forces of yin and yang is considered to be the basis for the healthy flow of qi. Therefore, any disturbance in the yin and yang system would disrupt the flow of qi, thereby becoming the basis for a state of disease or pain. Acupuncture treats a state of disease or pain by adding qi or releasing the excessive flow

of qi in order to restore the normal balance between yin and yang. Because qi is thought to flow through specific pathways in the human body, an effective acupuncture treatment demands that acupuncture needles be placed into acupuncture points located along the meridians (Chen, 2005).

Acupuncture points are special nodes (or outlets) on the meridians, where 'qi' enters, exits, meets and accumulates. There are 14 major meridians corresponding to internal organs, along which there are a total of 365 acupuncture points. A healthy body requires preservation of the harmonious balance, while an imbalance of energy flow within these meridians results in diverse ailments. The basic theory of acupuncture is that the insertion and manipulation of a needle at a particular point or points along a meridian related to an impaired organ stimulates the energy flow, restores a proper energy balance and thus normalizes the functions of the organ (Yang, 1997).

Most commonly, acupuncture is accomplished by manual manipulation or electrical stimulation via thin, stainless steel needles inserted in the acupuncture points. 'Manual acupuncture' involves the manipulation of the inserted needles by the hand of the acupuncturist, such as lifting, thrusting, twisting, twirling or other complex combinations. It is believed that different manipulations may elicit different effects for different conditions (Yang, 1997).

Streitberger (2002) reviewed the history and potential of acupuncture in anaesthesia from the view of western medical journals:

> Despite the long history of acupuncture, the first surgery in acupuncture analgesia without additional anaesthetics was reported to be performed in 1958 in China. This impressive introduction of acupuncture into anaesthesia was part of the political concept of Mao Tse Tung to combine TCM techniques and modern western medical concepts. The enthusiastic reports from China inspired acupuncturists and anaesthetists in the seventies, mainly from Austria and Germany to introduce acupuncture analgesia for surgery and to develop combined anaesthetic techniques. But these techniques remained in an experimental stage and in competition to the

modern anaesthetics and were never used widely in routine situations (Streitberger, 2002).

In Europe and America, acupuncture became popular mostly for the treatment of chronic pain conditions. Nevertheless, according to a National Institutes of Health (NIH) consensus conference on acupuncture in 1997, the best evidence of the efficacy of acupuncture is shown in two areas, postoperative and chemotherapy nausea and vomiting and postoperative dental pain (NIH, 1998).

The first report of acupuncture analgesia for surgery in a western medical journal can be found in 1971 in JAMA (Dimmond, 1971). One year later in 1972 the first surgery in acupuncture analgesia in Europe was reported from Vienna, Austria, when a tonsillectomy was successful performed without any other anaesthetics (Benzer, Bischko, Kropej, Pauser, Baum and Thoma, 1972). These procedures needed intensive preoperative preparation of the patient, usually additional premedication and sometimes if necessary application of local anaesthetic or intravenous analgesics during surgery. Later, especially in Europe, acupuncture analgesia was combined with general anaesthesia to improve patients comfort. Induction usually was performed with barbiturate and muscle relaxants and controlled ventilation was maintained with oxygen and nitroxide. With this combination, rapid recovery, cardiovascular stability and reduction in the need for opioid drugs was reported in heart surgery (Herget, L'Allemand, Kalweit, Walter, Hehrlein and Schlepper, 1976), as well as in thyroid surgery, abdominal surgery and eye surgery. All together more than 700 cases of acupuncture analgesia were reported 1976 in the German Journal "Anaesthetist" Volume 25 (Streitberger, 2002). In most of the reports, disadvantages of acupuncture analgesia were discussed. These included the technique being time consuming, lack of complete analgesia, the possibility of being a non-responder, discomfort and awareness (Streitberger, 2002).

Later some controlled studies were also performed. In the Lancet 1978, acupuncture analgesia was reported to be more effective than sham acupuncture for gastroscopy (Cahn 1978). In a study using acupuncture analgesia for abdominal surgery (Kho, Eijk,

Kapteijns and Egmond 1991), 90% less fentanyl was necessary than without acupuncture. In Oocyte aspiration for IVF (Stener-Victorin, Waldenstrom, Nilsson, Wikland and Janson 1999), acupuncture compared to alfentanil showed no difference in pain or nausea but more stress and discomfort with acupuncture.

Only a few studies were performed to investigate the effect of acupuncture on volatile anaesthetic consumption. In a recent investigation, TENS of an auricular acupuncture point was able to decrease volatile anaesthetic requirement of desflurane in volunteers (Greif, Laciny, Mokhtarani, Doufas, Bakhshandeh and Dorfer, 2002).

Depending on the author, or the location of the surgery, a variety of acupuncture points were described for acupuncture analgesia. Distal points like LI4, PC6 and ST36 are used as well as segmental points, para-incisional points or ear points. The needles were stimulated manually or electrically (1200Hz, 1-40mA). Usually stimulation of the acupuncture points started about 20 minutes before surgery and was continued during the operation.

In most of the reports, disadvantages of acupuncture analgesia like time intensity, lack of complete analgesia, possible non-responders, discomfort and awareness were discussed. Andersson and Lundeberg (1995) indicated that acupuncture is a pain-relieving method that activates endogenous pain-inhibiting systems such as the spinal/segmental gate mechanism and the endogenous opioid systems. It should be stressed that any acupuncture effect rests on physiological and/or psychological mechanisms (Stener-Victorin *et al*., 2002). Despite both experimental and clinical evidence of the effects claimed for electro-acupuncture (EA), its role in conventional medicine has been questioned (Renckens, 2002). The effect of EA as a pain-relieving method during surgical procedures has been evaluated in different situations. EA was reported to be as effective as conventional analgesics without any observed negative side-effects (Stener-Victorin *et al*., 1999). Another interesting observation in a study, which evaluated the effect of EA as an analgesic during oocyte aspiration, was the significantly higher pregnancy rate in the group of women who underwent EA compared with a group that used conventional analgesics (45.9% versus 28.3%). Even though these observations were interesting, the number of studied patients was small, and hence the power of the findings too

low for the results to be considered reliable. A study with a larger number of patients was thus needed to clarify this point. In a recent study (Paulus *et al*., 2002), acupuncture during embryo transfer in IVF cycles resulted in significantly higher pregnancy rates compared with the group that did not undergo acupuncture (42.4 versus 26.3%). The results in that study cannot be directly compared with those of a previous investigation (Stener-Victorin *et al*., 1999) as the study design and acupuncture protocol were different.

The disadvantage of the EA procedure used in the study (Soussis *et al*., 1995) was that the time taken to induce analgesia was more time-consuming than when conventional analgesics only were used. It would be of interest to investigate whether analgesia could be induced by EA in a <30 min procedure performed prior to oocyte aspiration.

Many couples undergoing IVF suffer great stress and anxiety and may need to undergo repeated attempts before treatment is successful. It is therefore important that patients are not left with unpleasant memories of the oocyte aspiration procedure. An interesting observation in the present study was that the EA group had less postoperative abdominal pain, nausea and stress compared with the alfentanil group. Stress may affect the implantation rate (Csemiczky *et al*., 2000) and for that reason this finding may be of great value. For those women who are willing to try EA, it may be a better analgesic method as the pain relief achieved pre-operatively is as effective as that induced by conventional analgesics. The women experience less abdominal pain, less nausea and less stress at 2 hour after oocyte aspiration, and also use less opiate analgesics than when conventional analgesics alone are used.

Acupuncture is being increasingly accepted by practitioners and patients worldwide. Chen (2005) stated that, in 1993, the United States Food and Drug Administration (FDA) estimated that Americans make 9 to 12 million visits per year to acupuncture practitioners and spend >500 million dollars annually on acupuncture treatments (Lytle, 1993). In 1997, there were 385 million recorded patient visits to primary care physicians, but 630 million recorded visits to alternative medicine practitioners. In a nationwide survey published in 1998, Eisenberg et al (1998) reported that office visits for alternative therapy were twice those for primary care and that money spent on alternative medicine was nearly equal to the out-of-pocket expenditures for conventional medical care. As summarized in a document published by the

World Health Organization (WHO) in 2002, many medical conditions may be effectively treated by acupuncture.

In keeping with an ever-growing demand for alternative medicine, the FDA classified acupuncture needles as medical equipment in 1996, subject to the same strict standards as medical needles, syringes, and surgical scalpels. Given the dramatic increase in the use of acupuncture as an alternative treatment modality, the National Institutes of Health (NIH) organized a Consensus Development Conference on Acupuncture in 1997. It as certained that acupuncture is extensively practiced by medical physicians, dentists, non-MD acupuncturists, and other practitioners, because, at least in part, the incidence of adverse effects is substantially lower with acupuncture than with many drugs and other commonly accepted medical procedures for the same conditions (Chen, 2005).

2.4 Traditional Clinical Application of Acupuncture

The procedures commonly used in clinical practice include pre-acupuncture evaluation, selection of acupuncture points and the use of acupuncture techniques.

Pre-acupuncture evaluation - Evaluating patients for acupuncture includes the following details (Yang, 1997):

- observing the patient's appearance by examining the tongue (shape, color, texture)
- asking about the predominant complaints, symptoms, and general medical condition
- feeling radial pulses.
- conventional medical examinations such as inspection, palpation, auscultation, percussion, range of motion of the extremities, reflexes, and neurological examinations are also used.

Selection of acupuncture points: Acupuncture points are usually chosen based on the practitioner's assessment of the particular imbalance between yin and yang that needs to be restored. The formulation of an acupuncture treatment is often highly individualized and largely based on the practitioner's philosophical constructs and subjective and intuitive impression about the patient's condition. Therefore, a practitioner may select different

acupuncture points at each treatment session that are based on the patient's particular complaints, symptoms, and presentations at the time of treatment. This explains why a repeat evaluation of the patient's condition is needed at each session to formulate an acupuncture treatment plan (Yang, 1997).

Acupuncture techniques: After the needle is inserted into an acupuncture point, the sensation of "de-qi" – a feeling of aching, swelling, tingling, numbness and/or heaviness at the insertion site – is thought to be necessary to obtain a therapeutic effect. An acupuncture needle may remain in place for 15-30 minutes through manual or electrical stimulation. In some cases, radiant heat from a lamp or moxa (burning herbs) can be applied to the top of an acupuncture needle to obtain additional effect (Yang, 1997). Interestingly, there are many different acupuncture techniques, including traditional Chinese acupuncture, Korean hand acupuncture, and Japanese acupuncture, scalp and ear acupuncture, and each remains in practice in different parts of the world (Chen, 2005).

2.5 Mechanisms of Acupuncture

For centuries and millennia, acupuncture was used empirically for treating various diseases and not necessarily considered as a real science. However, studies performed during the past few decades have provided scientific evidence for its uses and greatly facilitated its widespread applications. It is now known that the effects of acupuncture may be mediated via neural pathway, humoral pathway, opioid pathway and/or serotonic pathway.

Although acupuncture has been used for many thousands of years, its mechanisms remain largely elusive. A large number of studies in humans and animals have demonstrated that acupuncture produces diverse biological effects on the peripheral and central nerve system (CNS) and the production and release of humoral factors, neurotransmitters, and other chemical mediators (Chen, 2005). Based on Chen's review, the section below summarized some common views in relation to the mechanisms of acupuncture.

Peripheral nervous system: Consistent with the meridian system mentioned earlier, an intact peripheral nerve system is necessary for the analgesic effects of acupuncture to be effective. These analgesic effects can be abolished (or diminished) if the

acupuncture site is affected by herpetic neuralgia or intervened with local anesthetics (Bowsher, 1998; Chiang and Chang, 1973).

Humoral factors: In the mid-1970s, Mayer and colleagues revealed that acupuncture resulted in a significant increase in endogenous endorphin production and that its effect was blocked by the opioid receptor antagonist, naloxone (Mayer, Price and Rafii, 1977). It is believed that humoral factors may mediate acupuncture analgesia by releasing substances into the cerebrospinal fluid after acupuncture. This notion was supported by a cross-perfusion experiment, in which acupuncture-induced analgesic effects were replicated in a recipient rabbit that received cerebrospinal fluid from a donor rabbit that had undergone acupuncture (Han and Terenius, 1982).

Other methods of acupuncture include stimulating acupuncture points by heat (moxibustion, burning of the herb moxa), pressure (acupressure), laser irradiation or magnetic or electromagnetic waves. Electric acupuncture (EA) has been shown to alter polycystic ovaries induced by steroids through regulation of ovarian nerve growth factors (Stener-Victorin, Lundeberg and Cajander, et al., 2003). 'Transcutaneous electrical acustimulation (TEAS)' or 'transcutaneous electrical nerve stimulation (TENS)' refers to electrical stimulation performed via skin surface electrodes placed on the acupuncture points or nerve dermatomes. TEAS and TENS are very similar because acupuncture points are very likely distributed along the nerve dermatomes.

Central nervous system: Early studies reveal that EA at different frequencies can have different effects on the synthesis and release of neuropeptides in the CNS (Guo, Wang and Tian, et al, 1997). EA at 100 Hz markedly increased preprodynorphin mRNA levels, while EA at 2 Hz had no such effect (Guo, Wang and Tian, et al, 1997). Moreover, an μ-opioid receptor antagonist or antiserum against endorphin blocked acupuncture analgesia induced by EA at 2 Hz, but not at 100 Hz (Huang, Wang and Chang, et al., 2000). In addition, EA induced an increase in cholecystokinin-like immunoreactivity within the medial thalamic area after EA (Xu, Aiuchi and Nakaya, et al., 1990) and enhanced and restored the activity of natural killer cells suppressed by the hypothalamic lesion (Hahm, Lee and Lee, et al., 2000).

The application of neuroimaging techniques (eg, functional magnetic resonance imaging [fMRI] and positron emission tomographic [PET] scans) makes it possible to further understand the effects of acupuncture on human brain activity. Pain activates neuronal activity in the periaqueductal gray, thalamus, hypothalamus, somatosensory cortex, and prefrontal cortex regions of the human brain (Hsieh, Stahle-backdahl and Hagemark, et al., 1995), which is attenuated by the sensation of de qi after acupuncture (Hui, Liu and Marina, 2005). Compared to manual acupuncture, EA – particularly at low frequencies – produces more widespread fMRI signal changes in the anterior insula area, as well as the limbic and paralimbic structures (Napadow, Markris and Lin, 2005). These findings are further supported by data indicating that stimulation of different acupuncture points evokes both signal increases or decreases in different areas within the CNS (Yan, Li and Xu, et al., 2005). This suggests that there may be correlations between the effects of acupuncture and neuronal changes within the brain. Neurotransmitters: A large body of evidence indicates that acupuncture significantly affects the production and release of neurotransmitters, including epinephrine, norepinephrine, dopamine, and 5-hydroxytryptamine (Hou, Liu and He, et al., 2002). Stress-induced increases in norepinephrine, dopamine, and corticosterones, specifically, were inhibited by EA, a process blocked by the opioid receptor antagonist, naloxone, suggesting that EA effects on the release of neurotransmitters are likely to be mediated through endogenous opioids (Han, Yoon and Cho, et al., 1999). Similar results were observed in a number of animal studies examining acupuncture analgesia (Zhou, Wang, Fang, et al., 1995; Wang, Jiang, and Can, 1994; Wang, Wang and Zhang, 1991; Zhu, He and Cao, 1994; Zhu, Xia and Cao, 1990).

The functional significance of acupuncture-induced changes in neurotransmitters has been clearly indicated in a number of studies. For instance, EA at different frequencies (2, 10, or 100 Hz) elicited reliable analgesic effects and such effects could be at least partially blocked by a serotonin receptor antagonist (SRA) (Chang, Tsai and Yu, et., al., 2004). The effects of acupuncture on neurotransmitter release may depend on EA frequency because many brainstem regions can be selectively activated by EA at both 4 Hz and 100 Hz, whereas other regions can only be activated by EA at 4 Hz. Interestingly, the analgesic effect of EA at 4 Hz

is mediated through endogenous opioids (Lee and Beitz, 1993), while the analgesic effect of EA at 2 Hz may involve substance P as its mediator (Shen, Bian and Tian, et al., 1996).

Besides its effect on acupuncture analgesia, EA-induced modulation of neurotransmitter release may also mediate other therapeutic effects of acupuncture. There is evidence that EA at 100 Hz protects axotomized dopaminergic neurons from degeneration by suppressing axotomy-induced inflammatory responses (Liu, Zhou and Pan, et al., 2004), raising the possibility that acupuncture may be used to treat certain neurological disorders such as Parkinson's disease (Park, Lim and Joo, et al., 2003). Another study revealed that the excitatory effects on gastrointestinal mobility following EA or moxibustion in rats was abolished by serotonin inhibitors (Sugai, Freire and Tabosa, et al., 2004), indicating that serotonin may be a critical mediator of many acupuncture effects such as gastric emptying and analgesia. Similarly, the reduced production of nitric oxide within the gracile nucleus after acupuncture has been shown to reverse bradycardia (Chen and Ma, 2003).

Based on Reina Taguchi's review, numerous studies have shown that acupuncture, ear acupuncture, silver spike point (SSP) and TENS increase the somatic pain threshold (Hyodo, Nakamura and Yukimati, et al., 1973; Kitade and Hyodo, 1997; Ishimaru, Shinohara and Kitade, et al., 1990; Katayama, Suzuki and Katayama, et al., 1977; Ishimaru, Shinohara and Iwa, et al., 1991; Ishimaru, Kawakita and Sakita, 1995; Kitade, Minamikawa and Hyodo, 1980; Ishimaru, Sekido and Sakita, 2003). Kitade and Hyodo (1997) examined the influence of ear acupuncture point stimulation on the somatic pain threshold. Among the ear points, the lungs, sympathicus, Shen-Men and kidneys exhibited a remarkable increase in the pain threshold in comparison to a non-acupuncture ear point. Although the results varied considerably according to the individual and region of the body, to some extent they clarified that ear acupuncture points had counterparts in certain body regions and the authors were able to conclude that ear acupuncture was useful in achieving analgesia or anesthesia. Ishimaru and co-workers also examined how LFEA and SSP influenced the pain threshold in the abdominal area (Ishimaru, Shinohara and Kitade, 1990). Both LFEA and SSP induced analgesic effects in the abdominal area and acupuncture analgesia produced by LFEA was faster and higher than that of the SSP stimulation. These results suggested that LFEA and SSP would be beneficial for the control of pain after abdominal surgery. Katayama *et al*. further investigated

the effect of acupuncture analgesia on gingival tissue by using the 'Hoko' points. When 'Deqi' was not obtained by needling, the alleviation of pain was not improved. However, when 'Deqi' spread out from elbow to shoulder, there was noticeable improvement in the alleviation of pain. Moreover, they revealed that a better analgesic effect was obtained by a 30 min treatment rather than one only lasting 15 min (Katayama, Suzuki and Katayama, 1977).

As for deep pain threshold, a few reports investigated the influence of LFEA and TENS on the deep pain threshold of the skin surface as well as in the area 3 mm below the skin, the fascia, the muscle and the periosteum (Ishimaru, Shinohara and Iwa, et al., 1991; Ishimaru, Kawakita and Sakita, 1995). The greatest increase in deep pain threshold occurred when cutaneous stimulation using a non-insulated needle was combined with deep stimulation using an insulated needle. It was also clarified that the pain threshold of these tissues varied according to the electrodes used; the area stimulated by electrical acupuncture (insulated or non-insulated needle) and TENS (SSP, rubber and jeltrode). Thus, LFEA, SSP and TENS could increase the somatic and deep pain threshold. Since the increase in pain threshold varies according to electrode and stimulated area, it is important to use the electrode most suitable to the purpose.

Other authors investigated the mechanisms underlying the increased pain threshold produced by LFEA, SSP and TENS. Kitade and associates found that although the pain threshold increased by LFEA for 50 min, LFEA did not increase the plasma ß-endorphin and adrenocorticotropic hormone (ACTH) in the cerebral spinal fluid (CSF) (Kitade, Minamikawa and Hyodo, et al., 1980). These results suggested that ß-endorphin in plasma and CSF was not involved during acupuncture analgesia. It was considered, however, that there were some kinds of endogenous opioid peptides involved in acupuncture analgesia, because acupuncture analgesia was antagonized by naloxone, an opioid receptor antagonist. Similarly, Ishimaru and co-workers showed that LFEA for 30 min produced acupuncture analgesia (Ishimaru, Sekido and Sakita, 2003). They found, however, that although plasma ß-endorphin increased after the LFEA (Ishimaru, Sekido and Sakita, 2003; Ishimaru, 2000), plasma ACTH did not change (Ishimaru, 2000). This result was in line with findings of patients with post-operative pain (POP) (Ishimaru, 2000). These results suggested that although plasma ß-endorphin

induced by LFEA was involved in acupuncture analgesia, other analgesic mechanisms that differ from stress-induced analgesia might also be involved.

In summary, the Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines 2004 states that:

> *The mechanisms by which needling therapy works are now well understood, at least to the point where this information is applied. The physiologic effects of needling therapy directs restorative processes to any particular part or articulation in the body to address all neuromusculoskeletal and pain conditions. This approach permits application of consistent treatment protocols to obtain consistent clinical outcomes. This approach will enhance the quality of future outcome studies.*
>
> *Acupuncture works by initially causing minute tissue irritation, which triggers a complex localized neurogenic inflammatory reaction through an interplay of the blood coagulation and immune response mechanisms. The reaction is further sustained by axon reflexes involving the local afferent nociceptive nerve fibers. The nociceptive and resulting proprioceptive signals (group II static load fiber) activates spinal afferent processes which direct restorative descending control signals to the area. The amount of tissue trauma induced by strength of stimulation and the retention time of needle insertion have an influence on the characteristics of the net reaction needled.*
>
> *Mechanisms of needling bring about restorative effects which involves superficial tissue reactions, sensory systems, vascular system and related nerves, viscerosomatic relationships, and central nervous system. The CNS provides descending control to regions of the spinal cord that mediate inhibition of pain, relaxation of muscular tissue, normalization of vascular tone, and restoration of visceral homeostasis. Descending control processes are directed to those regions of the body activated by specific nodes.*

The original Chinese theories are based on anatomical physiological studies and are almost totally consistent with what is presently known by today's science. A physiological understanding of needling therapy allows a rational treatment strategy for any particular area of the body or articulation for the treatment pain and neuromusculoskeletal disorders. Segmental relationships are usually considered in selection of local and adjacent needling sites (neurovascular nodes) and also proximal locations. The non-segmental relationships are important in considering selection of distal nodes. In addition, in the treatment of neuromusculoskeletal problems the Chinese view of longitudinal distributions is always important to consider in selecting nodes, especially those used for the proximal and distal locations (Kendall 2002).

2.6 Clinical Data on Acupuncture for Post-operative Pain Conditions

Although acupuncture has gained much public and medical professional recognition over the last several decades, its application and overall efficacy remains a subject of debate. Clinical trials on the efficacy of acupuncture have unique issues such as individualization, placebo controls, and the crossover design.

Nevertheless, an increasing number of clinical trials have provided positive information, particularly on its role in clinical pain management. It is encouraging that more randomized, controlled clinical studies have replaced anecdotal case reports.

Several studies have demonstrated that patients receiving acupuncture prior to surgery have a lower level of pain, reduced opioid requirement, a lower incidence of post-op nausea and vomiting, and lower sympatho-adrenal responses. (Kotani, Hoshimoto and, Sato, et al., 2001; Lin, Lo and Wen, et al., 2002; Sim, Xu and Pua, et al., 2002; Wan and Kain, 2002). Acupuncture also has been used for pain management during labor. Partipants (90 patients in one study) who received acupuncture during labor had a significantly reduced need for epidural analgesia and better relaxation and there were no negative effects on delivery as compared to the control group (Ramnero, Hanson and Kihlgren, 2002; Skiland, Fossen and Heiberg, 2002).

Since 1980, the direction of acupuncture investigations has turned from anesthesia to analgesia. Acupuncture analgesia is presently considered a way to activate the body's endogenous analgesic system. Recently, with the rise of acupuncture as one of the most well known complementary and alternative medicine (CAM) therapies, acupuncture or moxibustion treatment has been reported for both acute and chronic pain. Even so, few clinical reports and original articles have been reported in Japan (Taguchi, 2007).

In 1971, a Japanese newspaper article on acupuncture anesthesia in China reported that low frequency electrical acupuncture (LFEA) was being used for anesthesia in abdominal operations such as appendicitis and that the consciousness of the patients remained clear during the operations. This report accelerated fundamental study on acupuncture anesthesia

and analgesia and acupuncture treatment was used for analgesia in the treatment of pain in Japan. The first examination of acupuncture anesthesia was done in China in about 1960. In Japan, Masayoshi Hyodo pioneered 30 cases of acupuncture anesthesia in 1972 at Osaka Medical College and became one of the more experienced persons using acupuncture anesthesia (Hyodo, Nakamura and Yukimati, 1973). Acupuncture anesthesia has some benefits: (i) it is simple and easy without complicated tools, (ii) there are no side effects, (iii) non-painful areas are induced without the involvement of innervations of the areas stimulated by acupuncture, (iv) the anesthetic effects lasts after acupuncture anesthesia and (v) the wound heals more quickly.

The most randomised controlled trials (RCT) in acupuncture exist for stimulation of PC6 for the prevention of PONV. In a review of 33 antiemesis trials, 21 were on PONV (Vickers, 1996). A Meta-analysis in 1999 found 19 RCT with different stimulation at PC6, such as acupressure, manual acupuncture, electro-acupuncture and TENS with an overall good result concerning early nausea and vomiting, except for children (Lee, 1999). But recent studies also showed significant effects for children in the prevention of PONV with Korean hand acupressure (Schlager, 2000) and intra-operative acupuncture and post-operative electrical stimulation at PC6 (Rusy, 2002).

In Japan, the analgesic benefits of acupuncture and moxibustion treatment for various kinds of pain are also accepted. However, this use has led to very few clinical reports and original articles. Taguchi (2007) indicated that there are some drawbacks, however: (i) anesthesia produced by acupuncture has individual variations and (ii) too much time is needed to induce anesthesia. For these reasons, investigations of acupuncture analgesia in preference to acupuncture anesthesia accelerated in the latter half of the 1980s. Numerous animal and clinical experiments carried out in various parts of the world led to wide recognition of acupuncture as a viable modality for the relief of pain (Han and Xie, 1984; Chen, Geller and Adler, 1996; Ma, 2004; Tsukayama and Yamashita, 2002). Acupuncture analgesia is presently considered a way to activate the body's endogenous analgesic system (Han, 2003). Recently, it was reported that acupuncture analgesia in inflammation conditions differs from that in normal conditions and that the immune system is involved in acupuncture analgesia on inflammation condition (Sekido, Ishimaru and Sakita, 2003, 2004).

Acupuncture has been used for the treatment of many conditions in addition to pain. For example, a number of clinical trials strongly support its therapeutic role (either needle acupuncture or applying acupressure to relevant acupuncture points) in postoperative nausea and vomiting, as compared to antiemetics (eg, droperidol and zofran) (Alkaissi, Evertsson and Johnson, 2002). An increasing number of patients are turning to acupuncture, either to supplement, or replace conventional treatment for depression, anxiety, obesity, spinal cord injury, insomnia, premenstrual syndrome, menopause symptoms, infertility, allergy, smoking cessation, and detoxification from opioids or other drug addictions, as summarized in a document published by the WHO in 2002 (www.who.int).

2.7 Electro-acupuncture

Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines 2004 gives the following concept and background in relation to electro-acupuncture:

Electroacupuncture (EA) is the application of a small electrical current to conductive needles that have been inserted into various locations of the body, and can be described in more technical terms, such as peri-cutaneous electroneural stimulation (PENS) and "percutaneous neuromodulation therapy" (PNT). “Percutaneous” refers to the fact that the needles are inserted ‘through the skin”. “Electroneural” refers to nerves being stimulated by the electrical current, though sometimes muscles are also directly stimulated. “Neuromodulation” refers to the ability to adjust the electrical current to very specific patterns and strengths.

While the original purpose of the electrical current was to replace traditional manual stimulation, it has the added benefit of making such stimulation repeatable and standardized, since an identical current setting can be reproduced when treating different patients in different locations. Electroacupuncture settings are typically finely adjusted using precalibrated devices.

Having thousands of years experience in treating every known disease affecting the human population by their understanding of the distribution of neurovascular nodes throughout the

body, the Chinese simply added electrical stimulation to a few key nodes used in particular treatment protocols to enhance the effect of acupuncture. Therapeutic use of EA started being popularized around 1958 when China started using small electrical devices attached to needles inserted through the skin to treat a wide range of medical conditions, and even using it to induce surgical analgesia.

The ancient Egyptians and Greeks may have been the first to use electrical stimulation for therapeutic reasons by use of electric fish. A depiction of malopterurus electricus (Nile catfish) is prominently displayed in an Egyptian tomb relief dated to the Fifth Dynasty, ca.2750 BCE. Both gnathonerus petersi and torpedo rays were depicted on ancient green pottery (Greek pinax) which were honored and feared for their unusual ability to numb the senses. In Hippocrates times electric fish could be stepped on or placed on a particular body location, such as the low back or forehead, to treat particular pain conditions.

The term "electric" was coined by the English physician William Gilbert in 1600 to describe some static electrical effects, distinguishing them for the first time from magnetism. This term was derived from the Greek word eleckrom for amber since it had been known from Roman times that rubbing amber with a dry cloth could produce a static electric discharge.

Interests in applying electrical devices to treat human ailments in Europe and the United States were evolved simultaneously with the exploration and understanding of electrical phenomena from 1600 to the late 1800s. Machines of various types were developed. Sarlandiere le Chevalier (1825) was perhaps the first to hook up an electrical device to inserted needles. This is the first known application of EA. In 1958 the Chinese reintroduced EA and used it to treat many common ailments, dental pain, nerve dysfunction, paralysis, substance withdrawal, musculoskeletal conditions, and to induce surgical analgesia. Many practitioners of TCM in the United States and Europe presently use EA in their normal clinical routines.

The NIH consensus panel on acupuncture states that the documented occurrence of adverse events in the practice of acupuncture is extremely low. The most commonly reported complication is bruising or bleeding at the needle insertion site. Other complications include

infection, dermatitis, and broken needle fragments. It is estimated that the average occurrence of adverse consequences with acupuncture treatment is about 50 cases per year in a 20-year period. However, since acupuncture is an invasive medical intervention, serious complications such as pneumothorax, hemothorax, organ puncture, and pericardial effusion, may occur if the treatment is not properly administered. These more serious complications often occur in older and debilitated patients with complex co-morbidities or in the hands of less skilled practitioners. Thus, it is important to follow the standards for acupuncture training that includes the strict requirement of knowledge of anatomy and sterile techniques.

For thousands of years, acupuncture has been used in China for a wide range of disorders including pain. Over several decades in China and other countries, a large number of scientific investigations have attempted to explore the analgesic mechanisms of acupuncture. While these mechanisms are still not completely elucidated, three explanations have been put forward - meridian, humoral and neural (Lin, 1996).

In 1992, Lin states that "any pain" is related to qi and xue (blood) stagnation. Therefore, improvement of the blood circulation and qi movement is an important concept in pain management. According to the meridian concept, acupuncture can rebalance yin and yang and harmonise the qi and blood circulation for pain relief (Lin, 1992; Dai, 1987).

According to the Gate Control Theory (McQuay, Bullingham, Moore, Evans and Lloyd, 1982) “one of the more important advances” (De Domenico 1982 p14) in pain theory, the neuronal C fibers transmit the pain sensation signal while A-beta neuron fibers transmit tactile sensations. When acupuncture is applied, both neurons are stimulated. A-beta fibers are thicker than the C fibers and transmit signals much faster than C fibers. Therefore A-beta fibers carrying the tactile sensations arrive at the spinal dorsal grey horn faster and close the 'gate' before the C fiber signal arrives, thus blocking the pain signal from entering the central nervous system (Coleman, 1987). When EA is applied, it stimulates both the A-beta and C fibers resulting in relief of pain (Lin, 1992).

Another pain relieving pathway has also been described, the ‘descending pain suppression’ theory, which involves direct stimulation from the A delta, and C fibres. The impulses being

responsible for descending pain inhibition by traveling through the spinal cord to the thalamus. Midbrain reactions occur resulting in axons descending back to the original site of stimulus. It is thought that an inhibitory interneuron acts on second order nociceptive neurons to suppress pain. Gate theory, together with 'descending pain suppression' theory led to the development of treatment methods like electro-acupuncture (De Domenico, 1982).

It has been suggested that acupuncture analgesia is a result of the stimulation of the body's natural inhibitors that can block pain pathways. Sensory pain fibres in the posterior root ganglia release "substance P", a neurotransmitter required by neurons to produce pain sensations. Enkephalin is also released by neurons close to the pain pathway and can block the release of substance P, thus inhibiting the transmission of pain sensation to the brain. Acupuncture enhances the release of enkephalin and other like substances from various locations. These are transported to pain fibres via the cardiovascular system thus decreasing the sensation of pain. The analgesic effect of acupuncture is delayed until enkephalin levels rise, and remains after the actual treatment ceases for up to eight hours (Tortora and Anagnostakos, 1989).

In 1981, Sodipo, Gilly & Pauser supported the hypothesis that endorphin activity accounts for analgesia provided by acupuncture and TENS. This research suggests that acupuncture stimulate deep sensory nerves causing the release of endorphins into the blood. The endorphins then occupy opiate receptors, which block pain signals from getting through nerve chains in the pathway. The analgesic mechanisms of acupuncture are therefore closely related to neuropeptides and monominergic neurons including serotonergic and noradrenergic neurons in the central nervous system (Sodipo, Gilly and Pauser, 1981; Lin, 1996).

The brain secretes endorphin and enkephalin that attaches to the periaquaductal grey area (PAG) above the opiate receptors. This activates the descending inhibitory pathway thus relieving pain. Also acupuncture needle stimulation activates the release of endorphin. Both of these substances appear to play an important role in pain analgesia (Lin, 1992).

Electroacupuncture (EA) is achieved by attaching the acupuncture needles to an electrical pulse generator and stimulating the acupuncture points with electrical pulses. After surgery,

sterile gelled electrodes connected to a battery operated stimulus generator that applied to the skin on both sides of the incision and dressed. The complications associated with TENS include skin irritation caused by the gel or adhesives used to apply the electrodes. Contra-indication for the use of TENS is the presence of a cardiac pacemaker (Brian and Richard, 2004).

During 1983-1985, P Poulin, E Pritchard-Leandri, A Laplanche et al studied EA analgesia in major abdominal and pelvic surgeries. This study was a randomised, control trial, involving 250 cancer patients undergoing abdominal or pelvic surgery, aiming to assess the use of EA compared with a standard anesthesia. There was no difference between the two groups in the anaesthetic dose requirements (related to body weight and duration of surgery), all of the patients in the control group required fentanyl whereas only 5% patients in the acupuncture group needed it. The postoperatively immediate excubation time was also reduced in the acupuncture group ($p<0.001$) (Poulain, Prichard-Leandri and Laplanche, et al. 1997). TENS was used for postoperative pain relief in the acupuncture group, while the control group received non-narcotic analgesics. There was no significant difference in the numbers of patients complaining of pain, but the requirement for the additional analgesia was lower when TENS was used ($p<0.01$). There was no difference in the period of postoperative ileus as measured by the return of normal bowel sounds. However, the return to normal self-caring was significantly improved in the acupuncture group ($p<0.02$). Both practically and economically this is probably the most important beneficial aspect of EA demonstrated by this study (Poulain, Prichard-Leandri and Laplanche, et al. 1997).

In 1985, Martelete and Fiori discovered that with the administration of electro-acupuncture, opiate analgesic doses could be halved and that the analgesic effects of opiates lasted longer. However, there was no placebo control group used in this research (Martelete and Angelo, 1985).

In 1989, Christensen, Noreng, Anderson and Nielsen used electro-acupuncture for postoperative pain relief in twenty total hysterectomized patients. The electro-acupuncture was applied postoperatively while the patients were still under the anaesthetic effect. It was found that PCA pethedine doses were significantly reduced, especially in the first two hours

of the postoperative period. In 1993, Christensen, Rotne, Vedelsdal, Jensen, Jacobsen and Husted used preoperative electro-acupuncture immediately following anesthesia, continuing through the entire procedure, and postoperatively. There was no reduction in the requirement of pethedine; the VAS scores also demonstrated no difference (Christensen, Noreng, Anderson and Nielsen, 1989; Christensen, Rotne, Vedelsdal, Jensen, Jacobsen and Husted, 1993).

In 1994, Ibrahim Tekeoglu conducted a study on 'music sound electro-acupuncture stimulation'. In this randomised, controlled trial, patients with migraine or cervical tension headache were divided into two groups (N =25 each group). One group received standard EA at 100 Hz while the other received 'music-sound' EA stimulation. Pain levels were scored by the patients on a five point scale. Analgesia obtained by the standard EA group was statistically significant ($p<0.01$). That obtained by the 'music sound' EA group was highly significant ($p<0.001$). This preliminary study has shown that the Music EA (MEA) device provided a safe, reliable and effective method for the management of pain and anxiety in migraine and cervical tension headache patients. Additional investigations are warranted, but on the basis of this trial, it would seem that MEA is more effective for the relief of pain than standard EA (Tekeoglu and Ibrahim, 1995).

In 1998, Lo studied 100 complete hysterectomized patients in four groups. The groups received different electro-acupuncture treatments consisting of a control treatment, sham-EA treatment (placebo effect), low frequency EA and high frequency EA treatment.

Lo's (1998) investigation indicated that pre-operative acupuncture treatment does improve pain control for hysterectomized patients. Specifically, his results were that the time for the first requirement of narcotic after operation was prolonged, PCA demands were decreased, and the opioid-related side effects were reduced in the first 24 hours post-operatively after preoperative EA treatment. However, these results were varied suggesting that further investigations in this area are required.

In 2000, Hsieh, Kwo and Chen et al, studied "the analgesic effect of electric stimulation of peripheral nerves with different electric frequencies using the formalin test". This study

sought to determine the effect of different EA frequencies in a Sprague-Dawley (SD) rat model of pain. Electric stimulation (ES) at frequencies of 2 Hz, 15 Hz, or 100 Hz was applied to the ipsilateral or contralateral sciatic nerve of the injected hind-paw of SD rats. Formalin (50μl, 5%) was subcutaneously injected into the plantar surface of the left hind-paw to induce a nociceptive response. Behaviour, including licking and biting, was observed to have two distinct periods, an early phase during the first five minutes and a late phase from 21- 35 minutes after injection. The total biting and licking count served as an indicator of nociceptive response. The results indicated that ES of the ipsilateral sciatic nerve at a frequency of 2Hz or 15 Hz reduced the nociceptive response in both the early and the late phase of the formalin test. Whereas EA at 2 Hz had greater antinociceptive effect than ES at 15 Hz in the early phase. No similar analgesic effect in the early phase was observed for ES at 100 Hz. Both pre-treatment with ES at 2 Hz and naloxone (3mg/kg, S.C.) produced a greater antinociceptive response in the late phase, than when ES at 2 Hz was delivered immediately after formalin administration. In addition, ES of the neck muscle or contralateral sciatic nerve at a frequency of 2 Hz also decreased licking and biting activity in both phases. The results of this study indicate that different analgesic mechanisms are involved in the response to ES at frequencies of 2 Hz, 15 Hz and 100 Hz, and that ES at 2 Hz has a greater analgesic effect on formalin induced nociceptive response, especially when it is delivered prior to the onset of pain. The analgesic effect of ES may be mediated via a central origin in the supraspinal level. These findings suggest that 2 Hz may be a good frequency selection for clinical EA applications in analgesia, and that pre-treatment with EA at 2 Hz may be an effective method to treat postoperative pain.

2.8 Silver Spike Point (SSP) Therapy (Needle-free Electro-Acupuncture)

Silver Spike Point Therapy (SSP) is an advanced form of low frequency electrical therapy that was developed in Japan in 1976, as a joint academic industrial study between Osaka Medical College (Department of Anaesthesiology) and Nihon Medix Company Limited, one of Japan's leading medical equipment manufacturers.

SSP Therapy was intended to simulate the analgesic effect of needle electro-acupuncture, without needles. Low frequency treatment using SSP therapy was found to provide effective

pain relief, with the added benefits of a simple, non-invasive treatment, free from side effects, and with no limit to the quantity or duration of treatments. There are two features of SSP Therapy that set it apart from needle electro-therapy and TENS. These are the unique SSP electrodes and the 1/f Yuragi low frequency fluctuation system.

SSP electrodes were designed to allow medical practitioners to achieve comparable results to needle electro-acupuncture, while eliminating the disadvantages of using needles. The electrode was manufactured of silver plated brass to ensure accurate transference of the electrical stimulation. Its conical shape enabled both deep and peripheral stimulation to a wide range of treatment points on the body (See Fig. 1). The electrodes were housed within a rubber cup, which maintains contact with the skin, by an adjustable vacuum mechanism. This ensured correct compression of the electrode for constant electrical stimulation.

Figure 1. SSP Therapy silver plated brass 'Spike'

To ensure comfortable treatment with unrestricted placement of paired electrodes, SSP treatment utilises spike waves and bi-directional waveforms. Nihon Medix introduced 1/f Yuragi fluctuated, irregular pulse stimulation into low frequency electrical-therapy based on research by the University of Tokyo and Tokyo Institute of Technology. It was reported that marked benefits of 1/f Yuragi compared to regular electrical stimulation was achieved, especially for 'difficult to treat' pain. The 1/f fluctuation is created by the inversely proportional relationship between frequency and power. The most agreeable and comfortable waveforms, e.g. the relaxed alpha rhythm of an electroencephalogram and classical music, conform to the 1/f fluctuation pattern (Takakura, 1982).

In 1989, an experimental study designed to increase the analgesic effects for pain following abdominal surgery using SSP therapy, was undertaken by Ishimaru and Shinohara of the Department of Oriental Medicine, Meji Hospital/College of Oriental Medicine. This study was carried out using ten healthy male volunteers (average age 23 years) to test pain thresholds in the upper abdominal surgical area. A Pain Thermo Meter was used to test pain thresholds under three different stimulation conditions with varying results. Keisou and Shoji found that the greatest increase in upper abdominal pain threshold was achieved by a mixture of local, high frequency stimulation and distant, low frequency stimulation (Ishimaru, 1989) described as below.

Test 1: Local area, single high frequency (dense-sparse wave) of 50 Hz/3 sec and 100 Hz/5 sec was applied alternately for 30 minutes to the areas as shown in Figure 2 below. Test 1 resulted in a 2.7°C increase in pain threshold*.

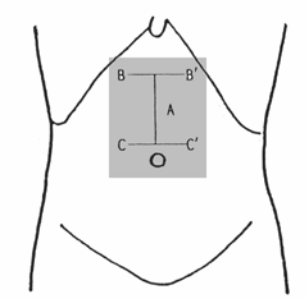

Figure 2. Abdominal areas receiving electrical stimulation to increase abdominal pain threshold.

*Abdominal pain area showed in gray. Area B - B' = 6cm, A = 15cm and C - C' = 2cm above belly button.

Test 2: Single distant low frequency (dense-sparse wave) stimulation on both sides of ST36 Zusanli, LI4 (He Ku) and LI11 Quchi with 3Hz/3 sec and 5Hz/5 sec for 30 minutes. Test 2 resulted in a 3.2°C increase in pain threshold.

Test 3: Test 3 was conducted combination stimulation with local high frequency (as in test 1) and distant low frequency (as in test 2) for 30 minutes. The combination test resulted in an 8.5°C increase in pain threshold.

Keisou and Shoji also found that, on completion of the stimulation, the lasting effect of the increase in pain threshold varied for the three test conditions. For test 1 and test 2 the lasting effect remained for around fifteen minutes after stimulation ceased, returning close to the original pain threshold. However for test 3, fifteen minutes after stimulation ceased, the effect remained at 4.2°C above the original pain threshold (Ishimaru, 1989). Keisou and Shoji explain that the results of the combination stimulation condition are related to endorphin secretion as well as Melzack & Wall's (1965) Gate Control Theory.

In 1990, Umeki and Iwa focused on SSP Therapy for the pain of post-abdominal surgery in 49 patients, and compared its effects on wound pain, the time of re-ambulation, and the time of first flatulence with epidural anaesthesia and control groups. It was found that in the first 24 hours after surgery, 42.9% of patients in the SSP Therapy group needed no analgesics, this percentage was significantly higher ($p< 0.01$) than in the control group (6.7%). Moreover, the time of re-ambulation was significantly shorter ($p<0.001$) in the SSP group than the control group, although no difference was seen for the time of first flatulence between the two groups. It was concluded that among the three SSP Therapy treatment subgroups (local, remote and mixed), mixed electrical stimulation was the most effective for the relief of post-operative wound pain (Umeki et al., 1990).

In 1990, Ishimaru, Shinohara and Kitade examined the effect on pain threshold of low frequency electrical acupuncture by needle (LFEA), and SSP electrical stimulation. Six healthy adult males (average age 23.5 years) were tested with a view to answering three separate experimental questions:

- Whether LFEA or SSP stimulation elevates the upper abdominal pain threshold?
- What is the most effective method of stimulation?
- Are the analgesic effects reproducible?

The results showed the peak value of the upper abdominal pain threshold reached 63.8°C ± 6.3°C for the LFEA and 59.0°C ±3.2°C for SSP stimulation. The time required to reach the peak pain threshold value was 35.0±12.2 min for LFEA, and 57.5 ±14.7 min for SSP stimulation. The increase in pain threshold for LFEA was achieved earlier with a stronger effect than that of the SSP stimulation. Increasing the electrical flow volume (mA) caused an elevation in pain threshold values for both LFEA and SSP stimulation. Pain threshold values showed greatest increases with a gradually increasing electrical flow volume stimulation than with constant flow stimulation. The result of re-test, performed ten days after the original test, indicated the reproducibility of analgesic effects. These results suggested that both LFEA and SSP Therapy would be effective for the control of post-operative pain following abdominal surgery (Ishimaru, Shinohara and Kitade et al, 1990).

As a kind of electroacupuncture devices, SSP needleless acupuncture machine matches the following features of typical electrostimulation devices detailed by the Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines 2004:

PRECAUTIONS in controlling amplitude related to this study include:

- It is necessary to make certain that all amplitude settings are at zero volts and unit is turned off before connecting leads to needles.
- It is important to zero out (turn down) the amplitude before disconnecting the leads from needles or turning the unit off.
- During initial application the amplitude is adjusted to the level that the patient can just feel the sensation. Care should be taken not to put the muscle into contraction.
- Be aware that in some cases of pain and also paralysis the patient may have impaired ability to feel the stimulating signal.
- Electrostimulation of a few muscle fibers eventually causes some of the adjacent fibers in the same muscle to start contracting in unison. More and more fibers can also be recruited until the entire muscle is contracting. This can actually be beneficial for some conditions, such as for releasing a muscle spasm, but harmful or irritating if applied directly to a torn muscle.

Frequency Control: Devices usually have a frequency control capability that is common to all outputs in order to select appropriate stimulation in terms of the number of pulses\second. Most biological and neural processes that beneficially respond to acupuncture and EA involve low frequency responses. Most EA devices provide either a range of selectable fixed frequencies or have an adjustable frequency capability. The most commonly selected fixed frequencies with a device which a rotary switch ranges are from 0.1, 1, 2, 10, 25, and 100 Hz. Some units provide considerably higher frequency settings at 1,000 to 1,500 Hz. Increasing the output signal frequency causes an increase in the intensity that the signal has on the body, and the subjective feeling experienced by the patient.

PRECAUTIONS in controlling Frequency include:

- When increasing the frequency during treatment, it is necessary to turn down the signal amplitude on all outputs being used before switching to the desired higher frequency.
- After increasing the frequency, the amplitude for all outputs then needs to be readjusted as necessary.
- Increasing the frequency without a corresponding reduction of the amplitude can lead to inducing stress analgesia.

Pulse Patterns: Most EA/TENS devices provide several different variations in output pulse patterns that offer certain advantages for specific type of treatments. Typical patterns include continuous, intermittent (discontinuous) and mixed (dense dispersed) operating modes.

Continuous Pulse Pattern: Continuous wave output pattern is characterized by a steady train of output pulses at a constant frequency selected by the practitioner. This a common and useful operating mode applicable to many standard clinical situations.

Discontinuous (Intermittent) Pulse Pattern: The discontinuous or intermittent pulse pattern consists of an output signal at the selected frequency that is on for only about

three seconds followed by no output for about three seconds. This on-off pattern continually alternates as long as the discontinuous pattern is selected.

PRECAUTIONS in controlling Discontinuous Mode Adjustment:

- Amplitude in discontinuous mode is adjusted only during the "on cycle" period of operation.
- Frequency is only changed during the "on cycle" period consistent with turning down the output amplitude before increasing the frequency and then readjusting the amplitude.

Mixed (Dense Dispersed) Pulse Pattern: In the mixed mode of operation a selected output frequency is provided for a short duration (approximately 3 seconds) followed by lower frequency for the same duration. The high and low frequencies portions of the mixed pattern continually alternate. In mixed mode, most devices only require selection of the high frequency with automatic generation of the low frequency component. Some devices allow selection of the low frequency setting as well.

PRECAUTIONS in controlling Mixed Mode Amplitude: Amplitude is only adjusted during the high frequency "on" period of the mixed cycle.

General Operational Guidelines: The physiological features of the body allow the use of simple, rational, repeatable rules for the application of EA. This includes proper placement of the output leads to achieve the best therapeutic effect while at the same avoiding unwanted current paths in the body. Perhaps the most important consideration in the use of EA, and acupuncture in general, is the selection of candidate neurovascular nodes (acupuncture points) to be employed to achieve the best clinical outcome for the patient's condition. Duration of treatment, output amplitude, output frequency, and selection of proper operating mode also need to be considered.

When to Consider Using EA: Generally the application of EA stimulation greatly enhances the effect of needling therapy and can increase level of analgesia and

significantly extends the period of treatment effectiveness. Many practitioners apply EA as a primary modality for acute and chronic pain and musculoskeletal problems because of its ability to produce a strong analgesic effect. The application of EA is a primary consideration for pain, muscle spasms, numbness, treating nerve dysfunction, paralysis, and atrophy. EA can also be employed in surgical or dental procedures as an adjuvant to normal anesthetics. EA is very effective in treating withdrawal symptoms of individuals quitting the use of addictive substances such as nicotine, alcohol, cocaine, opiates, and some prescription drugs. EA can also be used to enhance cervical dilatation and uterine contractions to induce labor. Stimulation promotes tissue repair, healing and regenerating of nerve fibers essential to treat many chronic disorders.

Duration of Stimulation: Typical duration of EA application is 15-30 minutes. In cases of dental or surgical analgesia, the duration may by longer. In treatment of withdrawal from a powerful opiate, the duration may be increased to 45 minutes and applied twice a day for 3-4 days.

Amplitude (Strength of Current): Under most conditions, amplitude of the output signal is only adjusted to the level that the patient can detect a slight sensation that feels like tapping on the skin. In many cases of trauma and pain there may be a deficit in sensory perception. These patients may not feel the electrical signal even though strong muscular contractions are activated. Thus, amplitude is adjusted only to the level where either the patient feels a slight sensation or the practitioner observes small movements of the needle or perhaps very slight muscular contractions. Excess strength of stimulation can induce a stress response. After several minutes of stimulation, control signals generated in the body reduce the response to the stimulus and the patient no longer feels the EA stimulus. Thus, the amplitude is periodically readjusted to maintain an awareness of a slight tapping sensation. The control response generated by the body is mediated by descending neural pathways in the spinal cord. This is the prime effect that is sought in the treatment of all problems, including musculoskeletal and viscera conditions.

Frequency and Operating Mode: Care needs to be taken not to induce stress by either excess amplitude or using frequencies that are too high. Low frequency application (2 Hz.) always invokes the analgesic and restorative processes of acupuncture. This frequency (2 Hz.) is suitable for use in treating all pain conditions, substance abuse, osteoarthritis, rheumatoid arthritis, vascular or blood distribution problems and organ dysfunction. Higher frequencies (25-50 Hz.) are selected where nerve dysfunction or paralysis is involved and this is usually in conjunction with a low frequency (mixed mode). Frequencies of 25 Hz. and above can produce tonic contraction of muscles and is useful in treating certain muscular conditions when applied in discontinuous or mixed mode. General considerations of mode selection involve the following:

Continuous mode: Used for most conditions, especially in treating pain, substance withdrawal symptoms, visceral problems, inducing labor, and using EA/PENS for surgical analgesia. Normal treatment duration is about 20-35 minutes and there is little risk of developing tolerance even if this is applied several times a day. When used for surgical or dental analgesia, the duration may be extended. Tolerance can be produced after many hours of continuous application or in several days with a few hours of daily EA/PENS stimulation.

Mixed mode: Is considered when a clinical condition involves paralysis, atrophy, and impairment due to loss of nerve function. Mixed mode can also be applied to enhance segmental levels with the higher frequency component as well as activating axial effects with the lower frequency component.

Discontinuous mode: Employed where a longer period of stimulation is needed and also where stimulation is directed to strengthen particular muscular areas or to treat problems such as scoliosis. In situations of long duration EA/PENS, use of discontinuous mode (about 3 seconds on and 3 seconds off) can be considered to reduce potential of developing tolerance.

General Precautions and Contraindications for EA:

- Profound analgesia induced by EA puts patient at risk of self injury, therefore the patient must be advised or restricted from strenuous physical activity after treatment.
- Contraindicated in left chest region for patients with cardiac pacemakers, or for areas with imbedded neural stimulators and other electrical devices.
- Not to be used on lower abdomen in pregnant women.
- High frequency or high amplitude application may induce stress, which is contraindicated in cases of hypertension.
- High amplitude EA that causes muscle fiber recruitment (twitching) can irritate or re-injure acute local strains and sprains.
- EA can sedate older or fatigued patients, causing drowsiness after treatment; hence some patients should arrange for others to drive them home after an EA treatment.

Traditionally acupuncture with needles has been the most effective way to restore equilibrium to the body. To avoid the disadvantages of E.A. by needles, SSP's stimulation is achieved without needle penetration. This involves a minor electrical impulse replacing the insertion of needles. Conical metal electrodes are positioned onto the skin, directing the electrical impulse to the acupuncture point while also gently stimulating the surrounding area through the wide electrode plate. Many points can be treated simultaneously without time restrictions. The electrical frequencies are regulated and adjustable depending on the individual condition. Other than pain management, SSP can be applied to medical treatments as does acupuncture. Exceptions are the hairy areas of the body and the gaps between toes and fingers. However, SSP allow safe use on the points of the body trunk where there could be a risk of damage to internal organs or membranes by needle acupuncture.

Disadvantages of acupuncture are associated mostly with the use of needles. For example, needle placement must be at a specific depth into the skin to achieve effective treatment. Acupuncture needles are very thin and when the electrodes are attached the needle depth and/or angle can be altered. This can potentially reduce the efficacy or damage internal body organs or membranes. The electrical stimulation through Acupuncture needles causes them to

vibrate, creating discomfort, pain and nervousness. Needles can also break with the application of electrodes although this is rare.

For patients where analgesic injections or nerve blocks are contra-indicated, electro-acupuncture can be safely and effectively applied. The application of EA will not only treat specific pain but will improve the patients general condition providing benefits to appetite, digestion, bowel movements, sleep patterns, rheumatoid arthritis, dermatosis and PMT.

E.A. can also be used safely in conjunction with other conventional treatment methods with no adverse side effects.

Studies have shown that even when SSP is simply used as transcutaneous electrical nerve stimulation (TENS) at the site of discomfort, that is without the knowledge of Acupuncture or TCM, analgesia is achieved. When combined with traditional acupuncture theory, SSP Therapy becomes an extremely effective pain control treatment.

Pomeranz and Chiu (1976) decribed that volunteers were administered acupuncture anesthesia or SSP anesthesia. The rise in pain threshoud was tested by means of a paon meter and by potassium ionophoresis. Then, Naloxone was administered intravenously with a drip and the pain threshold level rapidly decreased. Fithteen minutes after the end of the Naloxone injection, the pain threshoulf level returned to the same level as that before the injection.

Generally speaking there are three classifications of Acupuncture points, that is, Acupuncture Meridian Points, Extra Meridian Points, and Tender Points, also known as Pressure Points, which demonstrate sensitivity during pathological conditions. The Tender Points are easily located because they are sensitive to pressure. By using SSP electrodes on a tender point one can expect to obtain 80% of optimum results. One should start treatment with Tender Points, then treat Meridian and Extraordinary Points to further improve treatment results.

SSP Therapy is very comfortable for the patient, even when done on the face the patient doesn't feel any unpleasantness or apprehension. SSP therapy is frequently used for recovery of motor function. SSP Therapy alleviates pain and increases blood circulation so the patient

can gain more range of movement. The great advantage in SSP is that the affected area can be treated and exercised simultaneously.

2.9 Acupuncture Points Selection for Post-operative Pain

In ancient times, the number of acupuncture points was established to be the same as the number of days in the year: 365. These points were mapped to 14 major meridian lines, one meridian for each of the 12 inner organs, one meridian along the spine (called the governing vessel), and another along the midline of the abdomen (called the conception vessel). More recently, the number of points identified by acupuncturists has exploded. There are extra meridians (some of them outlined in ancient times, others modern) with their own sets of points, there are special points (off meridians), and there are complete mappings of body structures and functions by points along the outer ears, on the nose, in the scalp, on the hands, on the feet, and at the wrists and ankles. Despite the growing number of treatment zones, most acupuncturists still utilize the traditionally-identified points on the 14 main meridians. On each meridian there are a small number of points used repeatedly, because of their versatility, for a wide variety of patients and diseases. One such point on each major meridian is mentioned below, sometimes with a second point also briefly described, for a total of 21. It is important to recognize that although a list of disorders and diseases treated by each point can be given, sometimes the points are selected entirely or primarily on the basis of the TCM theory of balancing the flow in the meridians, so that the point might be used for other kinds of disorders, aside from those listed, because of its usefulness in this balancing process. For points not on the central line of the body, each point has a left and right side reflected location (the point is counted only once for enumeration purposes). For each point in this presentation, the name of the meridian, the number of the point, the number of standard points on the meridian, its designation by one of the number-based classification systems (two letters and the point number), and the Chinese name are given (Yang, 1997; http://chinese-school.netfirms.com/acupuncture-points.html).

The abdomen contains the zang-fu organs including the stomach, spleen, liver, gallbladder, large and small intestines, kidneys, bladder, etc., and the Hand and Foot Yangming channels, the Hand and Foot three Yin channels, the Foot Shaoyang channels and the Chong, Ren and

Dai channels pass through the abdomen. Some commonly used acupuncture points are always selected from these channels for pain relief. The web (http://chinese-school.netfirms.com/acupuncture-points.html) summaries the location and functions of these points which have been used or reported as having effects on post-operative pain:

- Large Intestine Meridian, point #4 of 20: LI4, Hegu (located on the back side of the hand between the thumb and first finger).
- Lung Meridian, point #7 of 11: LU7, Lieque (located above the wrist on the inside of the arm).
- Stomach Meridian, point #36 of 45: ST36, Zusanli (located on the front of the leg, just below the knee).
- Spleen Meridian, point #6 of 21: SP6, Sanyinjiao (located on the inner side of the leg just above the ankle). Another key point on this meridian is SP9 (Yinlingquan), located just below the knee.
- Gallbladder Meridian, point #20 of 44: GB20, Fengchi (located at the base of the skull where it joins the neck in back). Another key point on this meridian is GB34 (Yanglingquan), located on the outer side of the knee.
- Liver Meridian, point #3 of 14: LV3, Taichong (located on the top of the foot, between the first and second toes). The adjacent point in the meridian, LV2 (Xingjian), is at the webbing between the toes.
- Pericardium Meridian, point #6 of 9: PC6, Neiguan (located on the inner arm, just above the wrist).
- Heart Meridian, point #7 of 9: HT7, Shenmen (located on the outer side of the wrist).
- Urinary Bladder Meridian, point #40 of 67: BL40, Weizhong (located at the back of the knee). Another important point on the bladder meridian is BL23 (Shenshu), in the lumbar area (hip level) near the spine.
- Kidney Meridian, point #3 of 27: KI3, Taixi (located just behind the inner ankle).
- Triple Burner Meridian, point #5 of 23: TB5, Waiguan (considered to be a special type of organ system that spans the entire torso).
- Small Intestine Meridian, point #3 of 19: SI3, Houxi (located on the side of the hand, below the little finger).

- Governing Vessel, point #20 of 28: GV20, Baihui (located at the top of the head). Another key point on this meridian is GV14 (Dazhui), located just below the seventh cervical vertebrae (shoulder level).
- Conception Vessel, point #4 of 24: CV4, Guanyuan (located a little below the navel).

Examples of Combining These Points to Produce an Effective Treatment: In the book Modern Clinic Necessities for Acupuncture and Moxibustion (by Zhang Ren and Dong Zhi Lin), several treatment strategies are outlined. For menopausal syndrome, the main points recommended are GV20 and GV14, CV4, BL23, HT7, SP6 and ST36; secondary points include PC6, LV3, and KI3. For bedwetting at night among young children, recommended points include CV4, BL23 and SP6; secondary points include LU7, KI3, CV6, and ST36. For hayfever, recommended points include GB20, LI4, and ST36; secondary points include GV14, LU7, LI11, and SP6. In her book Insights of a Senior Acupuncturist, Miriam Lee describes a combination of points that have wide application: ST36, SP6, LI4, LI11, and LU7. This set of points, with slight adjustments (e.g., leaving out one or two, perhaps adding or substituting one or two) is shown to be helpful for the majority of common complaints seen in the Western acupuncture clinic. A popular treatment for injury and stress is to needle the "four gates," the right and left side points LV3 (feet) and LI4 (hands), which opens circulation throughout the meridians.

Depending on the author or the location of the surgery a variety of acupuncture points were described for acupuncture analgesia. Distal points like LI 4, PC 6, ST36 are used as well as segmental points, paraincisional points or ear acupuncture points. The needles were stimulated manually or electrical (1-200 Hz, 1-40mA). Usually stimulation of the acupuncture points started about 20 minutes before surgery and was continued during operation.

As described in the literature review, acu-point Zusanli is one of the most effective points in TCM. Zusanli is located on the leg portion of the stomach meridian. Several names ascribed to the point; however, most of them include the term sanli. In fact, in traditional acupuncture texts, such as the Internal Classic (Nei Jing) and the Systematic Classic of Acupuncture (Jia Yi Jing), the point is usually referred to simply as sanli. Zu refers to foot, indicating that the

point is on the portion of the meridian that runs to the foot: the stomach meridian is often referred to as the foot yangming meridian. Nei Jing Su Wen state that the bilateral Zusanli points are two of the eight points for eliminating heat from the stomach. Zusanli is also mentioned as a treatment for knee pain that "feels so severe that the tibia feels broken." Zusanli is described as a "he" point (confluence point) of the stomach meridian. "He" points are where the qi submerges in its flow along the meridian; it submerges into the vast interior ocean of qi and blood (Yang, 1997).

According to Ling-Su Nei-Jing, the most efficient acupuncture treatment is to choose the acu-point from the appropriate points in the related meridian. Zusanli (ST36) lies on the Stomach Meridian of Foot-Yangming, which circulates through the abdominal area. This meridian starts from the bridge of the nose, branching from the face it traverses the throat and passes through the diaphragm, enters the stomach and connects with the spleen. A branch from the stomach descends through the abdominal area surrounding the female reproductive areas, then traverses down the leg. Thus the selection of Zusanli (ST36) agrees with the concept of meridian point selection, being most related to the treatment target (See Figure 3).

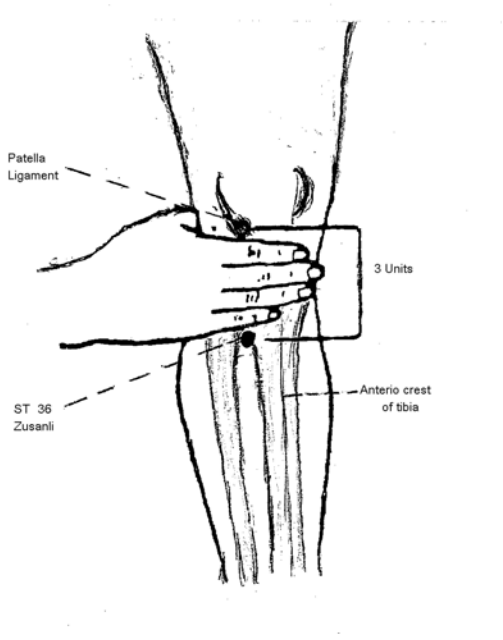

Figure 3. ST36 location

Zusanli (ST36) has been used historically to treat many complaints; it can also improve the digestive, respiratory and blood circulatory systems, as well as the immune system. It has been shown that the use of EA at Zusanli (ST36) can increase the pain threshold. There are other possible points that could be selected for the same purpose but to adhere to the Ling-Su, Nei-Jing Theory, it is necessary to use Zusanli (ST36) bilaterally only. Also, according to Huang (1985) and Dai (1987), acupuncture stimulation of Zusanli (ST36) increased the secretions of hormones from the pituitary gland and the adrenal cortex. This results in an improvement in the immune system, which assists the patient to a faster recovery.

Modern clinical research has been taken into two different directions with treatment at Zusanli. One of the treatments is relief of abdominal pain by stimulation of the acu-point. Patients have postoperative pain can be treated by stimulating at zusanli. Referring to previous research that stimulating zusanli could raise the pain threshold and inhibit pain transmission in the nervous system, especially in the abdominal area. In our research, the stimulation is to get the qi reaction, such as soreness, numbness, distension, and heaviness, through the silver plated brass spike (SSP therapy) continue the procedure for 30 minutes. The mechanism of acupuncture is that the system transfers signals from the acu-point to the organ through the meridian to produce a therapeutic effects. This is also described as the qi sensation along the pathway or meridian. As mentioned in Definition, health is considered to be a function of the smooth flow of qi. Qi is vital to life, it follows that if it is in poor condition, deficient in some way or not able to circulate freely throughout the body, then pain or ill-health may result (Hopwood, 2004). Therefore, obtaining the qi sensation is necessary to accomplish success of the treatment.

Thus, the most important procedure in an acupuncture treatment is the selection and combination of points. Since selection of points along the channels is guided by the Theory of Zang-Fu organs and channels, in our study, acu-point Zusanli was selected for stimulation based on the course of channels and the function, and difference and characteristics of the point (Zhongan, Aung and Deadman, 2002).

2.10 How and Why Acupuncture Works

There are a variety of forms of acupuncture incorporating medical traditions from both East and West. The most studied mechanism involves the insertion of solid needles in various patterns and combinations around the body. These needles may then be enhanced by electrical stimulation, manual stimulation or warming. The pattern or arrangement of needles around the body is important and is designed to address the underlying problem as seen through the oriental model.

Davidson (2000) in Dr Prange's www.drprange.com indicated that:

> This model of health describes a philosophy of man functioning harmoniously within an orderly universe. The models of health, disease and treatment are presented in terms of patients' harmony or disharmony within this larger order. This involves their responses to external extremes of wind, heat, damp, dryness and cold as well as to internal extremes of anger, excitement, worry, sadness and fear. Heat, for example, produces fever. Damp may produce a state of phlegm production. When combined, these two influences can lead to febrile bronchitis. Other factors include an imbalance between Yin (interior, cold, deficient) and Yang (exterior, hot, excessive). Organ functions include not only their conventional biomedical physiology but also energetic and metaphorical qualities (for example Kidney supervises bones, marrow, hearing and hair).

> The central issue from the classical TCM point of view is not why acupuncture works, but rather how and when to use it. The dynamic balance that TCM equates with health manifests as smooth and constant movement. When qi and blood stagnate, the processes of elimination and regeneration deteriorate, constituting the basic condition underlying many forms of illness. This model is accessed through a series of energy flow pathways that traverse the body called meridians. These meridians frequently run in the clefts between muscle groups containing fascial layers and neurovascular bundles. Thin, solid, sterile, stainless-steel needles enter the channels, activating or inhibiting the flow of qi and Blood. Fourteen major pathways traverse the body from the top of the head to the tips of the fingers and toes. Many principal acupuncture

points are located below the elbow and knee-where the qi changes its polarity from Yin to Yang and gathers force as it moves from the extremities toward the core. By eliminating congestion and activating circulation of qi, acupuncture interrupts and disorganizes patterns of illness.

Pain is also considered to be the result of congested qi, Blood or Moisture. Obstruction of the flow of energy or blood through the principal meridians manifests as musculoskeletal pain in the territory of the channel (for example the Bladder principal meridian passes through the lower back; lumbar pain reflects an obstruction of qi and blood flow through that channel).

A more western model of acupuncture incorporates the modern understanding of neuroanatomy into the classical Chinese model. Needles are placed in muscular trigger points or motor points of muscles to cause lengthening of the muscle and reduction of pain. Or they are placed in a segmental pattern along the spine to correspond with radicular symptoms of the extremities. Knowledge of dermatomal, myotomal, sclerotomal and autonomic innervation patterns is essential.

The great preponderance of clinical experience and research says that acupuncture clearly works. How often it works, how it works, and how to best study acupuncture are difficult questions. Measured effects occurring during acupuncture treatments on human and animal subjects include the following:

- Increase in endogenous opioid and monoamine systems
- Increase in plasma concentrates of PGE2 after successful acupuncture surgical analgesia
- Vasodilatation, rise in skin temperature
- Elevated blood cortisol levels
- Decrease in TG, cholesterol and phospholipids
- Increased phagocytic and fibrinolytic activity; increased beta-globulins and complement; impairment of leukocyte adherence to vascular cells
- Decrease in blood pressure

Likely mechanisms for its effects include nerve conduction, circulation, the lymphatic system, electromagnetic flow through fascial planes and interstitial fluid. Electric current has been measured along meridians not overlying single nerve trunks or muscle groups.

Applying contemporary research standards, there are more and more high-quality research assessing the efficacy of acupuncture compared with placebo sham acupuncture in recent years. In the past, there was a view that it is very difficult to use sham acupuncture points as they often produce some intermediate clinical benefit between that of real acupuncture and placebo.

The National Institute of Health (NIH) Office of Complementary and Alternative Medicine (CAM) selected studies considered to have sufficient data and divided them into two groups:

- Acupuncture compared with sham acupuncture or placebo
- Acupuncture compared with other interventions or no interventions.

In the view of the NIH, both animal and human laboratory and clinical experience suggest that the majority of subjects respond to acupuncture, with a minority not responding. Acupuncture compared with sham acupuncture or placebo. There is clear evidence that needle acupuncture is efficacious for adult postoperative and chemotherapy nausea and vomiting and probably for the nausea of pregnancy and for postoperative dental pain. There are reasonable studies showing relief of pain with acupuncture on diverse pain conditions such as menstrual cramps, tennis elbow, myofascial pain and fibromyalgia (NIH, 1998).

Although in the past scepticism has been voiced over the effects claimed for acupuncture, in recent years the effect of acupuncture on different conditions (pain and diseases) has been studied from a Western scientific perspective, and the results have demonstrated that acupuncture has both physiological and psychological impacts (Andersson and Lundeberg, 1995). Needle insertion into the skin and deeper tissues, in addition to subsequent stimulation

of the needles, results in a particular pattern of afferent activity in peripheral nerves, mainly the A-delta and possibly also the C fibres. Acupuncture stimulation has been demonstrated to activate inhibitory systems in the spinal cord, which results in segmental inhibition of the sympathetic outflow (Sato *et al*., 1997) and pain pathways, as predicted by the gate control theory (Melzack and Wall, 1965). EA releases endogenous opioids and oxytocin, which seem to be essential in the induction of functional changes in different organ systems (Andersson and Lundeberg, 1995). In this respect, particular interest has been dedicated to β-endorphin - an endogenous opioid with a high affinity for the μ receptor (Basbaum and Fields, 1984). Indeed, evidence suggests that this hypothalamic β-endorphin system plays a central role in mediating the pain-relieving effect of acupuncture (Wang *et al*., 1990). Furthermore, it has been shown that intense stimulation results in the activation of supraspinal pain inhibitory centres, and this mechanism is denoted diffuse noxious inhibitory controls (DNIC) or counter-irritation (Bing *et al*., 1990).

Martelete and Fiori (1985) indicated that in all surgery types, the post-operative pain relief presented by TNS and EA groups of patients was greater than that of meperidine treatment group. But the analgesia presented by the EA treated group of patients lasted longer and increased with the repetition of treatment. The differences of behaviour of TNS and EA analgesia suggest that their neurochemical mechanisms may not be the same. A comparative study between SSP and other EA treatment awaits to be conducted in the future.

Acupuncture is a reasonable option for postoperative pain, back pain. Positive clinical trials exist for addiction, stroke rehabilitation, carpal tunnel syndrome, osteoarthritis and headache. Acupuncture treatment for other conditions such as asthma or addiction should be part of a comprehensive management program. The World Health Organization lists over 40 conditions that may benefit from the use of acupuncture.

2.11 Perspectives, Suggetions and Future Directions

Medical research and statistical analysis have become more detailed in their own standardization, which has resulted in new studies on acupuncture and electro-acupuncture that are more reliable and of better quality. With increased demands by biomedicine, and with

practitioners who are better adapted to the practice of integrated medicine, it has become incumbent upon the TCM professional community to develop evidence-based acupuncture and electro-acupuncture practice guidelines that can be utilized by practitioners, patients, regulators, and third-party payors (Fennen, B and Esquivel, R., 2004).

WHO's Acupuncture: Review and Analysis of Reports of Controlled Clinical Trials (2002) reported with a view to strengthening and promoting the appropriate use of acupuncture in health care systems throughout the world. This analysis provided the following list of a variety of diseases, symptoms or conditions for which acupuncture has been proved, through controlled trials, to be an effective treatment: fibromyalgia, headache, knee pain, low back pain, myofascial pain, neck pain, periarthritis of shoulder, post-operative pain, sciatica, sprain, stroke, temporo-mandibular joint dysfunction and tennis elbow or epicondylitis.

In regards to the efficacy of acupuncture on pain, the WHO (2002) made a specific statement: "The effectiveness of acupuncture analgesia has already been established in controlled clinical studies. As mentioned previously, acupuncture analgesia works better than a placebo for most kinds of pain, and its effective rate in the treatment of chronic pain is comparable with that of morphine. In addition, numerous laboratory studies have provided further evidence of the efficacy of acupuncture's analgesic action as well as an explanation of the mechanism involved. In fact, the excellent analgesic effects of acupuncture have stimulated research on pain. Because of the side-effects of long-term drug therapy for pain and the risks of dependence, acupuncture analgesia can be regarded as the method of choice for treating many chronically painful conditions."

While the research reviews had inconsistent conclusions for many of the neuromusculoskeletal conditions considered, this is not unexpected due to the large number of trials each overview represents. However, it is significant that some reviews show promising results for low back pain, headache, osteoarthritis of the knee, lateral epicondylitis and fibromyalgia. The WHO (2002) study drew the most positive conclusions on the efficacy of acupuncture in managing various types of musculoskeletal disorders, including head, neck, shoulder, low back, elbow, lower extremities (sciatica) and knee, emphasizing its remarkable effects on alleviating pain anywhere in the body. All reviews agreed, in general, the

methodology involved in many acupuncture trials was inadequate, sample size low, and that higher quality of trials was needed.

In regards to chronic and post-operative pain, three postive RCTs were found in the above analysis to support the efficacy of acupuncture. In a comparative study of the analgesic effect of transcutaneous nerve stimulation (TNS), electroacupuncture (EA) and meperidine in the treatment of postoperative pain, 72 patients were randomly assigned to one of the three treatment groups. The study concluded: “In all surgery types, the postoperative pain relief presented by TNS and EA groups of patients was greater than that of meperidine treated group. But, the analgesia presented by the EA treated group of patients lasted longer and increased with the repetition of treatment. The differences of behaviour of TNS and EA analgesia suggest that their neurochemical mechanisms may not be the same.” (Brian and Richard, 2004).

In recent years, an increasing number of physicians have integrated acupuncture into their practices. To face the ever-growing healthcare cost in many countries in the world, more health insurance providers have begun to emphasize preventive measures and alternative therapies. Moreover, the National Center for Complementary and Alternative Medicine (NCCAM) has funded a good number of research projects related to acupuncture (Chen, 2005).

Despite positive developments in the use of acupuncture as an alternative treatment modality, current clinical research into this treatment still faces a number of challenges (Chen, 2005):

- Although many studies on acupuncture treatment have been published, the scientific merits of some are limited by study design and nonstandardized acupuncture practices.
- It may be difficult to maintain true blinding to patients in a clinical trial. Non-specific needling (ie, placing an acupuncture needle at an acupuncture point not intended for the treatment) or sham needling may elicit responses similar to responses to active acupuncture treatment, making it difficult to interpret the trial results. Furthermore, it was difficult to exclude a placebo effect in many clinical acupuncture trials.
- A clinical acupuncture treatment plan is often highly individualized for a given condition, which varies from one practitioner to another. As such, it is rather difficult

to compare the treatment outcomes if a given clinical condition is treated according to various parameters, including the choice of acupuncture points, needling techniques (eg, EA versus manual), duration of acupuncture in one session, and between-session intervals. Nonetheless, efforts should be made to standardize acupuncture clinical trials in order to improve their scientific merits. It is anticipated that complementary medicine, including acupuncture, is likely to play a growing and positive role in pain management.

Many reports described the challenging and successful attempts to perform acupuncture analgesia for surgery. Because of practical disadvantages, the uncertainty of failure and better modern anesthetics, this method was never fully established. The other studies focused on the effect of acupuncture for pain including postoperative pain. Some promising results need to be confirmed by further RCTs (Streitberger, 2000).

The best evidence is available for the prevention of PONV with acupuncture. But still optimal application time, duration or intensity of stimulus is not clarified. Even the location of stimulation may be variable. Nevertheless with further studies there is a good opportunity that acupuncture may be used routinely to prevent PONV in the future (Streithberger, 2000).

Since according to TCM, an obstruction is the basic pathogenesis of pain, clearing the obstruction may serve as the general therapeutic principle for treating abdominal pain. This may be accomplished by various measures according to the different syndromes (Yang, 1997).

Two fundamental concepts of TCM are involved in the experience of pain: the meridian system (Jing Luo); and the vital energy of the body (qi) that flows through the meridian system. When the flow of qi is blocked or stagnant, pain and illness result. Meridians exist at every level of the body. If qi is blocked at the skin level, you can see bruising or swelling of the tissue. Blockage in the flesh level can produce stiff, sore muscles; qi stagnation in the joints produces arthritis pain, TMJ pain, neck and back pain, etc. Internal blockages can produce many symptoms and kinds of pain, including headaches, sore throat, chest pain, stomach pain, menstrual pain, sciatic and nerve pain. Acupuncture is the principal treatment

modality employed by TCM practitioners to break up blockages and promote the free flow of qi through the body. When the affected meridian is correctly identified, and the hair-thin acupuncture needles are inserted into specific points along that meridian, qi flow is restored to normal. Because meridians connect every part of the body to every other part, you may find that an acupuncturist inserts needles on your feet or hands in order to treat a headache.

Because qi and meridians are not observable by current scientific methods, researchers in China and the West have conducted numerous studies which document the effects of acupuncture on the endocrine and nervous systems. Research shows that acupuncture stimulates the production of endorphins, which are our natural pain killers. Another proven mechanism is the dramatic increase of the adrenocorticotropic hormone (ACTH) with acupuncture treatment. Besides endorphins, additional neurotransmitters have been found in the natural substances whose release is stimulated by acupuncture therapy, such as serotonin, dopamine, epinephrine, norepinephrine and many others. Some studies indicate that transmission of pain signals through the central nervous system may be blocked by acupuncture. Many very well-designed clinical studies on migraine headache, low back pain, arthritis, sports injury, TMJ, and dysmenorrhea have shown significant differences between groups treated with acupuncture and the control groups not given such treatments (Liu and Gong, 2007).

For chronic conditions, a course of six to eight treatments is always recommended by acupuncturist. Some people notice relief right away; some need a few more treatments to notice the change. After six sessions, the practitioner typically reviews the case and discusses the progress. TCM requires collaborative effort between the patient and the practitioner - both have to work together to insure the best results. For the commonest health problem in the world – pain, TCM is an option worth investigating (Liu and Gong, 2007).

In summary, acupuncture treatment is valuable for acute pain such as surgical operations, post-operative pain (POP), neuropathic pain, pain from tooth extractions and extraction of impacted wisdom teeth. However, these areas are not exhaustive, because of the lack of clinical reports and original articles reported in Japan. A detailed examination should be done in the future to clarify treatment, dose, timing of treatment for acute pain and the propriety of

acupuncture treatment. It was clearly demonstrated by Lo's results using the Zusanli (ST36) point that the opioid sparing effects of electro-acupuncture depends on the frequency of the electrical stimulation. The above investigations demonstrate that electro-acupuncture can significantly decrease postoperative analgesic requirements by patients. However, these results remain varied, suggesting that further investigations in this area are required to determine whether acupuncture pre-, post-operation or combinations give the best results.

Chapter 3

Aims and Objectives

3.1 Aims and objectives

The aims of this study were to examine the effects of SSP needle-free electro-acupuncture (EA) analgesia on subjects recovering from hysterectomies. SSP needle-free EA was used in this study as opposed to standard acupuncture where needles are inserted into acupuncture points, as electro-acupuncture can generate stronger stimulation than needle acupuncture, providing more efficient analgesia. Standard acupuncture generally requires regular manipulation of the needles to achieve the stimulation required. This stimulation cannot be continuous and is both variable and uncontrolled. SSP needle-free EA stimulation is achieved continuously with controlled current and frequency ensuring that each subject received the same stimulation and dosages.

Objectives of this study were:

- To review the traditional TCM literature, both classical and contemporary, on acupuncture and its use to relieve pain;
- To design and undertake a clinical trial to investigate the analgesic effects of SSP needle-free EA on subjects recovering from hysterectomy;
- To determine the ideal time to administer SSP needle-free EA for optimum pain management.
- Obtain data for reference in future SSP needle-free EA studies.

3.2 Significance and Hypothesis

Hysterectomy has become a common surgical procedure in Australia. Most hysterectomies are performed for benign disease, such as myoma, endometriosis and fibroids. Other indications in gynaecological malignancy, such as cervical, uterine and ovarian cancer

account for around 8% of hysterectomies. Australian women over their lifetime have a 30% likelihood of having a hysterectomy (Dickinson and Hill, 1988). This figure varies depending on the state and even region of Australia, the majority of hysterectomies are either for non-life threatening conditions or elective (Dickinson and Hill, 1988). The procedure would generally be undertaken to improve the quality of life of the women either by eliminating the cause of discomfort or disease, or by negating the risk of pregnancy. The patient's well being therefore should not be overly compromised by the procedure. It would be beneficial if patients were able to recover faster with reduced side effects from opioid analgesics. The results of this study may help patients by contributing to the knowledge of pain control and providing significant improvement in treatment.

SSP needle-free EA has the advantage of being effective for pain control but having no opioid related side effects, such as nausea, dizziness, or the more serious respiratory depression, central nervous system depression including somnolence and conscious disturbance. Patients who had a hysterectomy would benefit, if SSP needle-free EA was effective.

Acupuncture has been used for pain relief across Asia for thousands of years. Electro-acupuncture has been used successfully for pain control in Taiwan for over twenty-five years. Lo's study in 1998 revealed that electro-acupuncture was effective in decreasing narcotic and PCA requirements, as well as reducing opioid side effects post-hysterectomy.

Unlike in Asian countries, the traditional TCM has not been broadly researched in Australia. SSP needle-free EA is unfamiliar to Australian acupuncturists and other health care practitioners, even though it has been a useful medical therapy worldwide for more than twenty years. Studies into the effects of SSP are required before people in countries like Australia will accept it as a valid therapy.

TCM provides not only a different perspective on health and disease, but a holistic perspective to treatment. Through this research on SSP needle-free EA, traditional TCM may become more acceptable to the Australian people, who could then receive the benefits of this treatment, which they might otherwise not consider.

This study was based on the following hypotheses:

- That the groups that receive the double treatment of SSP needle-free EA (both pre- and post-surgery) at acu-point Zusanli (ST36) would experience increased pain relief over a longer period of time, i.e. longer duration before requiring the first PCA dose, fewer PCA doses required, and fewer opioid related side effects compared to the sham and control groups.
- That the group that receives the low frequency treatment will achieve better pain relief compared to the high frequency treatment group, the sham and the control groups.

Chapter 4

Methodology

4.1 General Description and Study Design

The treatment component of this project was undertaken in Taiwan at the China Medical University Hospital (CMUH), under the principal supervision of Professor Lin Jaung-Geng, Director of the China Medical University. Associate supervisors were: Professor Tsai, Chang-Hai, Director of the CMUH, Dr. Rick Wu, Department Head of Anesthesia, CMUH, and Dr. Chen, Kuen Bao, Director of Anesthesia, CMUH. Professor Colin Torrance of La Trobe University Melbourne, supervised the proposal stage of this study, Associate Professor Hong Xu and Dr Kerry Watson supervised the study at the initial stage and the stage of data analysis, thesis preparation and completion.

Ethics Approval was gained from Latrobe University, Australia and China Medical University Hospital, Taiwan before conducting the clinical trial.

Hysterectomized patients at the China Medical University Hospital were invited to be subjects in the study. All subjects were asked to fill in a Medical Suitability Form for SSP needle-free EA treatment, received an Explanation Form, and sign a Consent Form. Forty-nine hysterectomized patients who had all received general anesthetics of propofol 2mg/kg and atracurium 0.5mg/kg for induction (but no narcotics), and sevoflurane with 50% nitrous oxide and oxygen for anesthesia, were randomly allocated to receive one of the four pre- and post-operative acupuncture procedures. Subjects were asked to take a draw from number 1-4 after they enrolled in this study, all subjects took number 1 were assigned into group 1, all subjects took number 2 were assigned into group 2, all subjects took number 3 were assigned into group 3 and all subjects took number 4 were assigned into group 4.

As a double blind study, the group interventions were kept blind from the subjects and data collectors.

In this study there were four groups of subjects (Table 1 and Figure 4). To ensure the groups consisted of randomly assigned subjects, each subject was assigned to a treatment group in numbered order, as they became available. That is, the first available subject was assigned to group one, the second available subject was assigned to group two, and so on. Every subject in each group received Patient Controlled Analgesia (PCA) (Pain Management Provider TM, Abbott Laboratories, North Chicago, IL, 60064, USA). The groups differed only in the acupuncture procedure they received. In an attempt to control for the placebo effect of SSP Therapy, one "Sham acupuncture point" treatment group (see Definitions) was included. This procedure minimises the medical effects of SSP Therapy, while maintaining its psychological impact. This is the most accepted control for clinical evaluation of SSP needle-free EA, as it attempts to minamise the placebo effect.

Table 1. The proposed four experiment groups and their treatment regimes

Subject Groups	**EA Treatment**	
	Preoperative	**Postoperative**
Group 1 PCA	NIL (Control Group)	NIL (Control Group)
Group 2 PCA	SSP electrode at sham acupuncture point near to ST36 (no stimulation) for 30 minutes.	SSP electrode at sham acupuncture point near to ST36 (no stimulation) for 30 minutes.
Group 3 PCA	SSP electrode at ST36 with continuous wave of 100Hz electrical stimulation for 30 minutes.	SSP electrode at ST36 with continuous wave of 100Hz electrical stimulation for 30 minutes.
Group 4 PCA	SSP electrode at ST36 with dense-sparse wave 3Hz/4sec, 10Hz/4 sec, and 20Hz/4sec electrical stimulation for 30 minutes.	SSP electrode at ST36 with dense-sparse wave 3Hz/4sec, 10Hz/4 sec, and 20Hz/4sec electrical stimulation for 30 minutes.

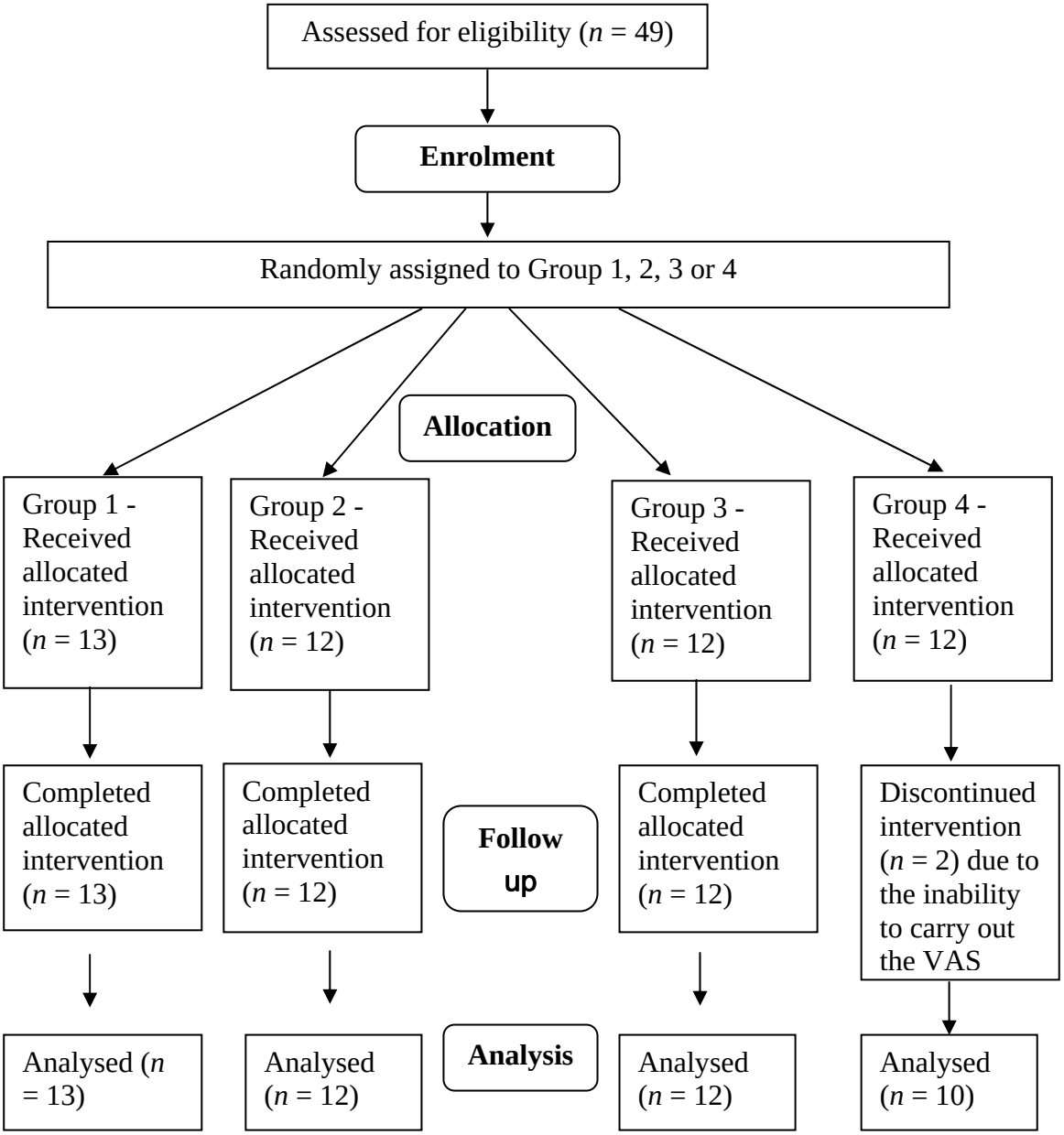

Figure 4: Flow chart of participants through each stage of the trial

TCM indicates that Zusanli ST36 acupuncture point is the most appropriate point for this study, as it lies on the Stomach meridian that traverses through the abdominal area surrounding the female reproductive organs. The acupuncture point ST36 is on the lower leg, three units (approximately the patient's four fingers width) inferior of the knee patellar ligament, and approximately one finger width lateral to the anterior crest of the tibia (See Figure 2).

In Groups 2, 3 and 4, subjects received SSP needle-free EA for 30 minutes commencing 30 minutes before general anesthesia. With Group 2, there was no stimulation. Subjects in Group 1 received general anesthesia only. Post surgery, SSP EA treatment was administered once only. It was initiated when the subject regained consciousness after the subjects returned to the recovery room. The SSP needle-free EA procedure was provided for thirty minutes, the 1/f Yuragi waves of SSP needle-free EA were used. All subjects in each group received patient-controlled analgesia (PCA) after the operation.

The time of the first PCA demand and the frequency of subsequent demands were noted over the first 24-hour period post-operatively. The total dosage of morphine used was calculated for each group. A visual analogue scale (VAS) measurement for pain intensity was administered. The VAS was used to determine the amount of perceived pain felt by each subject. It was a 0-10 scale with 0 being no pain and 10 being most severe pain. The data was collected over a 24 hour period commencing post operatively (See Figure 3). The Results were analyzed using a One-way analysis of variance (ANOVA) for Visual Analogue Scale (VAS), Patient Controlled Analgesia (PCA) doses delivered, and PCA doses demanded by the patients. This method is for testing the differences between means of independent samples. In this case, using SPSS and Student-Newman-Keuls (SNK) and Tukey post-hoc analysis performed a One-way ANOVA. T-tests were also carried out to determine significance between means of the variables, time of first ambulation and bowl movement, and total PCA demand and total PCA doses.

Before discharge, the subjects were asked to answer questions on the occurrence of any side effects from the SSP EA treatment, such as bruising, dizziness and anxiety. The VAS was again used to determine the intensity of pain.

4.2 Subjects

Women undergoing complete abdominal hysterectomies at the China Medical University Hospital were included in the study. Forty-seven subjects were finally recruited; and randomly assigned to one of the four groups. Subjects with medical conditions such as hypertension, diabetes, cachexia, cardiac, respiratory, kidney and nervous system problems, coagulopathy, and other bleeding disorders were excluded. Subjects with a history of opioid use, sensitivity to opioid related side effects (e.g. nausea, vomiting) were also be excluded. Each subject was instructed on the operational aspects of the PCA device (Pain Management Provider TM, Abbott Laboratories, North Chicago, IL, 60064, USA) at the initial preoperative visit and again in the recovery room. The use of SSP needle-free EA was also explained to groups 2, 3 and 4 before the operation.

The real acupuncture point loci Zusanli (ST36), one finger-width lateral to the tuberositas tibia, and the sham acupuncture point (on the same level as ST36 but above the tuberositas tibia) was identified in all subjects one day prior to the operation. Subjects received one of four different pre- and postoperative treatment regimes. All subjects were completely anesthetized throughout the surgery. After surgery, subjects were sent to post-anesthetic recovery (PAR).

4.3 Measurements

4.3.1 Patient Controlled Analgesia (PCA)

In its simplest form, a PCA system consists of an electronically-controlled infusion pump connected to a programmable device. When patients experience pain they trigger the infusion pump by means of a button or handset extending from the pump, causing it to deliver a preset dose of analgesic referred to as a bolus amount. Following the infusion of the bolus, the

timing device precludes the further administration of analgesic for a minimum time period, usually called the lockout period. The lockout period prevents a subsequent dose of analgesic being administered until the first dose has had time to take effect.

Modern PCA devices elaborate on the basic scheme outlined above by giving the patient and clinician greater control over the bolus amounts, lockout period, dosage limits and alarm conditions. Some devices also permit a low level background infusion to tide the patient over periods of sleep when no bolus requests are made.

The analgesic dosage levels at which patients experience pain relief vary greatly, as does the patients sensitivity to pain. Using PCA, patients are able to determine their own analgesic requirements.

After surgery all subjects were transported to a recovery room. After one hour in the recovery room all subjects in the four groups were connected to a patient controlled analgesia (PCA) system providing IV morphine with boluses of 0.8mg in the subsequent 23 hours. There was a lockout time of 8 minutes. Doses were registered on a chart. Blood pressure, heart rate and SpO_2 were recorded every 30 minutes for the first 2 hours and thereafter at 1 hourly intervals. Immediately on return to the general or ward from the recovery room, the subjects were asked to complete a 10cm vertical visual analogue scale (VAS) for intensity of pain at the time. The time of the first requirement of morphine, the postoperative analgesic requirement (in the 24 hours), the number of PCA demands (i.e. button presses) in the first 24 hours, and the opioid related side effects were recorded. Standard 10cm VAS scores were used to assess the pain (0 = no pain to 10 = maximum pain). The subject's age, weight, the duration of anesthesia and surgery, first requirement of morphine, VAS scores, PCA demands and incidences of side effects were analyzed using one-way analysis of variance.

4.3.2 Pain Measurement Tools

Pain measurement tools can range from simple descriptive scales to detailed questionnaires assessing pain on different dimensions. The measurement tool used in this study was the Visual Analogue Scale.

The Visual Analogue Scale

This is a 10cm line with extreme limits marked with perpendicular lines and appropriate labels. Point zero on the line equals no pain and the other end point, 10 cm away, equals maximum pain. There are no words or numbers at the end points. The subject is requested to mark the line with an X reflecting their level of pain. The main advantage of this scale is that it can be viewed as a ratio scale with an infinite number of points on the line.

The appointed nurse instructed the subjects on how to complete the Visual Analogue Scale (Figure 5) and answered any questions or concerns they had.

Instructions to the subject were:

Identify, by marking with an X on the line, how your pain is feeling at the moment. The more you move to the right-hand side of the scale the worse your pain is, and the closer you are to the left-hand end of the scale the less pain you are suffering.

No Pain Maximum Pain

Figure 5. Visual Analogue Scales

McCormack et al., 1988 indicated nine visual analogue scales (VAS) were used to evaluate pain. Each VAS consisted of a 10 cm line oriented vertically on a paper with nine different dimensions. The nine variables had the following endpoints: no pain and unbearable pain.

4.4 Instrument

This study was to determine the effect of pre- and post-operative SSP treatment on post-operative pain following hysterectomy. Group 3 received SSP stimulation at 100 Hz and Group 4 received SSP stimulation by a mixture of at 3 Hz, 10 Hz, and 20 Hz. The research evaluated the analgesic effect of SSP needle-free EA for post-operative pain relief of

hysterectomized subjects, and compared the difference between high frequency and low frequency stimulation. As a kind of electro-acupuncture device, the SSP needleless acupuncture machine matches the features of typical electrostimulation devices detailed by the Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines 2004, detailed in Chapter 2.

4.5 Analysis of Data

For this study, inferential statistics were computed and analyzed:

- The time between the end of the operation and the first dose of PCA morphine as requested by the subject.
- The frequency and amount of PCA morphine in the 24 hours following the operation.
- The number of opioid related side effects in the 24 hours following the operation.
- Inferential statistics using Unpaired F-tests, ANOVA and post-hoc analysis were applied to the data where relevant. For the F-test, degree of freedom are 3 and 42 or 3 and 43. Statistical significance is based on P value with $P < 0.05$; clinical beneficial is based on $P < 0.10$.

The subject numbers varies in many pain management projects using acupuncture, EA or SSP. Kurokawa (1979) reported that a clinical trial involved 30 subjects (10 in each group) showed positive outcomes of using SSP. Ishimaru, Kawakita ans Sakita (1995) indicated that significant results were gained by using EA in 16 subjects. Inamori et al (2000) indicated that significant treatment outcomes were observed in 37 subjects by using SSP. In this study, although the initial plan was to recruited 60 subjects as a clinical trial, however 49 subjects enrolled in this study and achieved significant outcomes in several measurements.

Chapter 5

Results

Finally forty-seven consecutive subjects (two subjects were excluded) who had hysterectomies were included in the study. Subjects were randomly allocated to four different groups. Except for the non-treatment control group, treatment procedures were conducted by an anesthetist and acupuncturist (Dr Chen, Kuen-bao) pre- and post-operatively and consisted of a course of sham, low or high frequency stimulation. All groups were assessed during the postoperative period for 24 hours using a VAS - Pain at the time of the first bowel movement and ambulation, opioid related side effects, total amount of PCA demand, and total amount of PCA doses were also recorded.

The four groups and their treatment regimes were:

- Group 1 (n = 13) - No treatment (Control Group)
- Group 2 (n = 12) - SSP electrode at sham acupuncture point near to ST36 (no stimulation) for 30 minutes.
- Group 3 (n = 12) - SSP electrode at ST36 with continuous wave of 100 Hz electrical stimulation for 30 minutes.
- Group 4 (n = 10) - SSP electrode at ST36 with dense-sparse wave 3 Hz/4sec, 10 Hz/4 sec, and 20 Hz/4sec electrical stimulation for 30 minutes.

The results were analyzed using a One-way analysis of variance (ANOVA) for Visual Analogue Scale, Subject Controlled Analgesia (PCA) doses delivered, and PCA doses demanded by the subjects. This method is for testing the differences between the means of independent samples. In this case, using SPSS and Student-Newman-Keuls (SNK) and Tukey post-hoc analysis performed a One-way ANOVA. F-tests were also carried out to determine significance between means of the variables (M), time of first ambulation and bowl movement, and total PCA demand and total PCA doses. F distributions are given with degree of freedom of 3 and 42 or 3 and 43.

5.1 Subjects Description

With approval from the China Medical College Hospital, 49 consenting females undergoing a hysterectomy were included in the study. Two of the 49 subjects were excluded from the analysis, from group 4, due to the inability to carry out the Visual Analogue Scale. The number of subjects in each group is listed in Table 2. The mean age ± standard deviation (SD) of the 47 subjects was 42.02 ± 8.31 years, with a range of 14 to 59 years. All subjects were randomly assigned to the four groups and the group interventions were kept blind from the subjects and data collectors. The mean duration ± SD of the operation was 127.70 ± 34.56 minutes with a anesthetic time 166.04 ± 35.95 minutes.

Table 2. Description of subjects

	N	**Minimum**	**Maximum**	**Mean**	**SD**
Age (Years old)	47	14.00	59.00	42.02	8.31
Weight (Kg)	47	40.00	158.00	59.74	17.54
Duration (min)	47	65.00	240.00	127.70	34.56
Anesthesia Time (min)	47	94.00	275.00	166.04	35.95
Valid N	47				

5.2 Post-operation General Recovering Conditions

Subjects' related general recovering condition, i.e. time of first bowl movement, time of first ambition and opioid related effects after the operation were recorded and comparisons were made between groups using F-tests, with degree of freedom of 3 and 42 or 3 and 43.

Table 3 shows the mean times (hr.) and SD of the first bowl movement after the hysterectomy for subjects within the four groups.

Table 3. Time of first bowl movement (in hr.)

Group	Number	Mean	SD
1	13	37.54	2.93
2	12	38.03	2.71
3	12	35.50	2.64
4	10	33.30	2.43

Table 4 shows the mean times (hr.) and SD of first ambulation after the hysterectomy for subjects within the four groups.

Table 4. Time of first ambulation (in hr.)

Group	Number	Mean	SD
1	13	32.50	2.41
2	12	33.75	3.11
3	12	33.13	3.18
4	10	29.90	2.95

As can be seen in Table 3 and 4 the means and SD of the four groups are within a close range. F-tests were performed on all means for each group in both of time of first ambulation and time of first bowl movement, which no significant differences between the means were found.

Table 5 shows the amount and percentage of subjects exhibiting opioid related side effects (e.g. nausea, dizziness, or the more serious respiratory depression, central nervous system depression including somnolence and conscious disturbance) within a 24-hour period post operatively. In this study, opioid related side effects were found in all groups. There are no significant differences between sham-EA, low-EA, and high-EA groups, but the control group had relatively low side effect percentage (38.5%) than the other groups. In the group 2 (sham-EA), 58% subjects were found different levels of side effects as well as subjects in group 3 (high-EA). However, the low-EA group has the highest degree (60%) of side effects.

Table 5. Opioid related side effects

Group	Amount showing side effects	Opioid related side effects
1	5	38.5%
2	7	58%
3	7	58%
4	7	60%

5.3 Visual Analogue Scale (VAS)

The VAS is using to determine the amount of perceived pain felt by subject (Table 6). It is a 0-10 scale with 0 being no pain and 10 being most severe pain. The data was collected over a 24-hr period commencing post operatively.

A one-way ANOVA was used to test for significant differences between the groups at each specific time interval. Figure 6 shows a clearly decreasing trend in the amount of pain felt over the 24hr period for all the four groups respect to the PCA and time.

Table 6. Pain Perceived by Subjects over a 24hr Period Using the Visual Analogue Scale (in Rank 0-10) *

group	Time after operation									
	Zero	half	one	one-half	two	three	four	eight	sixteen	twenty-four
1	8.04±2.65	7.27±2.34	6.77±2.29	5.81±2.19	5.58±2.13	6.00±1.57	5.65±1.56	4.81±1.38	4.46±1.38	3.50±1.27
2	7.92±2.26	7.29±2.19	5.83±1.98	4.63±1.69	3.83±1.39	4.38±1.61	4.17±1.70	3.54±1.54	3.04±1.20	2.54±0.86
3	8.59±1.71	6.95±2.65	6.45±2.78	6.05±3.03	5.48±3.02	4.73±2.30	4.14±2.11	3.86±1.71	3.55±1.67	2.68±1.63
4	7.07±3.44	5.07±3.62	3.93±2.98	3.57±2.96	3.14±2.30	3.00±2.27	2.71±1.83	2.57±1.41	2.00±1.75	1.21±1.31

*comparison sees below, standard deviations are also given.

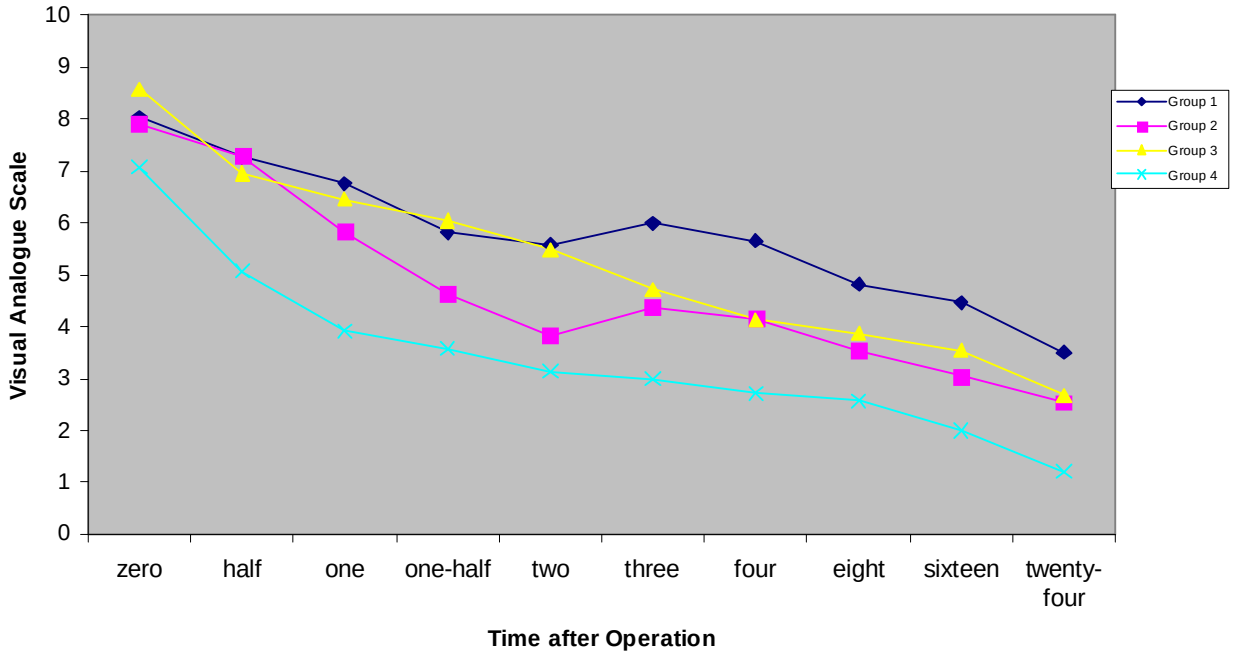

Figure 6. Pain Perceived by Subjects over a 24hr Period Using the Visual Analogue Scale

Differences were found between the means at two hours post-operatively, $F(3,42) = 2.66$, $p<0.10$; three hours post-operatively, $F(3,42) = 3.68$; $p<0.05$, four hours post-operatively, $F(3,42) = 4.33$, $p<0.05$; eight hours post-operatively, $F(3,42) = 3.33$, $p<0.05$; sixteen hours post-operatively, $F(3,42) = 4.25$, $p<0.05$; and twenty-four hours, $F(3,42) = 4.67$, $p<0.01$. Further post-hoc analysis showed that at one hour post-operatively, groups 1 and 4 were different to each other at the $p<0.10$ level. Also at three hours, group 1 ($M=6.05$) was significantly higher, at the $p<0.05$ level, than group 4 ($M=3.00$). This difference was also found at four hours, group 1 ($M=5.65$) and group 4 ($M=2.71$); eight hours, group 1 ($M=4.81$) and group 4 ($M=2.57$); sixteen hours, group 1 ($M=4.46$) and group 4 ($M=2.00$); and twenty-four hours, group1 ($M= 3.50$) and group 4 ($M=1.21$). M corresponds to the mean values as given in Table 6.

Both post-hoc comparison tests indicate that group 4 was significantly different from groups 1, 2, and 3 at twenty-four hours.

5.4 Patient Controlled Analgesia Doses

A one-way ANOVA was applied to determine the differences between the means over the four time intervals for PCA doses requirement (Table 7).

Table 7. Dose of Patient Control Analgesia Delivered (in mg)

	Means over the four time intervals for PCA doses delivered			
Group	**POR**	**one-eight**	**eight-sixteen**	**sixteen-twenty four**
1	4.08±1.66	18.08±5.64	10.88±4.50	9.67±3.30
2	5.17±2.98	17.73±3.52	8.28±2.50	7.55±2.37
3	4.58±1.31	15.34±2.80	7.68±3.55	8.13±4.66
4	2.30±2.00	14.22±3.55	8.30±3.67	6.77±3.43

Standard deviations are also given

Significant differences were found, $F(3,43) = 3.69$, $p<0.05$, in the Post Operative Room (POR) between the groups. Post-hoc analysis confirmed and found that group 4 (M=2.30) was significantly lower than groups 2 (M=5.17), and 3 (M=4.58). Post-hoc comparison tests indicate that mean PCA doses in the POR, for group 4 was significantly different from group 2 and 3. Mean PCA doses between groups 1 and 4 have no differences. These differences demonstrated in Table 7 and Figure 7. There was also found that differences between the groups between one and eight hours post-operatively, $F(3,43) = 2.33$, $p<0.10$. However post-hoc analysis did not confirm this finding between any of the four groups.

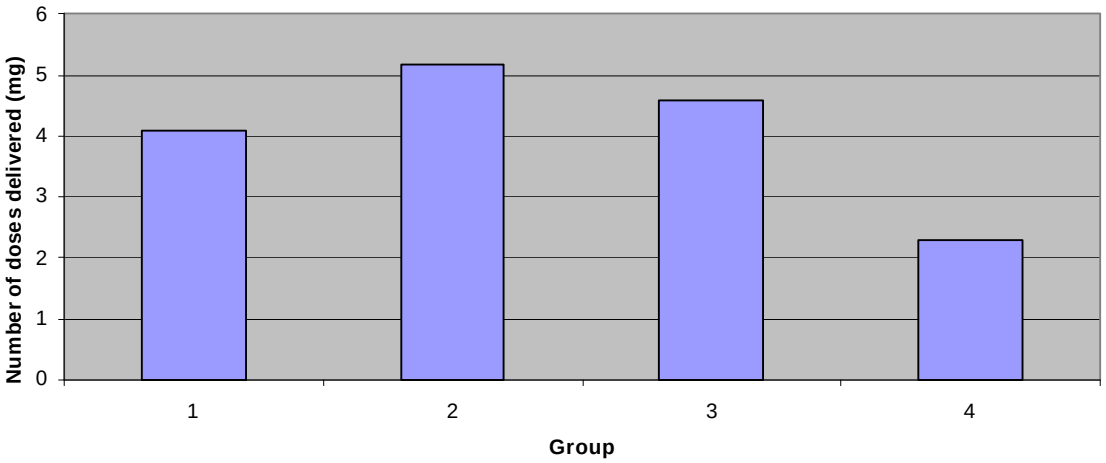

Figure 7. PCA Doses Delivered in the Post-Operative Room

5.5 Patient Controlled Analgesia Doses Demanded

To compare the mean amount of PCA demands of the four groups over the 24 hours post-operative (post-operation room: POR; one to eight hours; eight to sixteen hours and sixteen to twenty four hours) (Table 8), a one-way ANOVA with S.N.K and Tukey-HSD post-hoc tests was applied.

Table 8. Means of Patient Controlled Analgesia Demanded by Subjects of 24hrs Post-Operatively (in Times of Requests)

	Means of Patient Controlled Analgesia Demanded by Subjects of 24hrs Post-Operatively			
Group	POR	one-eight	eight-sixteen	sixteen-twenty four
1	15.08±11.34	49.54±34.61	22.08±14.03	12.92±6.06
2	30.83±28.98	55.75±36.76	13.08±10.18	8.75±6.44
3	13.00±4.95	29.75±13.21	12.25±9.20	10.17±10.43
4	5.90±4.32	22.30±19.90	11.80±12.41	7.50±5.37

Standard deviations are also given

Table 8 shows that the four groups have a similar trend within 24 hours postoperatively. However, significant differences were found between the means at the Post Operating room, $F(3,43) = 4.80$, $p<0.01$, and one to eight hours postoperative, $F(3,43) = 3.49$, $p<0.05$. Post-hoc analysis confirmed the significant difference between the means at one to eight hours postoperative that group 2 (M=55.75) was significantly higher than group 4 (M=22.30).

Post-hoc analysis also confirmed that group 2 (M=30.83) was significantly higher than group 3 (M=13.00) and group 4 (M=5.90) at the POR. No other significance was found between means.

5.6 Total Patient Controlled Analgesia Doses and Demands

As demonstrated in Table 9, there was no significant difference between the total PCA doses times given for the four groups over twenty-four hour's period post-operatively. However, a one way ANOVA was applied to compare the groups for total PCA doses demanded and significant differences were found between the groups $F(3,42) = 3.59$, $p<0.05$. Post-hoc analysis confirmed the difference between groups one (M=84.54) and four (M=41.60). Moreover, differences were found between the four groups for the amount of analgesia delivered in mg, $F(3,43) = 2.45$, $p<0.10$. Post-hoc analysis confirmed this finding between group one (M=38.63) and four (M=29.29).

Table 9. Total PCA Demanded and Delivered (in mg)

	Total PCA doses given for the four groups over 24 hour period post-operatively		
Group	Times Delivered 24hr	Times Demand 24hr	Dosage Delivered 24hr
1	29.16±11.79	84.54±38.66	38.63±11.08
2	31.82±11.98	74.18±39.33	34.20±6.40
3	27.75±11.78	52.17±21.87	31.14±8.15
4	23.30±11.93	41.60±36.47	29.29±8.89

Standard deviations are also given

Chapter 6

Discussion

In this study, the effects of Silver Spike Point (SSP) therapy, also known as needle-free electroacupuncture (EA), at classical bilateral acupuncture points (Zusanli, ST36) on postoperative pain and opioid-related side effects are examined.

6.1 Subjects' Recruitment

The study would have been of greater value if an adequate numbers of subjects were available in Australia as well as Taiwan, as a comparison of culture differences could have been explored. However, the experiment required a high level of hospital and patients' collaboration which was achieved at the China Medical University Hospital, Tai Chung, Taiwan.

6.2 Post-operation General Conditions

To improve subjects' time of first bowl movement, time of first ambulation and opioid related effects after the operation, ST36 is expected to regulate bowl movement, relieve abdominal pain and improving energy (Yang, 1997). The results of first bowl movement time and first ambulation time have not showed significant differences may be related to the small number of subjects in each group or other factors awaits to be studied.

The general theory of acupuncture's effect on pain relief is based on the premise that there are patterns of energy flow (qi) through the body that are essential for health. Disruptions of this flow are believed to be responsible for disease. Acupuncture may correct imbalances of flow at identifiable points close to the skin. Acupuncture points are located along the meridians, and when stimulated, cause predictable effects (Yang, 1997).

ST36 can relieve abdominal pain because each meridian, in turn, is associated with an organ, tendons and muscles, and other meridians. Stomach meridian where ST36 locates passes the abdominal operative area. Modern science has measured the electrical charge at acupuncture points, thus corroborating the locations of the meridians as mapped by the ancients (Yang, 1997).

6.2.1 Time of First Bowel Movement and Time of First Ambulation

Postoperative ileus is a transient impairment of bowel motility that is usually considered an inevitable response to surgery. It is a very common cause of delay in returning to normal gastrointestinal motility after abdominal surgery. The average duration of ileus after major abdominal surgery varies depending on which part of the digestive system is affected. Postoperative ileus is one of the most common causes of prolonged hospital stay following abdominal surgery. It appears the most likely causes of postoperative ileus are surgical manipulation of the bowel and stimulation of opioid receptors.

Clinically, acupuncture or acupressure on certain acu-points, especially ST36 can initiate intestinal movement, shorten the time of the first “breakingwind” and bowel movement. In our study, the mean time of the first bowel movement was 37.54, 38.03, 35.50, and 33.30 hours postoperatively in the control, sham, high and low EA groups respectively. There are no significant differences between the four groups. This may be related to the small sample size and may warrant further research.

One of the goals of the postoperative pain management plan is early ambulation. Mobilization has been thought to increase bowel motility. In a previous study at Taiwan China Medical Hospital which compared SSP Therapy for the pain of post-abdominal surgery with epidural anesthesia with regard to it’s the time of re-ambulation and time of first breaking wind, it was found that in the first 24 hours after surgery, 42.9% of patients in the SSP therapy group needed no analgesics. This percentage was significantly higher than in the control group. Moreover, the time of re-ambulation was significantly shorter in the SSP group than the control group, although no difference was seen for the first time of breaking wind between the two groups (Umeki et al., 1990).

6.2.2 Opioid Related Side Effects

Opioids are the principal treatment options for moderate to severe pain. Their use is also associated with the development of tolerance, defined as the progressive need for higher doses to achieve a constant analgesic effect. Opioids produce analgesia by binding to opioid receptors both within and outside the central nervous system. Opioid peptides and their receptors are widely distributed in the central nerves system (CNS), particularly in relation to known nociceptive pathways. Three opioid peptides are known to be involved in analgesia: enkephalins are present in laminae I and V of the dorsal horn and the PAG; beta-endorphin is found in the PAG and the arcuate nucleus of the hypothalamus; dynorphin is found throughout the spinal cord (Ernst and White, 2001). Opioid analgesics are classified as full agonists, partial agonists, or mixed agonist–antagonists, depending on the manner in which they interact with opioid receptors. In clinical practice, 30-60% of opioid-naive patients developed nausea and/or vomiting with initiation of opioid therapy. It is important to remember that the pain and anxiety associated with pain can cause nausea. The extent to which nausea and vomiting are mediated by opioid receptors is debateable. Some of the effects may come from stimulation of opioid receptors at the chemoreceptor trigger zone in the medulla.

Unrelieved pain after surgery can lead to complications, prolonged hospital stay, and delayed recovery. Because of side effects from opioids and differences in response, it is important to use non-pharmacological methods in addition to analgesics to decrease patient discomfort and anxiety. In our study, the efficacy of SSP needle-free EA to prevent postoperative opioids side effects had been assessed.

Several studies (see Chapter 2) have shown that in addition to reducing postoperative pain, non-pharmacological techniques such as acupuncture and electroacupuncture have the effect of decreasing postoperative nausea and vomiting. In our study, opioid related side effects were found in all groups. There are no significant differences between sham-EA, low-EA, and high-EA groups, but the control group had a relatively low side effect percentage (38.5%) than the other groups. In the group 2 (sham-EA), 58% subjects were found to have different

levels of side effects to those in group 3 (high-EA). However, the low-EA group had the highest degree (60%) of side effects.

6.2.3 PCA Demand and Doses

A similar study conducted by Lin (1996), explored the effect of high and low frequency electroacupuncture in pain after lower abdominal surgery. The study was designed to examine the effects of pre-operative EA at the classical bilateral acupuncture point of ST36 Zusanli on post-operative pain and opioid-related side effects. After surgery all patients were administered PCA of morphine. Post-operative pain was evaluated by recording the time of the first required analgesic, the total number of PCA administration, the total amount of morphine required by PCA, and the patient's subjective measure of pain via the VAS. The results of Lin's study were that the first time of analgesic request was 10, 18, 28, and 28 minutes in the control, sham, low, and high EA groups respectively. In addition, during the first 24 hours 21, 43, and 61% in the sham, low, and high EA groups decreased the total amount of morphine required respectively.

In our study, the results were that the total amount of PCA demanded was 50, 56, 30, and 22 times (button pressed) in the control, sham, high and low EA groups respectively. The PCA doses delivered in the postoperative room was 4.1, 5.2, 4.6, and 2.3 mg in the control, sham, high and low EA groups respectively. However, the total amount of dose delivery during the first 24 hours decreased to 53, 43, 53, and 48% in the control, sham, high and low EA groups respectively.

6.2.4 Pain Intensity

To assess the effect of acupuncture in the treatment of postoperative pain, Grube (2000) reported that a comparative study was conducted between three randomized groups with patients after defined operations (vaginal and laparoscopic hysterectomy, laparoscopic appendectomy), all patients received patient controlled analgesia (PCA) with piritramid. Group 1 (n = 18) received PCA and acupuncture after a defined time table; Group 2 (n = 17) received PCA and 1 g metamizol at the same time; Group 3 (n = 17) PCA only. Results

indicated that the use of acupuncture (group 1) lead to a reduction of piritramid application of more than 50 percent compared to group 3. In group 2, the consumption of piritramid was less than in group 3, but still higher than in group 1. The researchers also noticed that acupuncture reduced nausea and vomiting. They concluded that using scientific and reproducible parameters, acupuncture proved to be effective in the management of postoperative pain, nausea and vomiting. Especially multimorbid patients with risk of operation related or pharmacological side effects benefit from acupuncture. There was no effect of acupuncture regarding blood pressure and heart rate.

In our study, pain was assessed subjectively via the visual analog scale (VAS). The results of the study showed that there were significantly lower mean pain scores in the study groups compared with the control group. Pain assessment, for the first two hours, was every half hour, and subsequently at 3^{rd}, 4^{th}, 8^{th}, 16^{th} and 24^{th} hour by VAS. All groups had high mean pain scores at zero hour. In Group 1 and 4, the difference was significant at the 1^{st}, 3^{rd} and 4^{th} hours. However, in Group 1 and 3, the significant difference was shown at the 2^{nd} hour and parallel to the 24^{th} hour. These findings demonstrate that pre- and postoperative treatment with low EA can be clinically significant in subjects undergoing hysterectomy. It therefore seems that both acupuncture and SSP needle-free EA can help with post-operative pain management. In our study, blood pressure and heart rate were not analysied as part of the research data.

These results of the pain relief in this study could be supported by the theory outlined by Hyodo and Kitade (1979), that endorphins can be produced by SSP electrode stimulation as well as by acupuncture, both of the two modalities provide the same analgesic effect. The theory was also supported by Pomeranz and Chiu (1976) that, on the opposite, Naloxone, an anti-narcotic substance, reverses, when administered, the analgestic effect of endorphins because it combine with morphine receptors more strongly than endorphins do. The results of the study may be interpreted that low frequency surface point stimulation such as SSP is also related to endorphins released in the body.

Chapter 7

Conclusion

This study of SSP needle-free EA recorded changes in the time of first bowel movement and ambulation, opioid related side effects, total amount of PCA demand, and total amount of PCA doses. The results of PCA doses demanded by subjects indicated that there was no significant difference between the total PCA doses given for the four groups over twenty-four hour period post-operatively. However, a one way ANOVA was applied to compare the groups for total PCA doses demanded and significant differences or clinical benefits were found between the groups. Moreover, significant differences or clinical benefits were found between the four groups for the amount of analgesia delivered. Silver spike point needle-free electro-acupuncture has performed positive effects for postoperative pain management.

The findings of this study are important, especially for those patients who seek nonpharmacological analgesia without side effects. Although further study is needed to ultimately determine whether SSP needle-free EA has a place in the postoperative pain treatment, this study shows that SSP needle-free EA may be able to make a contribution as an adjunct to other forms of medical intervention, for post-operative surgical pain. Arguably this ‘needle free approach’ has benefits for patients who have difficulties with traditional acupuncture needling and at the same time are interested in a non-pharmacological approach to treating pain.

References

Acupuncture: Review and Analysis of Reports on Controlled Clinical Trials. P5. World Health Organization: 1999

Alkaissi A, Evertsson K, Johnson VA, et al. P6 acupressure may relieve nausea and vomiting after gynecological surgery: an effectiveness study in 410 women. *Can J Anesth* 2002;49(10):1034-9.

Andersson, S. and Lundeberg, T. Acupuncture – from empiricism to science: functional background to acupuncture effects in pain and disease. *Med Hypotheses* 1995;45:271–281.

Barratt S. *Advances in Acute Pain Management*. In Cousins MJ, Bridenbaugh PO. (Eds.) Neural Blockade in Clinical Anaesthesia and Management of Pain. J. B. Lipincott, Philadelphia: 22-47, 1997.

Basbaum, A.I. and Fields, H.L. (1984) Endogenous pain control systems: brain-stem spinal pathways and endorphin circuitry. *Annu Rev Neurosci* 1984;7:309–338.

Benzer H, Bischko J, Kropej H, Pauser G, Baum M, Thoma H. Acupuncture analgesia. (Preliminary report on the application of acupuncture within the framework of anesthesiology). *Anaesthesist* 1972;21(11):452-5.

Bing Z, Villanueva L. Le Bars D. Acupuncture and diffuse noxious inhibitory controls: naloxone-reversible depression of activities of trigeminal convergent neurons. *Neuroscience*, 1990;37:809–818.

Blalock JE. Production of peptide hormones and neurotransmitters by the immune system. *Chem Immunol* 1992;521-24.

Bossy J. Immune systems, defense mechanisms and acupuncture: Fundamental and practical aspects. *Am J Acupunct* 1990;18(3):219-32.

Bowsher D. *Mechanism of acupuncture*. In: Filshie J, White A, eds. Medical acupuncture. Edinburgh, Scotland: Churchill Livingstone; 1998:69-80.

Brian CF and Richard A E, *Acupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines*. Council of Acupuncture and Oriental Medicine Associations and Foundation for Acupuncture Research. August 2004.

Bruce P, Stux G, eds. *Scientific Bases of Acupuncture*. Springer-Verlag, Berlin, 1989.

Burns JW, Hodsman NB, McLintock TT, Gillies GW, Kenny GN, McArdle CS. The influence of patient characteristics on the requirements for postoperative analgesia. *Anaesthesia*. 1989; 44(1): 2-6.

Cahn AM, Carayon P, Hill C, Flamant R. Acupuncture in gastroscopy. *Lancet* 1978;1:182-3.

Chang FC, Tsai HY, Yu MC, et al. The central serotonergic system mediates the analgesic effects of electroacupuncture on Zusanli (ST36) acupoint. *Biomed Sci* 2004;11(2):179-85.

Chapman CR. Psychological aspects of postoperative pain control. *Acta Anaesthesiologica Belgica* 1992;43:41-52.

Chen L, Tang J, White PF, Sloninsky A, Wender RH, Naruse R *et al*. The effect of location of transcutaneous electrical nerve stimulation on postoperative opioid analgesic requirement: acupoint versus nonacupoint stimulation. *Anesth Analg* 1998;87(5):1129-34.

Chen L. *Acupuncture in Pain Management*. www.painmanagementrounds.org 2005 Volume 2, Issue 7

Chen S, Ma SX. Nitric oxide in gracile nucleus mediates depressor response to acupuncture (ST 36). *J Neurophysiol* 2003;90(2):780-5.

Chiang CY, Chang CT. Peripheral afferent pathway for acupuncture analgesia. *Sci Sin* 1973;16:210-217.

Christensen PA, Noreng M, Anderson PE, Nielsen JW. Electro-acupuncture and postoperative pain. *Brit J Anaesth* 1989;62:258-262.

Christensen PA, Rotne M, Vedelsdal R, Jensen RH, Jacobsen K, Husted C. Electroacupncture in Anaesthesia for Hysterectomy. *Brit J Anesth* 1993;71:835-838.

Christoph SB. Pain Assessment: *The Problem of Pain in the Critically Ill Patient*. In: Gould KA, Litwack K. eds., Critical Care Nursing Clinics of North America. Philadelphia: Harcourt Brace Jovanovich Inc., Vol 3 No 1, Mar 1991.

Citron ML, Kalra J. *Patient-Controlled Analgesia for the Treatment of Oncology Pain*. In: Ferrante MF, Ostheimer GW, Covino BG eds., Patient-Controlled Analgesia. Blackwell Scientific Publ., 1990.

Coleman DL. Non-narcotic and narcotic alternatives and their effect on pulmonary function. *Chest* 1987;92:520-526.

Cronin KD, Davies MJ. Intercostal block for postoperative pain relief. *Anaesth Intens Care*. 1976;4:259-61.

Csemiczky G, Landgren BM, Collins A. The influence of stress and state anxiety on the outcome of IVF- treatment: psychological and endocrinological assessment of Swedish women entering IVF-treatment. *Acta Obstet Gynecol Scand* 2000;79:113–118.

Dai SM. *Acupuncture: Questions & Answers*. 75-79, Chi-Yeh, Taiwan, 1987

d'Amours H, Ferrante M. Postoperative Pain Management. *JOSPT* 1996;24(4):227-234.

Davidson A. *Acupuncture*. 2000 in Prange. www.drprange.com/acupuncture.htm.

De Domenico G. Pain Relief With Interferential Therapy. *Aust J Physiother* 1982;28(3):14-18.

Dickinson JA, Hill AM. The Incidence of Hysterectomy and its effects on the probability of Developing Uterine Cancers. *Community Health Studies* 1988;11(2):176-180.

Dimmond EG. Medical education and care in People's Republic of China. *JAMA* 1971; 6;218:552–1557.

Dimond EG. Acupuncture anesthesia. Western medicine and Chinese traditional medicine. *JAMA* 1971;218(10):1558-63.

Drasner K, Katz JA, Schapera A. *Control of Pain*, in Hall JB, Schmidt GA, Wook LDH. eds, Prinicples of Critical Care, Chapter 82, McGraw-Hill (Health Professions Division), 1992.

Editorial: Postoperative pain. *Anaesth Intens Care* 1976;4:95-96.

Eige S. PCA Opioids: Commons Side Effects and Their Treatment. In: Sinatra R. S., Hord A. H., Ginsberg B., Preble L. M. eds., *Acute Pain, Mechanisms and Management*. Mosby Year Book, St Louis USA, 1992

Eisenberg DM, Davis RB, Ettner SL, et al. Trends in alternative medicine use in the United States 1990-1997, results of a follow up national survey. *JAMA* 1998;280(18):1569-75.

Ernst E, Pittler MH. The effectiveness of acupuncture in treating acute dental pain: a systematic review. *Brit Dent J* 1998;184(9):443-7.

Ernst E, White A. Prospective studies of the safety of acupuncture: a systematic review. *Am J Med* 2001;110(6)481-485.

Fennen B, Esquivel R. A*cupuncture and Electroacupuncture: Evidence-Based Treatment Guidelines*, August, 2004. Council of Acupuncture and Oriental Medicine Associations and Foundation for Acupuncture Research.

Ferrante MF, Covino BG. Patient-Controlled Analgesia: *A Historical Perspective*. In: Ferrante MF, Ostheimer GW, Covino BG. eds., Patient-Controlled Analgesia. Blackwell Scientific Publ., 1990.

Follin SL, Charland SL. Acute Pain Management: Operative of Medical Procedures and Trauma. *Ann Pharmacother* 1997;31:1068-1075.

Fujiwara R, Tong ZG, Matsuoka H, Shibata H, Iwamoto M, Yokoyama MM. Effects of acupuncture on immune response in mice. *Int J Neurosci* 1991;57(1-2):141-50.

Fulton J. S., Johnson G. B., Using High-Dose Morphine to Relieve Cancer Pain. *Nursing* 1993;23:34-39.

Galloway DJ, Boyle P, Burns HJG, Davidson PM, George WD. A clinical assessment of electro-analgesia following abdominal operations. *Surgery, Gynecol and Obstet* 1984;159:453-456.

Gill KM, Ginsberg B, Muir M, Sykes D, Williams DA. Patient-Controlled Analgesia in Postoperative Pain: The Relation of Psychological Factors to Pain and Analgesic Use. *Clin J Pain* 1990;6:137-142.

Gissen AJ, Covino BG, Gregus J. Differential sensitivity of fast and slow fibres in mammalian nerve. III. Effect of etidocaine and bupivacaine on fast/slow fibres. *Anesth. Analg* 1982;61: 570-575.

Greif R, Laciny S, Mokhtarani M, Doufas AG, Bakhshandeh M, Dorfer L *et al*. Transcutaneous electrical stimulation of an auricular acupuncture point decreases anesthetic requirement. *Anesthesiology* 2002;96(2):306-12.

Grube Th. *Postoperative pain management with acupuncture*. Abstracts of ICMART 2000 International Medical Acupuncture Congress. www.icmart.org/icmart00/abstract.

Guo HF, Wang XM, Tian JH, et al. 2 Hz and 100 Hz electro-acupuncture accelerate the expression of genes encoding three opioid peptide in the rat brain. *Sheng Li Xue Bao* 1997;49(2):121-7.

Gupta S, Francis JD, Tillu AB, Sattirajah AI, Sizer J. The effect of pre-emptive acupuncture treatment on analgesic requirements after day-case knee arthroscopy. *Anaesthesia* 1999;54(12):1204-7.

Hahm ET, Lee JJ, Lee WK, et al. Electroacupuncture enhancements of natural killer cell activity suppressed by anterior hypothalamic lesions in rats. *Neuroimmunomodulation* 2004;11(4):268-72.

Han JS, Terenius L. Neurochemical basis of acupuncture analgesia. *Ann Rev Pharmacol Toxicol* 1982;22:193-220.

Han JS, Yoon SH, Cho YW, et al. Inhibitory effects of electroacupuncture on stress response evoked by tooth-pulp stimulation in rats. *Physio Behav* 1999;66(2):217-22.

Han JS. Acupuncture and endorphins. *Neuroscience Lett* 2004;361:258-261.

Herget HF, L'Allemand H, Kalweit K, Walter P, Hehrlein FW, Schlepper M. [Combined acupuncture analgesia and controlled respiration. A new modified method of anesthesia in open heart surgery (author's transl)]. *Anaesthesist* 1976;25(5):223-30.

Hopwood V. Acupuncture in Physiotherapy. *Complement Ther Med* 1993;1(2):100-104.

Hou JG, Liu HL, He TX et al. Study of the acupuncture effect on monoamine transmitters in rabbit plasma and brain tissue by high performance of liquid chromatography with electrochemical detection. *Se Pu* 2002;20(2):140-3.

Hseih CL, Kwo CC, Chen YS. Analgesic Effect of Electrical Stimulation of Peripheral Nerves with Different Electric Frequencies Using the Formalin Test, *Am J Chin Med* 2000;28(2):291-299.

Hsieh JC, Stahle-backdahl M, Hagermark O, et al. Traumatic nociceptive pain activates the hypothalamus and periaqueductal gray: a positron emission tomography study. *Pain* 1995;64:303-314.

Huang C, Wang Y, Chang JK, et al. Endomorphine and mu-opioid receptors in mouse brain mediate the analgesic effect induced by 2 Hz but not 100 Hz electroacupuncture stimulation. *Neurosci Lett* 2000;295(3):159-62.

Huang WS. *Acupuncture Science*. 3-13: 482-490, 213. Cheng-Chung, Taiwan, 1985.

Hui KK, Liu J, Marina O. The integrated response of the human cerebro-cerebellar and limbic system to acupuncture stimulation at ST 36 as evidenced by fMRI. *Neuro image* 2005;27(3):479-96.

Hyodo M, Kitade T. A guide to silver spike point (SSP) therapy. 2nd ed. Tokyo: The Silver Spike Point Therapy Study Group; 1979.

Hyodo M, Nakamura N, Yukimati T, Ohki J, Yoshida A, Inamori K, et al. The experience of acupuncture anesthesia. Masui. *Jap J Anesthesiol*. 1973;22:251–8.

Hyodo M, Nakamura N, Yukimati T, Ohki J, Yoshida A, Inamori K, et al. The experience of acupuncture anesthesia. Masui. *Jap J Anesthesiol* 1973;22:251–8.

Inamori K, Kitade T, Kawachi A, Akatsuka M, Masahiko O and Mori H. A study on sliver spike point therapy (SSP) stimulation for low back pain. Oriental Medicine and the Pain Clinic. 2000;30:1-7.

Ishimaru K. Effects of acupuncture analgesia on post-operative pain after abdominal surgery and the relationship of endogenous analgesic substances. Meiji Shinkyu Igaku. *Bull Meiji Univ Orient Med* 2000;26:11–22.

Ishimaru K, Kawakita K, Sakita M. Analgesic effects induced by TENS and electroacupuncture with different types of stimulating electrodes on deep tissues in human subjects. *Pain.* 1995;63:181–7.

Ishimaru K, Sekido R, Sakita M. Association between endogenous analgesia and meridians in LI4 (Hegu, Gokoku) point electro-acupuncture. Zen Nippon Shinkyu Gakkai Zasshi. *J Jap Soc Acupunct Moxibust* 2003;53:184–9.

Ishimaru K, Shinohara S, Iwa M, Kawakita K, Higuchi J, Watanabe S, et al. Effects of electrical acupuncture on deep pain threshold in human subjects. Meiji Shinkyu Igaku. *Bull Meiji Univ Orient Med*. 1991;8:27–33.

Ishimaru K, Shinohara S, Kitade T, Kouda H, Kudou D, Watanabe K, et al: Experimental Study to Increase Analgesic Effects for Pain Following Abdominal Surgery by Silver Spike Point Therapy. Meiji Shinkye Igaku, *Bull Meiji Univ Orient Med* 1989;5:1-6.

Ishimaru K, Shinohara S, Kitade T, Morioka T, Kudou D, Umeki N et al: Effect on Pain Threshold of Low Frequency Electrical Acupuncture (LFEA) and Silver Spike Point (SSP) Electrical Stimulation. Meiji Shinkyu Igaku. *Bull Meiji Univ Orient Med* 1990;6:61-67.

Ishimaru K, Shinohara S, Kitade T, Morioka T, Kudou D, Umeki N, et al. Effect on pain threshold of low frequency electrical acupuncture (LFEA) and silver spike point (SSP) electrical stimulation. Meiji Shinkyu Igaku. *Bull Meiji Univ Orient Med*. 1990;6:61–7.

Jacqueline F, White A. eds. *Medical Acupuncture: A Western Scientific Approach,* Chapters 6-9. Churchill Livingstone, London, 1998

Jadad AR, Carrol D, Glynn CJ, Moore RA, McQuay HJ. Morphine responsiveness of chronic pain: double-blind randomised crossover study with patient-controlled analgesia. *Lancet* 1992;339:1367-71.

Jankovic BD, Maric D. Enkephalins and anaphylactic shock: Modulation and prevention of shock in the rat. *Immunol Lett* 1987;15:153-60.

Jankovic BD, Maric D. Enkephalins and immunity. In vivo suppression and potentiation of humoral immune response. *Ann NY Acad Sci* 1987;496:115-25.

Jankovic BD. Neuroimmunomodulation: From phenomenology to molecular evidence. *Ann NY Acad Sci* 1994;741:1-38.

Jankovic BD. The immune microenvironment is a multisystem. *Immunol Lett* 1979;1:145-6.

Jaros JA. *The Concept of Pain*. In: Gould K. A., Litwack K. eds., Critical Care Nursing Clinics of North America, Philadelphia: Harcourt Brace Jovanovich Inc., Vol 3 No 1, Mar 1991.

Katayama I, Suzuki Y, Katayama T, Kochi T, Tsuzimoto Y, Matsumoto T, et al. Effect of the acupuncture anesthesia to gingival tissue by using the "Hoku" points. *Bull Josai Dent Univ*. 1977;6:219–23.

Kendall DE. *Dao of Chinese Medicine: Understanding an Ancient Healing Art*. 2002. Oxford University Press.

Kendall DE. Scientific Model for Acupuncture, Parts 1 and 2. *Am J Acupunct* 1989,17:(3): 251-268; 17:(4)343-360.

Kenyon JN. *Modern Techniques of acupuncture*. New York: Thorsons Publ., 1983.

Kho HG, Eijk RJ, Kapteijns WM, van Egmond J. Acupuncture and transcutaneous stimulation analgesia in comparison with moderate-dose fentanyl anaesthesia in major surgery. Clinical efficacy and influence on recovery and morbidity. *Anaesthesia* 1991;46(2):129-35.

Kitade T, Hyodo M. The effects of stimulation of ear acupuncture points on the body's pain threshold. *Am J Chin Med*. 1979;7:241–52.

Kitade T, Minamikawa M, Hyodo M, Nakao K, Oki S, Imura H. ß-endorphin and ACTH concentrations in plasma and cerebrospinal fluid during acupuncture analgesia in human subjects. Touyouigaku to Peinkulinikku. *Oriental Medicine and the Pain Clinic* 1980;10: 116–20.

Kluger MT, Owen H. Patients' Expectations of patient controlled analgesia. *Anaesthesia*. 1990;45(12):1072-4.

Kotani N, Hashimoto H, Sato Y, Sessler DI, Yoshioka H, Kitayama M et al. Preoperative intradermal acupuncture reduces postoperative pain, nausea and vomiting, analgesic requirement, and sympathoadrenal responses. *Anesthesiology.* 2001;95(2):349-56.

Kurokawa M. Analgesic effects of SSP therapy on postoperative pains. *Oriental Medicine and the Pain Clinic.* 1979;9:1.

Lange PM, Dahn MS, Jacobs LA, Patient-controlled analgesia versus intermittent analgesia dosing. *Heart Lung* 1988;17:495-8.

Lao L, Bergman S, Langenberg P, Wong RH, Berman B. Efficacy of Chinese acupuncture on postoperative oral surgery pain. *Oral Surg Oral Med Oral Path* 1995;79:423-428.

Lee A, Chan S. Acupuncture and anaesthesia. *Best Pract Res Clin Anaesthesiol* 2006;20(2):303-14.

Lee A, Done ML. The use of nonpharmacologic techniques to prevent postoperative nausea and vomiting: a meta-analysis. *Anesth Analg* 1999;88(6):1362-9.

Lee JH, Beitz AJ. The distribution of brain stem and spinal cord nuclei associated with different frequencies of electroacupuncture analgesia. *Pain* 1993;52(1):11-28.

Lin JG, Lo MW, Wen YR, et al. The effect of high and low frequency electroacupuncture in pain after lower abdominal surgery. *Pain* 2002;99(3):509-14.

Lin JG. *New Acupuncture Discussions*. China medical College, Taiwan, 1992.

Lin JG. A Concept in Analgesic Mechanisms of Acupuncture. Chin Med J 1996;109(3): 179-192.

Liu W, Gong CZ. *Acupuncture: Natural, Safe and Effective Healing Method for Pain*. www.tcmpage.com/hppain.html. Cited on Oct 17, 2007.

Liu XY, Zhou HF, Pan YL. Electroacupuncture stimulation protects dopaminergic neurons from inflammation-mediated damage in medial forebrain bundle transected rats. *Exp Neurol* 2004;189(1):189-196.

Liu YC. *Basic Theories of Traditional Chinese Medicine*. Xue Yuan Publishing House, Beijing, 1998.

Lo MW. *Effects of Electro-acupuncture on Postoperative Pain Relief in the Lower Abdominal Surgery*. China Medical College, Taiwan, 1998.

Lu DP. Acupuncture anaesthesia/analgesia for pain and anxiety control in dental practice Part 2: Techniques for clinical applications. (Review) compendium 14-4: 464-468, 470-472, 1993.

Lubenow TR, Ivankovich AD. *Patient-Controlled Analgesia for Postoperative Pain*. In: Gould KA, Litwack K. eds., Critical Care Nursing Clinics of North America. Philadelphia: Harcourt Brace Jovanovich Inc., Vol 3 No 1, Mar 1991.

Lundeberg T, Eriksson SV, Theodorsson E. Neuroimmunomodulatory effects of acupuncture in mice. *Neurosci Lett* 1991;128(2):161-4.

Lundeberg, T, Acupuncture Mechanisms and the Relevance to Clinical Practice. Acupunct in Med 2002;20(2-3):109-120.

Lytle CD. *An Overview of Acupuncture*. 1993. Washington, DC: United States Department of Health and Human Services, Health Sciences Branch, Division of Life Sciences, Office of Science and Technology, Center for Devices and Radiological Health, Food and Drug Administration.

Maric D, Jankovic BD. Enkephalins and immunity. II: In vivo modulation of cell-mediated immunity. *Ann NY Acad Sci* 1987;496:126-36.

Marks RM, Sachar EJ. Undertreatment of medical inpatients with narcotic *Analg Annals of Internal Med* 1973;78:173-181.

Martelete M, Angelo MC. Comparative study of the analgesic effect of Transcutaneous Nerve Stimulation (TNS); Electro-acupuncture (EA) and meperidine in the treatment of postoperative pain. *Acupunct Electrother Res* 1985;10:183-193.

Martelete M, Fiori AM., Comparative study of the analgesic effect of transcutaneous nerve stimulation (TNS); electroacupuncture (EA) and meperidine in the treatment of postoperative pain. *Acupunct Electrother Res* 1985;10(3):183-93.

Mather LE, Owen H. *The Pharmacology of Patient-Administered Opioids*. In: Ferrante M. F.,Ostheimer G. W.,Covino B. G. eds., Patient-Controlled Analgesia. Blackwell Scientific Publ., 1990.

Mayer DJ, Price DD, Rafii A. Antagonism of acupuncture analgesia in man by the narcotic antagonist naloxone. *Brain Res* 1977;121:368-372.

McCormack HM. Clinical applications of visual analog scales: A critical review. *Psychol Med* 1988;18:1007-1019.

McGurk M, Robinson P. Clinical comparison of Dexketoprofen Trometamol, Ketoprofen and Placebo in postoperative dental pain. *J Clin Pharmacol* 1998;38:46-54.

McQuay HJ, Bullingham RE, Moore RA, Evans PJ, Lloyd JW. Some patients don't need analgesics after surgery. *J Roy Soc Med* 1982;75:705-708.

McQuay HJ. Pre-emptive analgesia. Brit J Anaesth 1992;69:1-3.

Melzack R. *Psychological Aspects of Pain: Implications for Neural Blockade*. In: Cousins M. J., Bridenbaugh P. O., eds., Neural Blockade - in Clinical Anesthesia and Management of Pain, Chapter 25, pp845-860, 2nd ed., J. B. Lippincott Company, Philadelphia, 1988.

Melzack, R., Wall, P. Pain mechanisms: a new theory. *Science* 1965;150: 971-977.

Meredith TJ, Vale JA. Non-narcotic analgesics: problems of overdosage. *Drugs* 1986;32:177-205.

Merskey H., Pain terms: A list with definitions and notes on usage. Recommended by the International Association for the Study of Pain Subcommittee on Taxonomy. *Pain* 1979;6: 249.

Moore DC. Intercostal nerve block for postoperative somatic pain following surgery of thorax and upper abdomen. *Brit J Anaest* 1975;47:284-88.

Moote CA. Continuing Medical Education - The Prevention of Postoperative Pain. *Can J Anaesth* 1994;41(6):527-33.

Murphy DF. Continuous intercostal nerve blockade for pain relief following cholecystectomy. *Brit J Anaesth* 1983;55:521-24.

Napadow V, Markris N, Lin J, et al. Effects of electroacupuncture versus manual acupuncture on the human brain as measured by fMRI. *Hum Brain Mapp* 2005;24(3):193-205.

National Institutes of Health, *National Center for Complementary and Alternative Medicine. Acupuncture Information and Recources*. Gaithersburg, MD, 2001

NIH Consensus Conference. Acupuncture. *JAMA* 1998;280(17):1518-24.

Notcutt WG, Morgan RJ. Introducing patient-controlled analgesia for postoperative pain control into a district general hospital. *Anaesth* 1990;45(5):401-6.

Papper EM, Brodie BB, Rovenstine EA. Postoperative pain: Its use in comparative evaluation of analgesia. *Surg* 1952;32:107-109.

Park HJ, Lim S, Joo WS, et al. Acupuncture prevents 6-hydroxy dopamine induced neuronal death in the nigrostriatal dopaminergic system in rat Parkinson's disease model. *Exp Neurol* 2003;180(1):93-8.

Parker RK, Holtman B, White PF. Patient-controlled analgesia: does a concurrent opioid infusion improve pain management after surgery? *JAMA* 1991;266:1947-52.

Plotnikoff NP. Opioids: immunomodulators. A proposed role in cancer and aging. *Ann NY Acad Sci* 1988;521:312-22.

Pomeranz B and Chiu D. Naloxone blockade of acupuncture analgesia: endorphin implicated. *Life Sci* 1976;19:1757-1762.

Poulain P, Prichard Leandri E, Laplanche A. Electro-acupuncture analgesia in Major Abdominal and Pelvic Surgery: A Randomised Study. *Acupunct in Med* 1997;15(1):10-13.

Qian, XZ. *Achievements in scientific studies on acupuncture studies on acupuncture-moxibustion and acupuncture-anaethesia in China*. In Zhang XT, ed. Research on acupuncture-moxibustion and acupuncture-anaethesia. Beijing, Science Press, 1986:1-13.

Ramnero A, Hanson U, Kihlgren M. Acupuncture treatment during labor – a randomized controlled trial. *BJOG* 2002;109(6):637-44.

Rawal N, Sjostrand UH, Dahlstrom B, Nydahl PA, Ostelius J. Epidural morphine for postoperative pain relief: a comparative study with intra-muscular narcotic and intercostal nerve block. *Anaesth Analg* 1982;61:93-98.

Renckens CN. Alternative treatments in reproductive medicine: much ado about nothing: The fact that millions of people do not master arithmetic does not prove that two times two is anything else than four: Hermans WF, *Hum Reprod* 2002;17:528–533.

Roop Moyer SM, Howe CJ. Pediatric Pain Intervention in the PACU, *Crit Care Nursing Clin North Am* 1991;3:(1).

Rudolph H. *An Adaptive System for Patient-Controlled Analgesia*. Thesis. 1995. The University of Melbourne, Australia.

Rusy LM, Hoffman GM, Weisman SJ. Electroacupuncture prophylaxis of postoperative nausea and vomiting following pediatric tonsillectomy with or without adenoidectomy. *Anesthesiology* 2002;96(2):300-5.

Sakic B, Kojic L, Jankovic BD, Skokljev A. Electro-acupuncture modifies humoral immune response in the rat. *Acupunct Electrother Res* 1989;14(2):115-20.

Saso, R. Neuroimmunomodulation – A Scientific Foundation for an Ancient Skill. *Acupunct in Med* 2002;20(2-3):109-120.

Sato A, Sato Y, Schmidt RF. *The Impact of Somatosensory Input on Autonomic Functions.* Springer-Verlag, Heidelberg. 1997.

Schlager A, Boehler M, Puhringer F. Korean hand acupressure reduces postoperative vomiting in children after strabismus surgery. *Br J Anaesth* 2000;85(2):267-70.

Shen S, Bian JT, Tian JB, et al. Frequency dependence of substance P release by electroacupuncture in rat spinal cord. *Sheng Li Xiu Bao* 1996;48(1):89-93.

Sim EK, Xu PC, Pua HL, et al. Effects of electroacupuncture on intraoperative and postoperative analgesic requirement. *Acupuncture Med* 2002;20(2-3):56-65.

Skiland E, Fossen D, Heiberg E. Acupuncture in the management of pain in the labor. *Acta Obstet Gynecol Scand* 2002;81(10):943-8.

Sodipo JOA, Gilly H, Pauser G. Endorphins: Mechanism of Acupuncture Analgesia. *Am J Chinese Med* 1981;9(3):249-258.

Soussis I, Boyd O, Paraschos T, Duffy S, Bower S, Troughton P, Lowe J, Grounds R. Follicular fluid levels of midazolam, fentanyl, and alfentanil during transvaginal oocyte retrieval. *Fertil Steril* 1995;64:1003–1007.

Stanley TH, Cazallaa JA, Atinault A, Coeytaux R, Limoge A, Louville Y. Transcutaneous cranial electrical stimulation decreases narcotic requirements during neurolept anaesthesia and operation in man. *Anaesth Analg* 1982;62:836-866.

State of California, Business and Professions Code, Section 4927 (e).

Stener-Victorin E, Lundeberg T, Cajander S, et al. Steroid-induced polycystic ovaries in rats: effect of electro-acupuncture on concentrations of endothelin-1 and nerve growth factor (NGF), and expression of NGF mRNA in the ovaries, the adrenal glands and the central nervous system. *Reprod Biol Endocrinol* 2003;1(1):33.

Stener-Victorin E, Waldenström U, Nilsson L, Wikland M, Janson PO. A prospective randomized study of electro-acupuncture versus alfentanil as anaesthesia during oocyte aspiration in in-vitro fertilization. *Hum Reprod*. 1999;14: 2480–2484.

Stener-Victorin E, Waldenström U, Wikland M, Nilsson L, Hägglund L, Lundeberg, T. Electro-acupuncture as a peroperative analgesic method and its effects on implantation rate and neuropeptide Y concentrations in follicular fluid. *Hum Reprod* 2003;18(7):1454-1460

Stener-Victorin E, Wikland M, Waldenström U, Lundeberg T. Alternative treatments in reproductive medicine: much ado about nothing. Acupuncture - a method of treatment in reproductive medicine: lack of evidence of an effect does not equal evidence of the lack of an effect. *Hum Reprod* 2002;17:1942–1946.

Streitberger, K. Acupuncture in Anaesthesia. Advances in acupuncture mechanisms and clinical practice. Icmart 10th World Congress 2002. Edinburgh Conference Centre, Heriot-Watt University, Edinburgh, Scotland. 3rd - 6th May 2002. http://www.icmart.org/icmart02

Sugai GC, Freire Ade O, Tabosa A, et al. Serotonin involvement in the electroacupuncture and Moxibustion induced gastric emptying in rats. *Physiol Behav* 2004;82(5):855-61.

Taguchi, R. Acupuncture Anesthesia and Analgesia for Clinical Acute Pain in Japan**.** *eCAM* Advance Access published online on June 11, 2007.

Tamsen A, Hartvig P, Dahlstrom B, Lindstrom B, Holmdahl MH. Patient controlled analgesic therapy in the early postoperative period. *Acta Anaesthesiologica Scandinavica*. 1979;23(5): 462-70.

Tamsen A. *Patient-Controlled Analgesia: A Review of the Current State of Knowledge*. Seminars in Anesthesia, Vol. V, No 2 pp100-107, Jun 1986.

Tobias J. Postoperative Pain Management. *Pediatr Annals* 1997;26(8):490-497.

Torda, TA. Postoperative Analgesia. *Aust Prescriber* 1995;18(4):88-91.

Tortora GJ, Anagnostakos NP. *Principles of Anatomy & Physiology*. Harper Collins, New York, 1989.

Umeki N, Iwa M, Ishimaru K, Shinohara S, Kitade T, Hata K, et al. Silver Spike Point Therapy on the Pain of Post Abdominal Surgery. Meiji Shinkyu Igaku. *Bull Meiji Univ Orient Med* 1990;7:55-60.

Vickers AJ. Can acupuncture have specific effects on health? A systematic review of acupuncture antiemesis trials. *J R Soc Med* 1996;89(6):303-11.

Wan SM, Kain ZN. P6 acupoint injections are as effective as droperidol in controlling early postoperative nausea and vomiting in children. *Anesthesiology* 2002;97(2);359-66.

Wang H, Jiang J, Can X. Change of norepinephrine release in rats nucleus reticularis paragigantocellularis lateralis in acupuncture analgesia. *Zhen Ci Yan Jiu* 1994;19(1):20-5.

Wang Y, Wang S, Zhang W. Effects of naloxone on changes of pain threshold and contents of monoamine neurotransmitters in rat brain induced by EA. *J Tradi Chin Med* 1991;11(4):286-90.

Washisu M. (Nihonjuiseimeikadai), Postoperative pain and dysfunctional management by acupuncture. *J Vet Oriental Med*, 2006;14;2;23-25.

White A, MacPherson H. Reports on acupuncture safety. *Brit Med J* September 2, 2001.

White PF. Management of Postoperative Pain & Emesis. *Can J Anaesth.* 1995;42:1053-1055

White PF. Use of patient-controlled analgesia for management of acute pain. *JAM*. 1988;259: 243-7.

WHO Acupuncture review and analysis of report on controlled clinical trials. 2002. www.who.int.

Xu H, Ryan D and Li K. Clinical Investigation into the Effectiveness of Needleless Acupuncture in the Management of the Symptoms of Osteooarthritis of the Knee: A Preliminary, Single-blind and Sham-controlled Study. *Aust J Acupunct Chin Med* 2007;2(2):9-15.

Xu M, Aiuchi T, Nakaya K, et al, Effect of low frequency electric stimulation on in vivo release of cholecystokinin like immunoreactivity in medial thalamus of conscious rat. *Neurosci Lett* 1990;118(2):205-7.

Yan B, Li K, Xu J, et al. Acupoint-specific fMRI patterns in human brain. *Neurosci Lett* 2005;383(3):236-40.

Yang JS. *Acupuncture and Moxibustion* (Zhen Jiu Xue). 3rd edition. People's Public Health Press. 1997. Beijing, China.

Zhongan S, Aung S, Deadman P. The *Treatment of Pain with Chinese Herbs and Acupuncture*. Churchill Livingstone, 2002.

Zhou Y, Wang Y, Fang Z, et al. Influence of acupuncture on blood pressure, contents of NE, DA, 5-HT of SHR and interrelation between blood pressure and whole blood viscosity. *Zhen Ci Yan Jiu* 1995;20(3):55-61.

Zhu J, Xia Y, Cao X. Effects of noradrenaline and dopamine in preoptic area on acupuncture analgesia. *Zhen Ci Yan Jiu* 1990;15(2):117-22.

Zhu JM, He XP, Cao XD. Changes of release of beta-endorphin like immunoreactive substance and nor-adrenaline in rabbits preoptic area during acupuncture analgesia. *Sheng Li Xue Bao* 1990;42(2):188-93.

Zieglgansberger, W. Future Directions for Acupuncture Research. Acupuncture in Medicine 2002; 20(2-3):109-120. www.medical-acupuncture.co.uk/aimintro.htm