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Auricular Transcutaneous Electrical Stimulation: A Review

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AURICULAR TRANSCUTANEOUS ELECTRICAL STIMULATION: A REVIEW

by

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Bachelor of Science in Physical Therapy
University of North Dakota, 1996

An Independent Study
Submitted to the Graduate Faculty of the
Department of Physical Therapy
School of Medicine
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Master of Physical Therapy

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1997
This Independent Study, submitted by Greg R. Burton in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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(Chairperson, Physical Therapy)
PERMISSION

Title  Auricular Transcutaneous Electrical Stimulation: A Review

Department  Physical Therapy

Degree  Master of Physical Therapy

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Date  12-15-96
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ABSTRACT

Pain has oppressed man for centuries and is the most common symptom for which patients seek medical treatment. The goal of medical research has been to discover the simplest method of pain relief with the least detrimental or undesirable side effects. If pain is not treated successfully, it can lead to a chronic condition with crippling effects that can profoundly affect the individual's quality of life. Pain can also prevent the successful treatment of other disorders.

Auricular transcutaneous electrical stimulation (ATENS) is one of the most recent methods of pain management to arise from research. It combines both acupuncture and electrotherapy as a simple, non-invasive method of pain relief that does not have the detrimental or undesirable side effects that accompany other methods of pain management such as surgery or drugs.

The purpose of this literature review is to present the history by which ATENS has evolved, the theories for its effectiveness, and, finally, the clinical applications of ATENS for the physical therapist as suggested by research in multiple professions.
CHAPTER I

INTRODUCTION

Pain has oppressed man for centuries and is the most common symptom for which patients seek medical treatment. The goal of medical research has been to discover the simplest method of pain relief with the least detrimental or undesirable side effects. If pain is not treated successfully it can lead to a chronic condition with crippling effects that can profoundly affect the individual’s quality of life. Pain can also prevent the treatment of other disorders until its effects are successfully relieved through treatment. Due to these factors, an extensive amount of research has been put into pain management over the centuries. A wide variety of approaches to treatment have been created and evolved with different parts of the world emphasizing different approaches.

The Western world has emphasized the use of surgery, drugs, electrotherapy, and thermal therapy in an attempt to eliminate the effects of pain. On the other hand, the Eastern world while still using surgery and thermal agents has placed more of its emphasis on the use of hypnosis and acupuncture to provide pain management. The two groups have been hesitant to accept each other's view,
although, recently, they have begun to come together. This has not only benefited those who suffer from pain, but has also helped the health care providers who are responsible for providing pain relief.

In the Western world physical therapists are one of the principal sources for providing pain management and are often requested to provide a large number of pain relieving treatments on a daily basis. Due to this factor, physical therapy has a devout interest in pain management and has played an important role in its research. Recently, physical therapy has begun to utilize the wisdom of both the Eastern and Western worlds via the use of auricular transcutaneous electrical nerve stimulation (ATENS), a method of pain management that combines acupuncture and electrotherapy. The purpose of this study is to review the history by which ATENS has evolved, the theories for its effectiveness, and, finally, the clinical applications of ATENS for the physical therapist as suggested by research in multiple professions.
CHAPTER II

HISTORY

The history by which ATENS evolved has its beginnings over two centuries ago with the use of acupuncture in China. Stone needles found in archeological surveys in China, with pictures carved on rocks demonstrating their usage, were the first sound evidence of the use of acupuncture as a method of medical treatment.

Eastern World

The practice of acupuncture is based on the manual stimulation of needles inserted into points on the body for purposes of removing disease or other physiological symptoms such as pain. It is based on twelve meridians which are pathways arranged symmetrically on the left and right sides of the body deep within the muscles. According to Eastern medicine, the meridians join the various physiological systems of the body to form one complete system in which Qi, the flow of energy, moves throughout the body. If the flow of Qi is disturbed it will lead to disease or other physiological symptoms such as pain.

Although the meridians are deep within the muscles, early Eastern physicians found that they emerge at various points at the surface of the skin and are subject to
stimulation by needles. The physicians further noted that when stimulation occurred at the appropriate points, normal flow of Qi was reestablished and the body was restored to normal function. Relatively little change in identified location has occurred since the meridians and 365 acupuncture points were recorded in the Yellow Emperor's Classic of Internal Medicine. Advances in technology in the twentieth century, however, have brought new developments to acupuncture relative to electrical stimulation of needles and the discovery of ATENS.

Electrical stimulation of the needles was introduced in the 1930s (electro-acupuncture) and by the 1960s manual stimulation became virtually obsolete. Since that time, electro-acupuncture has been used successfully in the Eastern world even as an anesthesia for a variety of surgical procedures.

Western World

Although acupuncture existed among Eastern people in the United States it was not introduced to the medical community until 1825 by Franklin Bache. However, due to a lack of aseptic techniques, infections readily occurred and interest in the research of acupuncture was practically void. It was not until the early 1970s that a spark of interest ignited after President Richard Nixon's visit to China. This historical event opened the Eastern world to visiting physicians who were able to observe the use of acupuncture
firsthand, allowing for acupuncture research to begin in the West.

Unfortunately, the research in the United States concentrated on the needles' size and alloy type and failed to consider the treatment methods. This led to another decline in research and to the question of the legality of acupuncture practice and treatment. Fortunately, in 1980 the United States District Court in the Southern District of Texas affirmed the right of Americans to seek acupuncture treatment when it stated:

"Acupuncture has been practiced for 2,000 to 5,000 years, it is no more experimental than is the Chinese language as a mode of communication. What is experimental is not acupuncture, but Westerners' understanding of it and their ability to utilize it properly...Whatever the best explanation is for how acupuncture works, one thing is clear: it does work. All the evidence put before the court indicates that, when administered by skilled practitioners for certain types of pain and dysfunction, acupuncture is both safe and effective." (p 61)

Although acupuncture was placed on the back shelf of research in the United States, this was not true for all of the Western world. In 1972, Paul Nogier, a French neurologist, published his discovery that all of the
traditional Chinese acupuncture meridians were represented as points on the external auricle. The discovery occurred after observing that several of his patients had been treated successfully for sciatica by cauterization of a certain point on the auricle. He then performed clinical trials and proposed that (1) the body surface and internal organs of the body are represented on the external ear in a somatotopic organization that resembles an inverted fetus (see Fig 1); (2) disease and pain at any body structure is reflected by increased tenderness and skin conductance at a corresponding point at the ear; and (3) electrical stimulation or acupuncture of the appropriate point leads to a decrease in pain of the corresponding part of the body. These proposals intrigued researchers in Eastern medicine who then performed over two thousand clinical tests which subsequently supported Nogier's hypothesis. Additional French research support came from a controlled double-blind study of forty patients in which Oleson et al tested the somatotopic relationship. The results showed a 75.2% correlation between the actual medical diagnosis and the diagnosis determined by the person performing auricular electro-acupuncture. However, the above noted auricular research had little effect on pain practices in the United States where the "traditional" use of transcutaneous electrical nerve stimulation (TENS) was prevalent.
Fig 1.--Somatotopic representation of fetus on auricle.
Then, in 1991, James Reston, a New York Times columnist, wrote about his account of receiving acupuncture as an anesthetic when he received an emergency appendectomy while visiting China in advance of President Nixon's visit ten years earlier.\textsuperscript{2,9} The popularity of the story intrigued the general population which led to the investigation of acupuncture by the general media. Since this time the interest in and the knowledge of acupuncture has constantly increased in the United States. This has not only led to advanced research in acupuncture, but has also allowed knowledge from both the Eastern and Western worlds to come together in creating ATENS, a simple, non-invasive method of pain relief that does not have the detrimental or undesirable effects that can accompany surgery, drugs, or even needle acupuncture. ATENS is the electrical stimulation of the auricle through the use of a stimulating probe or surface electrodes in order to cause physiological effects.
CHAPTER III
THEORIES OF EFFECTIVENESS

The exact mechanism by which ATENS achieves its effectiveness is not known; however, researchers have established three dominant system theories: (1) the meridian system, (2) the gate control system, and (3) the endogenous opioid system.

Meridian System

As with acupuncture, the Eastern world feels that ATENS achieves its effectiveness by influencing the meridian system.\textsuperscript{10,11} Unlike elsewhere on the body, six of the twelve paired meridians are within close proximity to one another at the auricle. These six meridians then go on to connect with the other six meridians at the back of the neck. Through this interconnection of meridians, the auricle is joined to every part of the body. Thus, through electrical stimulation of the acupuncture points of the auricle any part of the body can be affected. This allows a medical professional to reestablish the normal flow of Qi and restore the body to its normal function without the need to stimulate any acupuncture points other than those found on the auricle.
Gate Control System

The auricle has a profuse sensory nerve supply with branches from the vagus, trigeminal, facial, glossopharyngeal, and major and minor occipital nerves.\textsuperscript{12,13} This has led some researchers to use the gate control system of pain modulation to explain ATENS effectiveness. First introduced by Melzack and Wall\textsuperscript{14} in 1965, the theory proposes that information from slow nerve fibers, such as those for pain, could be modulated by the use of fast nerve fibers, such as those for touch and pressure. Pain fibers tend to inhibit small interneurons in the substantia gelatinosa of the spinal cord. This allows pain information to reach transmission cells which then travel to higher centers of the brain where conscious sensation of pain is perceived. On the other hand, touch and pressure fibers facilitate the small interneurons which then "close the gate," keeping much of the pain information from reaching the transmission cells.

The gate control theory was revised following a study at the Shanghai Traditional Medical College\textsuperscript{15} which found that the peripheral nerves of the auricle and the acupuncture points lie in close proximity to each other. The researchers proposed that the higher centers of the brain including the reticular and limbic systems can modulate pain information through a "central control trigger."\textsuperscript{16} Through activation of the trigger, information can be blocked at either the
substantia gelatinosa or by directly altering the information in the ascending transmission cells.

Following electrical stimulation at the auricle, information from the peripheral nerves enters the reticular formation and activation of the trigger occurs. The trigger then sends inhibitory information to intercept the ascending pain information in the spinal cord. Through this inhibitory method of pain modulation, electrical stimulation of different points on the auricle can selectively cause analgesia to different areas of the body.

Endogenous Opioid System

Since the discovery of endogenous morphine-like substances such as endorphins and enkephalins in the body, many researchers have investigated their action in the alteration of pain. Sjolund et al\textsuperscript{17} and Malizia and coworkers\textsuperscript{18} found that electro-acupuncture was mediated by the release of endorphins into the cerebral spinal fluid and peripheral blood. Follow up studies by Sjolund and Eriksson\textsuperscript{19} and Eriksson et al\textsuperscript{20} found that acupuncture-like TENS not only released morphine-like substances into the cerebral spinal fluid but was also accompanied by significant analgesia. Furthermore, the researchers found that the analgesic effects could be partially reversed by the administration of an opioid antagonist, naloxone, thus verifying the opiates as providers of pain relief. Abbate and associates\textsuperscript{21} had similar results of increased endorphin
levels and reversible analgesia in twelve patients undergoing thoracic surgery who were anesthetized by electro-acupuncture.

Finally, in 1978, Basbaum and Fields\textsuperscript{22} proposed that electrical stimulation causes analgesia through a negative feedback loop which includes the release of endorphins and enkephalins into the brain and spinal cord from the pituitary gland. Ascending information from the pain fibers travels to many higher centers including the reticular formation and pituitary gland. According to the proposal, electrical stimulation of various sites on the body, including acupuncture points, can lead to a stimulation of the pituitary gland, which then releases endorphins. The endorphins bind to opiate receptors especially in the midbrain and block ascending pain information.

Although none of these theories can explain every aspect of pain modulation, they do provide possible ways in which ATENS can inhibit pain perception. More likely, the effectiveness of ATENS is due to a combination of some or all of these theories.
CHAPTER IV
APPLICATION AND USAGE

Although the research of ATENS is sparse, it is sufficient to show a general trend as to the best mode of clinical application. There are also numerous reports which describe how ATENS can benefit multiple professions including physical therapy.

Application

ATENS has been applied by various methods, including TENS to electrodes clipped to the ear lobes, simultaneous stimulation of electrodes attached to various acupuncture points, and separate stimulation of acupuncture points by the use of a probe. The last method will be described in this study due to the strong scientific techniques which have been used in its research. There are many variables which have been found to be important determinants of successful treatment.

The most important determinant of success is the choice of appropriate points of stimulation. There are over forty acupuncture points on the ear and studies have shown that the effectiveness of ATENS requires stimulation of the appropriate points.\textsuperscript{12,23-25} The Shen-Men, lung, and dermis points on the auricle are associated with analgesic and
sedative effects.\textsuperscript{24,25} The lung and dermis points are also associated with decreasing hypersensitivity of the skin. These points must be stimulated when using ATENS to decrease pain along with points corresponding to the appropriate part of the body. This means that a physical therapist must stimulate these three points along with the elbow point when using ATENS to treat lateral epicondylitis pain (see Fig 2). However, Krause et al.\textsuperscript{26} also noted that there is no significant difference between ipsilateral and bilateral stimulation of the appropriate points. There was also no significant difference noted in patients receiving ATENS alone or in combination with TENS to appropriate body points.\textsuperscript{23}

The frequency and intensity of ATENS treatment are other important determinants of the physiological effects.\textsuperscript{27-30} Acupuncture-like TENS (low frequency/high intensity) has been shown to produce longer lasting analgesic effects than conventional TENS (high frequency). Douglas et al.\textsuperscript{27} reported significantly greater hypesthesia in the trigeminal nerve with 5 and 100 Hz ATENS than with 2000 Hz. The majority of studies using probe stimulation used a frequency of 1 Hz with the intensity being set to the patient's maximum tolerance (usually near 1000 micro-amps). The only study which used a stimulator with a maximum output of 200 micro-amps did not show significant results.\textsuperscript{31} A positive polarity and constant
Fig 2.--Acupuncture points on auricle.
current were also used by the researchers since these have been shown to be most effective.27-29

The duration of treatment is another important aspect of ATENS and needs to be researched further. Various researchers report good results using 45, 60, and 90 second stimulation to each point.12,24-26 Certainly an optimal treatment time needs to be determined.

Usage

When applied to the appropriate acupuncture points of the ear and in an effective manner, ATENS has been reported as an effective treatment for a variety of disorders. ATENS has been used by itself or in combination with other methods to treat malignancy pain4, Meniere's disease32, chronic bronchitis33, drug withdrawal9, dental pain13, obesity34,35, cholelithiasis36, auditory hallucinations37, smoking cessation38, alcoholism39, and amblyopia.40

ATENS has also been used to treat disorders which are often treated by physical therapists. Oliveri et al12 used ATENS to elevate pain thresholds in forty-five subjects following electrically induced pain at the ipsalateral wrist. Subsequent studies also reported a significant increase in experimental pain thresholds with both unilateral and bilateral treatment. Furthermore, ATENS significantly reduced pain in fifteen outpatients experiencing distal extremity pain.24,26 Another study reported that ATENS equally increased pain threshold when applied on the auricle
or in combination with body points. Throughout all of these studies the pain thresholds did not change when ATENS was applied to inappropriate points or when a placebo pill was used.

Jichova et al. also used ATENS in combination with stimulation of body points on patients with burns prior to surgical procedures or dressing changes. The researchers reported that the patients required less than half of the usual dosage of anesthesia along with fewer analgesics following the procedure. Another study revealed that eleven patients showed a significantly greater decrease in pain when provided with ATENS following wound care of burns than when administered a placebo pill. It was noted further that the decrease in pain also continued for up to 60 minutes. Chun and Heather reported an improvement of at least 25% in 48 of 57 chronic pain syndromes following ATENS. Further research of chronic pain in twenty patients used ATENS in combination with body points and reported significant improvement in both pain and psychiatric symptoms. Kajdos reported using ATENS to provide either complete relief or improvement in 48 of 54 patients suffering from migraine headaches. Paris et al. used ATENS in combination with standard physical therapy to treat second-degree ankle inversion sprains. The researchers reported that patients receiving this treatment had a significantly shorter rehabilitation time and attained normal range of motion
sooner than patients who received standard physical therapy alone. Leo described a case study in which the symptoms of sympathetic dystrophy in a child were completely relieved following six ATENS treatments. A three month follow up revealed that the child had remained symptomatic free. Another case study reported success in using ATENS to control spasticity in a child with cerebral palsy. Abbate et al used ATENS on twelve patients during and after thoracic surgery. It was noted that all of the patients required significantly less dosages of anesthetics during surgery and decreased analgesic use during recovery. In their review of the literature Richardson and Vincent documented the use of ATENS in China for the relief of headaches, temporomandibular pain, and cervical pain. Further research has shown ATENS to be used in China for the treatment of Bell's palsy, facial spasms, dysmenorrhea, sciatic nerve pain, arthritis, lateral epicondylitis, and epilepsy.

The only study which failed to support the effectiveness of ATENS did not use probe stimulation, used a low intensity, and failed to stimulate the lung, dermis, and Shen-Men points. However, subsequent work by the same authors revealed that ATENS significantly reduced phantom limb pain in amputees using the authors' original parameters.
CHAPTER V

CONCLUSION

Through clinical research ATENS has proven to be a simple, non-invasive method of pain relief. When applied in an effective manner by a trained professional, ATENS can be used by itself or in combination with other treatment methods to benefit those who suffer with pain. However, ATENS needs to be researched further so as to establish exact parameters for its use.

The research which used the strongest scientific methods has shown that ATENS can benefit physical therapy practice in the following ways: (1) ATENS is simple to apply and can significantly decrease pain as is often needed prior to other treatments; (2) When used prior to surgery and following surgery, patients require fewer drugs. This can shorten rehabilitation time by decreasing side effects which can delay the progression of therapy; (3) ATENS will not only decrease pain in patients with burns, but can also be administered at a location other than the burn site. This decreases the risk of infection; (4) ATENS significantly reduces rehabilitation time in patients with second-degree ankle sprains. Further studies need to be performed to see if other orthopedic pathologies could also utilize this
benefit; (5) ATENS can significantly decrease pain due to a variety of disorders in the distal extremities. Further study is also needed in this area so as to determine if ATENS can benefit all distal extremity pain or only certain specific disorders; (6) ATENS can reduce phantom limb pain and sensations; and (7) ATENS can benefit those who suffer from migraine headaches. Although ATENS has been used for cerebral palsy and sympathetic dystrophy, further studies need to be performed to verify this use.

Physical therapists can contribute to the body of knowledge on ATENS by performing controlled, scientific research. Much more research is needed when it comes to the application of ATENS in a clinical setting. Furthermore, it is recommended that therapists become trained in the proper use of ATENS before applying it in a clinical setting.
REFERENCES


