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# Magnetic Therapy: an Alternative Approach to Treatment

Becky S. Rohr
*University of North Dakota*

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MAGNETIC THERAPY: AN ALTERNATIVE APPROACH TO TREATMENT

By

Becky S. Rohr
Bachelor of Science in Physical Therapy
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An Independent Study

Submitted to the Graduate Faculty of the

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for the degree of

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This Independent Study, submitted by Becky S. Rohr 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.

_Michelle LaBrecque_
(Faculty Preceptor)

_Thomas Mohr_
(Graduate School Advisor)

_Thomas Mohr_
(Chairperson, Physical Therapy)

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## ABSTRACT

Magnetic therapy has been a treatment of choice for hundreds of years in many European countries as well as in several areas of the Orient, but has only recently been gaining popularity in the United States and Canada. It is believed that applying static magnets to a painful body structure will bring relief to the patient. It is also proposed that a general feeling of wellness and increased energy will be gained from magnetic therapy. These benefits are theorized to be attained through the placement of a static magnet on the surface of the body, which blocks the transmission of pain to the central nervous system and causes vasodilatation of local blood vessels allowing the body to heal itself.

The purpose of this literature review is to provide a better understanding of the body's responses to natural magnets and the resulting physiological changes that occur. A review of the nervous system with particular attention given to the afferent pain sensation pathway and its controls will be presented, followed by a brief discussion on the physical makeup and chemical components of the circulatory system. A description of natural magnets and their properties will be given, along with a review of how natural magnets affect the nervous and circulatory systems and their potential use in the field of physical therapy.

# CHAPTER I

## INTRODUCTION

For thousands of years, mankind utilized the beneficial powers of magnetism, knowing little about the specific reasons it worked or affects it created, but realizing only that curative results could be achieved. In fact, the oldest known use of magnetic powers was traced to Africa where a lodestone (magnetite) mine was found more than 100,000 years ago.[1-4] The magnetite was ground up and used in potions, foods, and topical applications for relief of numerous ailments. In ancient Greece, Aristotle was the first person in recorded history to mention the therapeutic properties of natural magnets.[1,3,4] Nevertheless, it is believed most civilizations, including the Hebrews, Arabs, Indians, Egyptians, and Chinese, used magnets for healing. Nearly 200 years following Aristotle's discoveries, the Greek physician, Galen, found that pain from many different types of illnesses could be relieved by applying natural magnets.[1,2,4,5]

In the first century, the Chinese began documenting effects on health and disease related to variations in the Earth's magnetic field using very sensitive compasses to monitor those variations.[1] Shortly after this, approximately 1000 A.D., a Persian physician documented the use of magnets to relieve disorders such as gout and muscle spasms.[1,2,4,5]

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Further historical facts of magnetic therapy include an English physician named Gilbert who wrote of magnetism in the 1500s and Paracelsus, a physician and alchemist, who reported he was able to relieve conditions of "hernias, dropsy, and jaundice"[5] with magnetic applications. In the same century, there are the writings of Ambroise Pare which describe how physicians took lodestone, ground it into a fine powder, and mixed it with a liquid substance to be taken internally.[5] This magnetic powder was also mixed with honey and applied to external openings, wounds, ruptures, and other forms of human ailments. It is interesting to note that the basis of this 16th century practice is currently being used in the most modern laboratories and hospitals in Israel.[5] Scientists and medial personnel in this country mix medicine and antibiotics with magnetic powder and orally administer the mixture to their patients. An improvement over the 16th century method, yet considered a slightly crude approach to healing, is to locate the area needing medication by applying a magnet to the outside of the body.[5]

During the 1700s, a physician named Mesmer wrote a dissertation on magnetism that has proven to be a foundation for magnetic healing in the Western culture.[1] Dr. Mesmer was ridiculed, however, for his advanced discoveries and his abilities to use magnetism to promote wellness. At that time, the medical community viewed his discoveries as unscientific and unreliable and magnetic therapy was deemed an unworthy practice. Despite the increasing ridicule, other studies were performed by numerous medical professionals which revealed several positive effects of magnetic therapy on the human body.[1] A

number of studies performed by various individuals in the early 1900s, however, found that a constant magnetic field had no significant affect in improving overall health and wellness.[1] This continued to be the theory for the majority of medical professionals in Western countries for some time.

Future research and development were soon to become monumental in reawakening interest in magnetic therapy. In the 1930s, researchers, such as Davis in 1936 and Hansen in 1938, began to investigate and experiment using magnetism.[1] Hansen reported that subjective complaints were being relieved by the application of magnetism, such as in sciatica, low back pain, and joint pain. Davis's studies showed differing effects of the north and south pole energies when applied to plants and animals. Japanese researchers also became heavily involved in magnetic therapy and have made the greatest advances in this field since 1958.[3] In more recent times, numerous studies have documented the effects of magnets and magnetic therapy.[1,2] Research continues in the United States, Canada, England, France, Japan, Russia, India, and China, providing data on how magnetic fields affect the nervous and circulatory systems as well as the cells of humans, animals, and plants.[4]

Magnetic treatment is currently being used in 45 countries around the world.[6] Japan and Germany have been using magnetic products more often and for a longer period of time than any other country.[7] In fact, magnetic field products are licensed as a medical device in Japan as well as in Korea and other Asian countries.[8-10] Magnetic therapy has also received governmental approval

in Russia, Israel, and several European countries including Germany, where the use of certain devices is covered by medical insurance.[11,12]

Worldwide, over 100 million people use magnetic therapy. In Japan alone, 30 million people use magnetic therapy and 10 million sleep on magnetic beds to counter the effects of stress, pain, fatigue, and various ailments.[7,13] In fact, research findings in Japan have proven so conclusive that many mattress manufacturers are including magnets in most of their mattresses produced.[3]

Magnetic therapy has been available for over 70 years in the United States. The use of magnetic therapy, however, ha been limited primarily to alternative-minded physical therapists, pain specialists, and sports medicine personnel.[14,15] Currently, the use of natural magnets in healing and improvement of musculoskeletal disorders is considered an alternative therapy approach. As with any alternative therapy technique, most practitioners in medicine and rehabilitation within the United States have not shown a great deal of interest in magnetic therapy mainly due to the lack of research. Interestingly, in a 1993 study by David Eisenberg, M.D., data were collected on people who used alternative therapies. He found that over two-thirds of patients who see their primary care physician use one type of alternative treatment, such as acupuncture, massage, vitamin supplements, or magnetic healing.[16] With this study in mind, it appears as though the medical community will need to increase its knowledge of magnetic therapy, as well as other types of alternative therapies, as this field continues to grow within the United States.

The purpose of this paper is to provide a better understanding of the body's responses to natural magnets and the resulting physiological changes that occur. A review of the organization of the nervous system with particular attention given to the afferent pain sensation pathway and its controls will be presented, followed by a brief discussion of the physical makeup and chemical components of the circulatory system. A description of natural magnets and their properties will be given, along with a review of how natural magnets affect the nervous and circulatory systems and their potential use in the field of physical therapy.

CHAPTER II

ORGANIZATION OF THE NERVOUS SYSTEM

The nervous system is one of the major control systems in the body.[17,18] It coordinates the activity of other organ systems so that all operate efficiently with one another. In this chapter, the focus will be on the sensory system with attention given to the sensation of pain and its transmission to the sensory cortex of the brain. An understanding of the nervous system and pain transmission is needed, as the properties of static magnets are believed to be effective in blocking the transmission of pain.

Overview of the Central and Peripheral Nervous Systems

The brain, brain stem, and spinal cord form the central nervous system (CNS), while the nerve fibers that enter and exit the brain stem and spinal cord make up the peripheral nervous system (PNS).[17,19,20] The PNS has a somatic and autonomic portion; sensory nerves bring information from sensory receptors to the CNS in the somatic nervous system, while sensory nerves in the autonomic nervous system transmit information about the condition of internal organs to the CNS. The nervous system is organized to receive information from sensory organs, interpret the information, and respond to the sensory inputs by transmitting information through motor nerves to organ systems which initiate the correct responses.

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## Cells of the Nervous System

The nervous system contains a complex organization of over a trillion cells.[17] This system is composed of two types of cells, neuron and neuroglia. Neurons transmit information from one cell to another throughout the entire system. Neuroglia, found only in the CNS, help maintain the environment surrounding neurons and aid in their ability to transmit information rapidly.[19]

Neuroglia

There are three basic types of neuroglial cells in the CNS: oligodendroglia, astroglia, and microglia.[17,20,21] Oligodendroglia wrap themselves around axons forming myelin, which insulates the axon and prevents the passage of ions through the axonal membrane. The nodes of Ranvier are located between the myelinated regions of the axon occurring approximately every 1 to 2 mm.[18] The exposed nerve membranes at these nodes contain a high concentration of voltage-sensitive sodium channels. It is in these nodes that electrical impulses called action potentials are generated and conducted along the length of the myelinated axons. One oligodendroglia will myelinate many axons in the CNS.[19,22]

In the PNS, Schwann cells play a similar role in ogligodendroglia in forming myelin around the nerve fibers; however, one Schwann cell will myelinate only one axon in the PNS.[19,.22] The immediate outer covering of the Schwann cells is made of a connective tissue material called the endoneurium. The perineurium surrounds bundles of nerve fibers and the epineurium covers the entire nerve trunk. These connective tissue sheaths serve to support the

nerve fibers and their associated blood and lymphatic vessels. As with oligodendroglia, Schwann cells have areas where myelin is absent and are also known as nodes of Ranvier. In these areas, the axon is surrounded by a single Schwann cell layer. Myelinated nerve fibers (A and B fibers) allow the nerve action potential to move from node to node, which increases the speed of conduction. In unmyelinated nerves (C fibers), which are wrapped by a single layer of Schwann cells, the action potential must pass through all points on the nerve, in turn decreasing the speed of conduction. The Schwann cell sheath allows for potential regeneration of damaged nerves in the PNS; damage in the CNS is usually irreparable because oligodendroglia sheaths cannot guide regeneration.[17-19]

Astroglia are star-shaped cells, exhibiting the greatest diversity of function among neuroglial cells in the CNS.[18,21] There are various types of astroglia, two being fibrous and protoplasmic astrocytes, with both forming "glial end-feet" on blood vessels.[18,19,21] The anatomical relationship between glial end-feet and blood vessels was once believed to represent the blood-brain-barrier that prevented unwanted substances found in the circulatory system from penetrating the brain.[19] However, recent studies have shown that tight junctions between endothelial cells that make up the blood vessels are the key cellular components of the blood-brain-barrier.[19] Another type of astrocyte, the reactive astrocyte, appears during injury to the brain and removes debris by the process of phagocytosis.[18,21] Other types of astrocytes regulate the concentration of potassium ions ($K^+$) in the extracellular space by absorbing and redistributing

them to other astrocytes.[18,21] They also regulate the concentration of chemicals called neurotransmitters that are released by nerve cells during the process of synaptic transmission. This uptake of neurotransmitters is needed to terminate synaptic transmission.

Microglia are found in the nervous system near blood vessels.[18,23] After injury, they migrate to the site of damage where their main function is the removal of cellular debris by phagocytosis. Unlike other neuroglial cells, recent studies have demonstrated that microglia originate from outside the brain, most likely from bone marrow.[19]

Neurons

Approximately 10% of the cells in the nervous system are neurons.[18] Nerve cells (neurons) have four functionally distinct regions: the soma (cell body), dendrites, axon, and axon terminal (telodendria). The soma is the cell body of a neuron and its metabolic center. Dendrites are fiber-like structures that branch out from the cell body. Together dendrites and soma form the surface of a neuron, which receives information from other nerve cells. The axon is a long fiber-like structure that extends from the soma to make contact with other nerve cells. The axon hillock, a specialized portion of the soma which gives rise to the axon, along with the initial segment of the axon make up the trigger zone. This zone has the lowest threshold on the nerve cell membrane and, therefore, is the area where the action potential is generated.[18,20] The axon ends in many axon terminals (telodendria), which make contact with other nerve cells at junctions called synapses to transmit information to other cells.

Neurons can be classified in two ways: 1) by their structure, as multipolar, bipolar, or unipolar neurons, and 2) by their function, as sensory, motor, or interneurons.[17,19] A multipolar neuron has several short dendrites and one long axon, while a bipolar neuron has one axon and one dendrite, on opposite sides of the soma. A unipolar neuron has one short branch that gives off an axon and a dendrite. A sensory or afferent neuron carries information about external or internal stimuli from sensory receptors to the CNS. A motor or efferent neuron carries movement instructions to muscles from the CNS in response to sensory stimuli. An interneuron, found in the intermediate zone of the spinal cord, connects sensory and motor neurons and integrates their functions. Motor neurons are typically multipolar, whereas sensory neurons are often unipolar.[24]

## Ion Channels of Nerve Cell Membranes

An action potential is the electrical impulse that initiates synaptic transmission and is dependent on the properties of the axon membrane. This membrane is made up of a double layer of lipids with specialized proteins penetrating the double layer.[18,21] These proteins regulate the movement of ions across the membrane which in turn creates the action potential. Certain ions (sodium, potassium, chloride, and calcium) can cross the membrane only through protein pores in the membrane that form ion channels.[17,19] These channels allow only specific ions to pass, while blocking others because of their size, charge, or state of hydration.[19] There are three basic types of ion channels: passive, chemical, and voltage-activated.[17] Passive ion channels are found in membranes throughout all areas of the nerve cell. Each passive channel is

identified according to the specific ion it allows through. Chemically activated ion channels are located on dendrites and the soma. These channels are generally closed by "gates" to prevent the flow of ions through the membrane. Chemical transmitters bind to sites on these protein channels and open the gate to permit the flow of ions through the channel.[17] Voltage-activated ion channels, found in the membranes of axons and soma, are opened when they detect a certain voltage. They are responsible for initiation and propagation of the action potential.[17,18]

## The Membrane Potential

With the exception of water, the major chemical components of the extracellular fluid are sodium ions ($Na^+$) and chloride ions ($Cl^-$). The intracellular fluid contains high concentrations of $K^+$ and organic molecules, including proteins and phosphate compounds, which present with a negative charge.[18] Therefore, a membrane potential will exist because of the difference in the number of positive and negative charges across the membrane.[18,20,21] These charges are attributed to the cations (positively charged ions) and anions (negatively charged ions) that occur on each side of the membrane.[20,21] Since there is a difference in charge between a point in the extracellular space and a point within the cell when the cell is at rest, an electrical potential is established.[18,21] In many nerve cells, this electrical potential difference across the membrane (resting membrane potential) is approximately -70 millivolts (mV).[18] The minus sign indicates that the inside of the cell is more negative than the extracellular fluid. Other sources list the resting membrane potential of the nerve cell at -60 mV.[17,20,21] Overall, the

resting potential will vary from 5 to 100 mV, depending on the cell type and its environment.[18]

The ease with which ions can flow through an ion channel is called conductance. Factors affecting conductance include the size, charge, and state of hydration of the ion, which were previously mentioned. Therefore, each type of channel has a specific conductance for its associated ion.

The overall effect of all of the channels for a particular ion is called the membrane conductance for that ion. Membrane conduction of an ion depends not only on concentration and electrical gradients, but also on the number or density of a particular type of channel within a region of the membrane. For example, the membrane conductance for $Na^+$ is greater in the region of the initial segment of the axon and nodes of Ranvier than in other areas of the cell.[19,20] This regional difference in the number of $Na^+$ channels aids in the initiation and propagation of the action potential.

<div align="center">Concentration Gradients</div>

A high concentration of $K^+$ and a low concentration of $Na^+$ is located within nerve cells while the opposite is true in the extracellular fluid.[17,18,19,20,21] It is well known that ions will move from an area of high concentration to an area of low concentration. Therefore, the high intracellular concentration of $K^+$ in comparison to the extracellular compartment produces a concentration gradient that causes $K^+$ to diffuse out of the nerve cell through passive $K^+$ channels. Similarly, high extracellular concentration of $Na^+$ causes this ion to diffuse into

the cell through passive $Na^+$ channels. The action of the active transport system of the sodium-potassium pump works to transport $K^+$ in and $Na^+$ out of the cell.

## Electrical Gradients

Potassium and $Na^+$ ions along with $Cl^-$ ions have an effect on the membrane potential of a cell with $Cl^-$ having a very minimal influence. The high extracellular concentrations of $Na^+$ and $Cl^-$ create a concentration gradient for passive diffusion of these ions into the cell. However, $Na^+$ and $Cl^-$ do not diffuse across the cell membrane as easily as $K^+$ because the membrane is 50 to 75 times more permeable to $K^+$ than $Na^+$.[18] When the nerve cell is at rest (does not generate an action potential), its membrane is most permeable to $K^+$ which moves out of the cell due to the high concentration gradient. This is the reason that the resting membrane potential (-70 mV) is near the equilibrium potential for $K^+$ (-90 mV).[18] However, as more $K^+$ leave the cell, an electrical gradient is created, preventing further passive diffusion of $K^+$ into the extracellular space and causing movement of small amounts of $K^+$ back into the cell. Sodium ions will enter the cell because of the electrical gradient, but the amount will be very small due to the low permeability of the membrane to $Na^+$.

## Action Potentials

Action potentials are a change in membrane potential voltage that causes the nerve cell membrane to go from its negative resting state to a positive value for a very short period of time. The change in membrane potential typically occurs in the axon of the nerve fiber where $Na^+$ ions are able to move through the membrane with less difficulty.

The membrane potential is initially at its resting level of -70 mV. As the membrane potential becomes more positive, a process known as depolarization, it reaches a threshold value at approximately -55 mV. After reaching threshold, the membrane potential rapidly changes to a more positive value during a rising phase. It reaches a peak at +35 mV and begins to repolarize. In repolarization, the membrane becomes hyperpolarized, or more negative than in the original resting state. It remains hyperpolarized for a time before returning to the resting level of -70 mV (Fig 1).

The voltage changes seen in the action potential are a result of the opening and closing of voltage-sensitive ion channels that control the influx of $Na^+$ and the efflux of $K^+$. In the resting state, voltage-sensitive $Na^+$ and $K^+$ channels are closed. The simultaneous activation of many $Na^+$ channels in the membrane of an axon causes an influx of $Na^+$. This influx of positive charges causes the membrane potential to become more positive, producing a gradual depolarization of the membrane. At the threshold level of the membrane potential (-55 mV), more voltage-sensitive $Na^+$ channels are activated, resulting in a greater influx of $Na^+$. This influx of positive charges depolarizes the membrane further, leading to continued influx of $Na^+$ and, in turn, further depolarization.

At the peak of the action potential, the membrane is much more permeable to $Na^+$ than to K+; therefore, the membrane potential (+35 mV) is closer to the $Na^+$ equilibrium potential (+55 mV) than to the $K^+$ equilibrium potential (-90 mV). After the peak has been reached, the inactivation channels
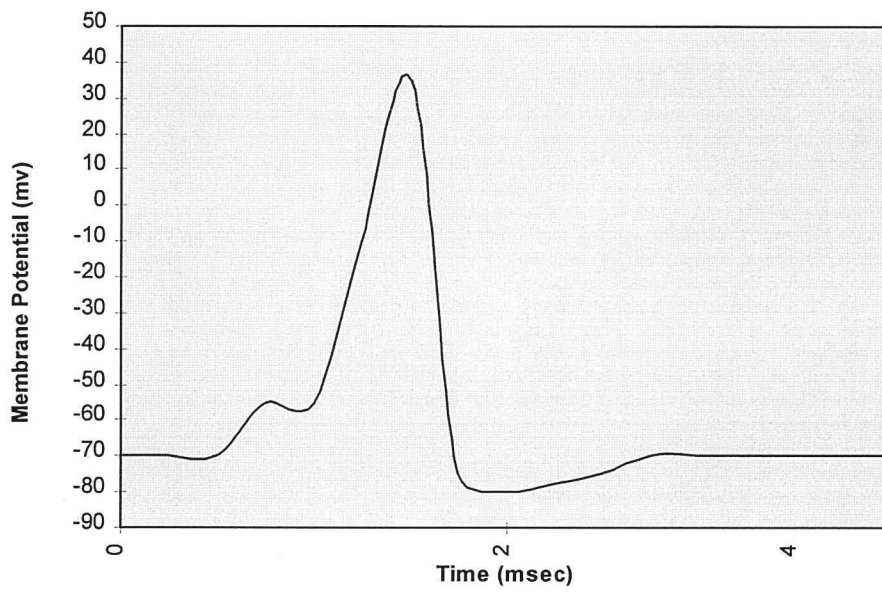
Figure 1. Action Potential

of $Na^+$ are closed, $Na^+$ influx is then blocked, and the membrane potential begins to repolarize as $K^+$ begins to move out of the cell because conductance for $K^+$ is greater than that for $Na^+$ at this point. As the $Na^+$ channels become inactivated, the potassium channels begin to activate and the increase in potassium conductance out of the cell causes the membrane potential to become negative and contributes to the repolarization phase. Finally, the prolonged opening of $K^+$ channels causes a continued efflux of $K^+$ resulting in the membrane potential becoming hyperpolarized for a short time before returning to the resting level.

Not all depolarizations will result in an action potential. If the depolarization is too small, too few sodium channels will be activated and no action potential will be produced. Thus, the action potential is an "all or none" phenomenon. Once initiated, the action potential will travel down the axon from its initial segment to the terminal endings. In unmyelinated nerve fibers, the speed of conduction of the action potential is dependent on the diameter of the axon with an increase in velocity present in an axon with a larger diameter. Likewise, myelinated nerve fibers with axons of large diameter will also experience increased conduction velocity. The distance between the nodes of Ranvier in myelinated nerve fibers will also affect the speed of action potential propagation; the greater the distance between the nodes of Ranvier, the greater the conduction velocity of the action potential.

## Refractory Periods

The absolute refractory period of the nerve cell membrane refers to the amount of time before an axon is able to generate a second action potential. An axon is not able to initiate a second action potential immediately after a return to resting membrane potential because the $Na^+$ inactivation gates are still closed and will remain closed regardless of the voltage difference across the sodium channel. Therefore, the time interval of the absolute refractory period determines the fastest frequency at which an axon can generate action potentials.[18] The action potential must move down the axon from its initial segment to the terminal endings because the previous segment of the nerve membrane that carried the action potential cannot depolarize due to the absolute refractory period.

Following the absolute refractory period, an axon is capable of generating a second action potential, but only if the membrane is depolarized to a large degree. This time interval is known as the relative refractory period with a second action potential possible due to the fact that most (but not all) of the sodium channels have been reset. With an increase in threshold voltage, some of the sodium channels will be capable of opening to allow a second action potential to take place.

## Communication Between Nerve Cells

The communication between nerve cells occurs at junctions called synapses located at the terminal endings of the axon. Most synapses will occur between the axon terminals of one neuron and the cell body (soma) or dendrites

of another.[18]  Within the nervous system, there are two types of synapses:

electrical and chemical.[18,19,25]  The majority of synapses in the nervous system

are chemical, while only a few located within the CNS are electrical.[18,25]

Therefore, attention will be focused on the function of chemical synapses.

Chemical Synapses

The nerve cell carrying the action potential to its terminal ending is known

as the presynaptic cell, while the cell receiving the signal is referred to as the

postsynaptic cell.  The presynaptic cell may transmit information to a single

postsynaptic cell or it may carry its signal to many postsynaptic neurons.[25,26]

Numerous synaptic vesicles containing neurotransmitters are located in the

terminal ending of the presynaptic cell.  These vesicles will fuse to the cell

membrane releasing their contents into the synaptic cleft, which is the space

located between the presynaptic and postsynaptic cell membranes.  The release

of the neurotransmitter is produced by the action potential when it reaches the

terminal ending.[26]  The change in the membrane potential of the presynaptic

axon activates voltage-sensitive calcium ion ($Ca^{2+}$) channels which results in an

influx of $Ca^{2+}$ into the terminal ending.  The influx of $Ca^{2+}$ causes the synaptic

vesicles to fuse with the presynaptic membrane and release their

neurotransmitters into the synaptic cleft.

After the neurotransmitter is released into the synaptic cleft, it will bind to

a receptor site on the postsynaptic cell membrane.  This action allows the

receptor to open allowing charged ions to either enter or exit the postsynaptic

cell resulting in depolarization or hyperpolarization of the postsynaptic cell

membrane. The chemically activated ion channels found on the postsynaptic cell membrane will remain open as long as the neurotransmitter is bound to the receptor. These channels are not sensitive to changes in the membrane potential unlike the voltage-sensitive ion channels that are responsible for the initiation and propagation of action potentials.[26,27]

There are two types of postsynaptic potentials, excitatory and inhibitory, transmitted from the presynaptic cell. Excitatory postsynaptic potentials cause the membrane of the postsynaptic cell to depolarize. An action potential will be generated in the axon hillock of the postsynaptic neuron if the summation of the excitatory postsynaptic potentials is large enough to reach threshold. In contrast, inhibitory postsynaptic potentials result in hyperpolarization of the postsynaptic cell membrane. Inhibitory postsynaptic potentials also summate and, if large enough, can prevent the postsynaptic neuron from generating an action potential.

Excitatory and inhibitory postsynaptic potentials may be summated through spatial and/or temporal processes. Spatial summation involves several excitatory or inhibitory potentials reaching more than one synaptic site on the cell membrane. Temporal summation takes place when the stimuli act on only one synaptic input and occur in rapid, close succession of one another.

## The Somatic Sensory System

The somatic sensory system is sensitive to external stimuli that affect the skin or the surface of the body.[27,28] The receptor sites of the external stimulus are activated when they detect the specific stimulus that is unique for each type

of sensory receptor. This specific stimulus is known as an adequate stimulus. Each of the major types of somatic sensory receptors have their own specific adequate stimulus; tactile receptors are activated by mechanical stimulation of the body's surface, while thermal receptors respond to changes in temperature. Proprioceptive receptors are activated by the movement of the limbs and pain receptors respond to noxious or harmful stimuli.

Once an adequate stimulus is perceived, a change in the membrane potential of the sensory receptor cell will occur. This change in membrane potential is known as a generator potential and is similar to an excitatory postsynaptic potential. Therefore, if a high number or magnitude of generator potentials are produced, an action potential will be generated within the sensory receptor cell. Generator potentials are also summated through spatial and temporal processes as are excitatory postsynaptic potentials.

## Pain Transmission

Nociceptors are free nerve endings that detect painful stimuli. Mechanical nociceptors include A delta fibers which respond to intense, sharp pain stimulation and C fibers that are activated by long lasting, dull pain sensations.[26,28] The A delta fibers are small, slow conducting, myelinated axons, while C fibers, also slow conducting, are unmyelinated.[26,29] Heat nociceptors respond to temperatures above 45° C.[23,24,26,28]

The axons of these receptors will carry the action potential to the cell bodies which are located in the dorsal root ganglia. The nerve fiber then enters the spinal cord where it synapses with the second order neuron in the substantia

gelatinosa of the dorsal horn of the gray matter. The second order neuron will cross to the contralateral side of the spinal cord and enter the lateral spinothalamic tract which ascends the spinal cord to end in the ventral posterolateral nucleus (VPL) of the thalamus. The cell bodies of the third order neuron are located in the VPL of the thalamus and end in the postcentral gyrus of the parietal lobe where sensory information is processed.

## Pain Modulation

The perception of pain can be altered by other sensory inputs from the periphery or controlled by descending inputs from the brain stem and higher brain centers.[26,28] The neurotransmitter for pain fibers of the periphery is a peptide known as substance P. Without the presence of this neurotransmitter, pain transmission will not continue to its perception area found in the postcentral gyrus, thus pain sensation is not detected. An inhibitory interneuron located in the dorsal horn of the spinal cord is capable of preventing the release of substance P through a process known as presynaptic inhibition.[26,28,29] The terminal ending of the inhibitory interneuron can release the peptide enkephalin which is responsible for inhibiting the release of substance P from the terminal endings of the pain fiber. The inhibitory interneuron can be activated by sensory fibers associated with touch, pressure, and vibration or by fibers from higher brain centers.[28,29] Inputs from other types of sensory systems, such as the application of pressure to the location of superficial pain sensation, can block the transmission of pain to higher brain centers. The process described above is

known as the gate theory and is just one of several theories relevant to pain
modulation.

CHAPTER III

OVERVIEW OF THE CIRCULATORY SYSTEM

The circulatory system is responsible for maintaining a stable internal environment allowing normal cellular activity to occur.[30] When the body experiences disease or injury, the vascular system removes harmful chemicals produced by the disease or injury process. It is theorized that magnetic therapy is effective in causing vasodilatation of local blood vessels, which in turn allows the body to remove foreign substances and speed the process of healing. A review of the circulatory system is necessary in order to acquire an understanding of its function and transportation of blood through the body.

Properties of Whole Blood

Whole blood is a red, liquid connective tissue consisting of three microscopically visible elements: red blood cells (erythrocytes), white blood cells (leukocytes), and platelets (thrombocytes), all of which are suspended in an amber intercellular fluid called plasma.[30,31] Blood accounts for approximately 6% to 8% of adult body weight with normal adult blood volume ranging from 4.5 to 5.5 liters for a female and 5.0 to 6.0 liters for a male.[30] The distribution of blood between the heart and various types of blood vessels is not equal. Generally, 12% of the blood is in the pulmonary vessels, 79% is in systemic vessels, and 9% is within the heart.[30]

Properties of Plasma

Plasma can be defined as whole blood without the blood cells and platelets. Normal plasma is transparent, light yellow in color, and approximately 93% water and 7% solutes.[30] One liter of human plasma contains about 930 grams (g) of water, 60 g of protein, 8 g of inorganic substances, such as $Na^+$, $K^+$, $Cl^-$, $Ca^{2+}$, hydrogen bicarbonate ($HCO_3^-$), and 2 g of nonprotein organic substances, such as glucose, glycerol, and fatty acids.[31] Plasma also contains dissolved gases (oxygen, nitrogen, carbon dioxide, hormones, enzymes, vitamins, pigments, minerals), a variety of cell waste products (urea, uric acid), and cell nutrients, such as amino acids.[30] The composition of plasma will vary due to the continuous movement of these substances in and out of the blood vessel's membrane.

General Functions of Blood

Blood is a living connective tissue made up of approximately 45% cellular elements and 55% intercellular fluid.[30] The role of blood in maintaining a stable internal environment includes transportation, defense against foreign agents, and the maintenance of internal temperature and pH.[30,31]

Blood is responsible for the transportation of many substances throughout various areas of the body for a variety of purposes. For example, oxygen and carbon dioxide are both carried by blood, which delivers oxygen to respiring tissues and removes carbon dioxide from the body by transporting it to the lungs where it is released through expiration. Other cellular wastes, including urea, uric acid, and excess water, are carried by blood to the organs of excretion.

Nutrients, electrolytes, and water are absorbed from the gastrointestinal tract and transported to body tissues through blood flow. Hormones and other chemical messengers are carried by blood from their sites of production to target cells. From the examples listed above, one can clearly understand that blood is the primary means by which substances are moved from one area of the body to another.[30]

Not only is blood an important means of transportation, it is also effective in defending the body against foreign agents. Some blood cells are capable of ingesting toxic substances and rendering them harmless to the human body, while other cells produce and release antibodies which in turn react with foreign agents leaving them harmless. Still further defensive processes of blood cells include the regulation of blood flow and blood clotting in response to injury.

In order to maintain a stable internal temperature, excess heat produced through body metabolism must be dissipated into the environment.[30] Blood is a component in the conduction of this excess heat from the body's core to the lungs, respiratory passageways, and skin where dissipation occurs. Blood also plays a major role in the regulation of extracellular fluid pH.

## Organization of the Circulatory System

The purpose of the circulatory system, which consists of arteries, arterioles, capillaries, venules, and veins, is to maintain a constant flow of blood to the tissues. The role of the arteries, arterioles, venules, and veins is to direct blood flow to and from the capillaries where the exchange of substances takes place.

The Arterial System

The aorta, arteries, and arterioles are responsible for carrying blood away from the heart to the various tissues within the body.  The arteries are large vessels which offer little resistance to the flow of blood.  Arterial walls consist of smooth muscle and elastic tissue which allows them to expand and recoil as variation in blood flow occur due to the contraction and relaxation of the heart.

The diameter of the arterioles is quite smaller than that of the arteries, which results in a large increase in the resistance to blood flow at this level of the circulatory system.  As the diameter of a vessel decreases, the resistance to flow increases.  Another factor affecting blood flow through the arterioles is the increase in the number of smooth muscle cells found at this level when compared to the arteries.  The smooth muscle cells are arranged so that when they contract they cause a decrease in the diameter of the arteriole resulting in further resistance to flow.  These two properties of high resistance and variable diameter of the arterioles allow the body to adjust blood flow through different organs and tissues.  Because the resistance to blood flow through the arterioles is greater than that through the arteries, the amount of blood distribution to a specific tissue region is determined almost entirely by the resistance of the arterioles.  Therefore, by adjusting the arteriolar diameter, individual tissues can regulate the distribution of local blood flow.[30]

The distribution of blood flow is regulated by three main factors:  vascular tone, input from the nervous system, and certain hormones.[30,31]  The contractile state or vascular tone of the smooth muscle determines the extent of local blood

flow.[31] Vascular tone is defined as the normally maintained contraction of the arterioral smooth muscle at all times. Resting vascular tone is important since an increase in activity of an organ demands greater blood flow which is achieved through relaxation of the arteriolar smooth muscle to produce dilation of the arteriole. Several factors, such as blood pressure and metabolic activity, can affect the resting tone of the arteriole. An increase in arterial blood pressure causes the arteries and arterioles to increase their diameters by stretching the elastic components in the artery wall. In turn, an increase of the vessel's radius occurs and decreases the resistance to blood flow. This stretching of the arteriole wall and its smooth muscle cells causes an increase in the number of membrane depolarizations which leads to an increased level of contraction. This increase in contractile activity secondary to the stretch of arteriolar smooth muscle cells is known as myogenic activity. An increase in myogenic activity controls the extent of vasodilatation so that an excessive amount of blood is not distributed to the region of involved tissues.[30-32] A decrease in blood pressure and flow results in decreased myogenic activity which causes vasodilatation in an attempt to minimize the reduction of blood flow through the tissue or organ. However, blood flow to many organs tends to remain fairly constant, despite changes in the blood pressure, through the process of autoregulation.

Increased metabolic activity calls for an increase in blood flow to the target tissues due to the chemical changes that occur as a result of cellular metabolism. The chemical changes include a decrease in oxygen concentration, an increase in carbon dioxide and other metabolic waste products, and an

increase in $K^+$ concentrations within the interstitial fluid of the vessel. All of these changes promote vasodilatation of the arteriolar smooth muscle and, in turn, increases local blood flow which returns the concentrations of oxygen, metabolic waste products, and $K^+$ to normal values.[30,31] The chemical changes are involved with the autoregulation process mentioned previously.

The sympathetic nervous system, which innervates most of the arterioles, causes a contraction of the smooth muscle found in arterial walls. Therefore, this system contributes to the resting tone and vasoconstriction of the arterioles. The parasympathetic nervous system releases a neurotransmitter that causes vasodilatation. However, parasympathetic nerve fibers are not very involved in the neural regulation of blood flow.[30] It appears that input from the nervous system will only result in vasoconstriction. This does not create a problem for two reason. First, in tissues that rely on a great deal of sympathetic input for normal blood flow, such as the skin, there is a high level of sympathetic nerve activity and, in turn, a high level of resting tone. Therefore, vasodilatation is achieved through a decrease in sympathetic nerve activity. Secondly, neural regulation of blood flow tends to come into play to restrict flow to nonessential organs during times of physiological stress.

There are a number of hormonal substances that affect local blood flow through the body. Relaxation and vasodilatation of the arterioles occurs in response to the binding of epinephrine to beta receptors of smooth muscle cells. Epinephrine can also bind to alpha receptors and cause vasoconstriction, but this only occurs at high concentrations of the hormone. The main effect of

epinephrine is to antagonize the vasoconstrictor activity of the sympathetic nervous system.

The Capillary System

The capillaries are a major point of communication between the interstitial fluid and the blood and consist of an extensive network of blood vessels that are only one cell thick.[31] Capillary walls contain no smooth muscle, only endothelial cells, but some will have a small band of smooth muscle at the beginning of the capillary known as the precapillary sphincter. Therefore, the activity of the arteriolar and precapillary sphincter smooth muscle will determine the blood flow through the capillary. The size and number of endothelial pores, small clefts located between endothelial cells that allow the passage of molecules, will vary from tissue to tissue.

There are three different mechanisms by which substances can cross the capillary wall: pinocytosis, diffusion, and bulk flow. Pinocytosis, the movement of large molecules across the capillary wall by vesicles that pinch off from the plasma membrane, accounts for a small portion of the total exchange.[30] Diffusion is the most important mechanism for exchange of water and dissolved substances.[30,31] As a result of concentration gradients, there is a movement of oxygen and glucose out of the capillary and carbon dioxide into the capillary. Molecules will diffuse across the capillary walls either through the pores or directly through the endothelial cells. Molecules that are only slightly soluble in lipids will diffuse through the pores, while lipid-soluble molecules will diffuse directly through the plasma membranes of the endothelial cells. Physical factors

that contribute to the rapid diffusion across the capillary walls include: 1) the small distance that molecules must move, 2) a large surface area of capillary walls, and 3) the slow rate of blood flow through the capillaries.

The exchange of water and dissolved substances also occurs through the endothelial cells by bulk flow which results from the pressure gradient between the inside and outside of the capillary. Water will flow out of the capillary because the pressure gradient is always from the inside of the capillary to the outside. The total exchange of fluid through bulk flow is usually quite small with an exception in the kidneys.

CHAPTER IV

MAGNETIC PROPERTIES

In order to gain a full understanding of magnetic therapy, a review of the properties of magnets themselves is necessary. This chapter will include a brief description of these properties along with several definitions of the terminology involved in magnetic therapy. The different types of configurations available for magnetic products will also be presented.

Magnetism

A permanent magnet, also known as a natural, premier, static, direct current (DC), steady, or solid state magnet, is composed of a north pole which presents with a negative charge and a south pole with a positive charge. Opposite poles will attract each other, while like poles will repel each other due to the charges present within the magnetic poles. The permanent magnet, which is made from iron or its alloy, is able to produce magnetic fields in the absence of an electrical current.[33] These magnetic fields will leave one end of a bar magnet (north pole), sweep around, and enter the other end (south pole). The forces will converge at the center of the magnet where the strength of the repelling fields is the weakest.[13,33] The magnetic field will weaken with distance from its source but will always be infinite, never coming to an end.[13]

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At this time, there is a general agreement among researchers that the north or negative pole promotes long-term healing and helps normalize metabolic functioning when applied at a high strength.[12,13,34] It is believed that the south or positive pole will introduce stress to the body, possibly causing exacerbation of symptoms, if used at a high strength for a prolonged period of time.[12,13,34] Prolonged exposure of the positive pole can interfere with metabolic function, produce acidity, decrease cellular oxygen supply, and encourage the replication of latent microorganisms.[12] However, a positive pole may be used to stimulate functions of various glands and is used in cases of chronic disease.[13] The strength of a magnetic field is measured in units called Gauss with every magnetic device given a Gauss rating by the manufacturer. The actual strength of the magnetic field at the skin's surface is often much less than the manufacturer's Gauss rating. For example, a magnet with a 4000 Gauss rating will only transmit 1200 Gauss to the patient.

When a magnet is manufactured, the material is exposed to a magnetic field of great strength causing the molecules present within the substance to align themselves in the same direction (similar poles pointing in the same direction) which is due to the magnetic component found in all molecules. This process of proper molecular alignment in the manufacturing of magnets is known as magnetization or magnetism with the strength of the magnet determined by the percentage of molecules that are aligned. Magnetism allows the magnetic field to present with a particular force and direction.

A distinction should be made between alternating current (AC) and DC fields. Alternating current electricity is produced by an electromagnetic field (EMF) composed of both electrical and magnetic field components. The electric field is due to the presence of charged particles and the magnetic field is due to the movement of the charged particles.[33,34] Alternating current electricity, supplied through power lines, is what runs appliances and electronics. Current research suggests that the 60 cycles per second (CPS) magnetic field created by the AC electrical current may be linked to cancer, childhood leukemia, learning disabilities, and reproductive difficulties.[13,34] Most human organs have a functional vibrating rate of approximately 7.96 CPS, while the heart and liver have a rate of 15 CPS which is also the natural pulsing frequency of the Earth.[13] Therefore, one can understand why a 60 CPS AC electric current may disturb the body systems by interrupting the natural body vibration rates.

A DC magnetic field can be produced either from DC electricity moving down a power line in one direction (still an EMF) or from a permanent magnet. The magnetic field created by a DC power line is not as harmful as an AC EMF, but is not a pure magnetic field. A solid state magnetic field has no detectable electrical field, no EMF, and is a pure magnetic field.[34] Direct current magnetic fields, which naturally occur on the surface of the Earth, are beneficial to life and have healing capabilities.[34]

Earth's Natural Magnetism

The human body is full of magnetic materials, affected by the Earth, sun, and almost everything electrical.[13] The Earth's surface presents with a negative

magnetic field which has been decreasing in strength in recent years. Research has shown that over the last 1,000 years this magnetic force has declined by 50%, with a 5% decline in the last 100 years.[6,13,34,35] Some physicists believe that within 1500 years a sufficient magnetic field to support life will be gone if the decline continues at its present rate.[13] Researchers believe that the decline of the magnetic field of the Earth is further complicated by modern hi-tech society with AC electricity and its positive magnetic field adversely affecting the natural magnetic fields of the Earth and blocking the human body from the benefits of the Earth's therapeutic fields.[6,13,34,35,36] Due to the overwhelming amount of electrical products that are used in modern times, researchers refer to the positive magnetic field of AC electricity as producing electromagnetic pollution or smog which disrupts the body's ability to heal itself.[34,36] This depletion of the electromagnetic systems of the body has been referred to as magnetic deficiency syndrome. This term was introduced in 1976 by Dr. Kyoichi Nakagawa, director of Tokyo's Isuzu Hospital. Symptoms he has associated with this syndrome include a lack of energy, insomnia, general aches and pains, upper back and neck stiffness, lower back problems, headaches, migraines, dizziness, memory loss, and changes in heartbeat and blood chemistry.[13,34] Many of these symptoms are similar to a deficiency in our society known as chronic pain syndrome. It is also interesting to note that when man first began space travel, returning astronauts required approximately six weeks for recuperation as a result of being away from the earth's magnetic field.[34] Today,
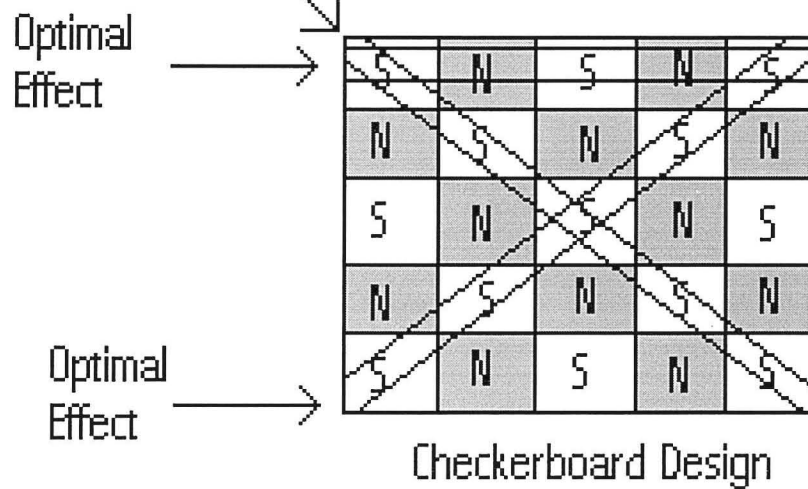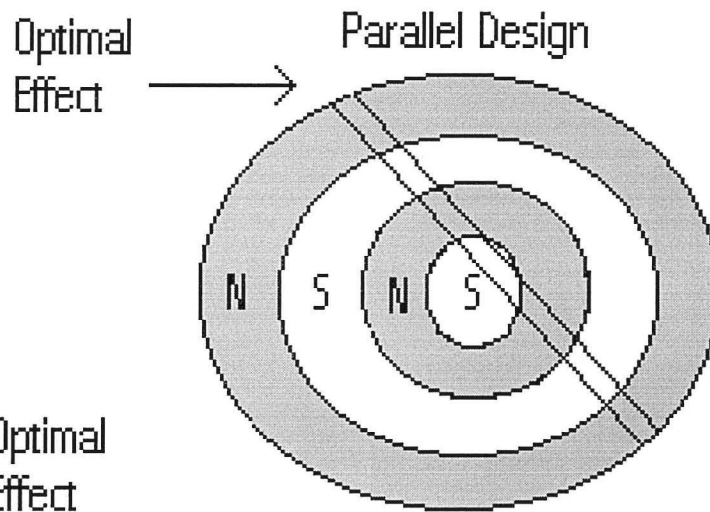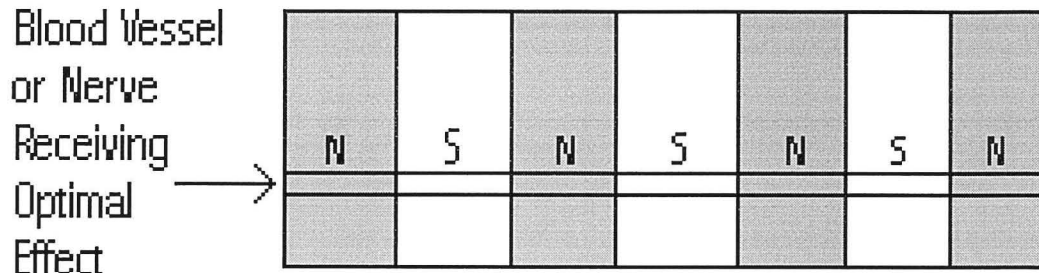
space suits are lined with magnetic material to minimize the recovery time needed after being in space.[34-36]

## Magnetic Configurations

Magnets used in magnetic therapy are flat with either a unipolar or bipolar design; using a random arrangement of magnets will not achieve beneficial results.[12,13] Unipolar magnets have only the north or negative pole facing the surface of the body, while bipolar magnets have a configuration of both north and south poles. Currently, there are three different types of bipolar magnetic designs available to the consumer: parallel, concentric, and checkerboard arrangements (Fig 2).

In 1981, Arno Latske, a Swiss scientist, was the first to arrange the polarity of magnets in an alternating parallel fashion.[10,11] The German scientist, Horst Baermann, later developed a concentric arrangement of alternating polarity magnets in rings.[10,11,13] This was an improvement over Laske's parallel design, but the therapeutic limit of 4 to 10 millimeters between existing poles was exceeded causing the magnetic field strength to be reduced.[13] In turn, a blood vessel traveling outside this area would not be affected by the magnetic field.

Recently, an American engineer, Vincent Ardizzone, created a checkerboard pattern by arranging alternating polarity magnets.[10,11,13] Each pole is adjacent to four alternating poles which greatly increases the range of effectiveness. Ardizzone also included a thin steel backing on his magnets that reflects the magnetic field strength and improves penetration by over 20%.[11] The flexibility and checkerboard design of the magnet allows it to be produced in any

Blood Vessel
or Nerve
Receiving
Optimal
Effect

| N | S | N | S | N | S | N |

Optimal
Effect

Parallel Design

Optimal
Effect

N S N S

Concentric Design

Optimal
Effect

Optimal
Effect

| S | N | S | N | S |
| N | S | N | S | N |
| S | N | | N | S |
| N | S | N | S | N |
| S | N | S | N | S |

Optimal
Effect

Checkerboard Design

shape or size without affecting its properties and effectiveness.  For these
reasons, many researchers believe that the checkerboard design is the best and
most versatile method of administrating magnetic therapy.[10,11]

In determining the effectiveness of a magnetic design, a principle of
physics known as the Hall Effect comes into consideration.  The Hall Effect
describes the behavior of charged particles moving through a magnetic field.  A
voltage is generated perpendicular to the flow of charged particles moving
through a magnetic field when that flow is directed perpendicular to the magnetic
fields.  The Hall Effect states that blood vessels traveling perpendicular to the
alternating magnetic polarities will achieve the greatest gains in therapeutic
effectiveness.  Therefore, as shown in figure 2, the checkerboard design of the
alternating magnetic polarities is most effective at influencing the majority of the
blood vessels and nerves which run at random angles throughout the body.

# CHAPTER V

## THERAPEUTIC EFFECTS OF MAGNETIC APPLICATION

As stated in previous chapters, the two major effects thought to be brought about through magnetic application are the blockage of pain transmission and local vasodilatation. In this chapter, the theories behind these effects of magnetic therapy will be presented along with the therapeutic differences between unipolar and bipolar applications. A brief discussion on the indications, contraindications and side effects, size and strength of the magnets, and duration of application time will also be included. Finally, the relevance of magnetic therapy to the practice of physical therapy will be outlined.

### Blockage of Pain Transmission

It is believed that the transmission of pain sensation can be diminished and possibly blocked through the application of natural magnets.[6,7,13,37] One theory states that the magnetic field apparently reduces the neural depolarization of only slow conducting C fibers which transmit long lasting, chronic, dull pain sensations.[37] This is achieved through the Hall Effect which affects those nerves running perpendicular to the magnetic field. Through the Hall Effect, a voltage is produced in those nerves running perpendicular to the magnetic field, adding to the nerve's resting membrane potential (-70 mV). The threshold value (-55 mV) is, therefore, more difficult to reach.[37] For example, with the resting membrane

potential at -70 mV, the additional voltage produced through the Hall Effect may change this value to -80 mV which would require an increased stimulus in order to reach the threshold value of -55 mV. This theory is critical when applied to those neurons experiencing chronic stimulation which causes the repolarization process to be less than optimal. The chronic condition creates a resting membrane potential of less than -70 mV, which means that a stimulus of decreased intensity can depolarize the neuron and, in turn, send a transmission of pain sensation to the CNS.[13,37] For example, a neuron experiencing chronic, continuous stimulation may only present with a -60 mV resting membrane potential which means a stimulus of only 5 mV would cause the nerve to depolarize and pain to be perceived.

Another theory on the diminished sensation of chronic pain involves the defection of ions found within and outside of the nerve membrane.[37] This also is believed to occur as a result of the Hall Effect. The deflecting action of the magnetic field on the ions could make it more difficult for the ions to pass through the nerve membrane. For example, $Na^+$ may be deflected from entering the axon hillock which, in turn, prevents an action potential from taking place. Either through the additional voltage produced or the deflection of nerve membrane ions or possibly a combination of the two, nerve depolarization is prevented and, in turn, the cycle of pain transmission is stopped.

## Vasodilatation

Along with blocking the transmission of pain, magnetic application is believed to promote vasodilatation of local blood vessels.[6,7,10,11,13,38] Through the

principle of the Hall Effect, ions found within blood vessels are deflected which causes heat to be produced within the vessel and, in turn, vasodilatation.[13,38] Vasodilatation leads to an increase in blood flow to the involved area which allows more oxygen and nutrients to reach the area and metabolic wastes to be removed. This process of removing wastes and supplying nutrients promotes repair and healing of the traumatized area. Although there are many different types of modalities which enhance local circulation, it is believed that magnetic therapy speeds the process as well as penetrates deeper into the body tissues.[13] Ultrasound can influence structures at a one or two centimeter (cm) depth and diathermy or hot packs at .5 cm or less. Magnetic fields, however, may penetrate as far as 5 to 20 cm, depending upon the strength of the magnetic device.[38-40]

## Unipolar Application

As previously mentioned, it is believed that the north pole of a permanent magnet promotes healing, while the south pole may create a counterproductive response.[12,13,34] Therefore, unipolar magnets generally consist of only the north pole facing the surface of the body upon application. For those who choose the unipolar design, the guidelines suggest a strength of 2000 to 4000 gauss with application of the magnet directly on the area being treated.[13,34] It is believed that the longer the magnet is applied to the injured area, the greater the symptom relief and more quickly it heals.[13] A duration time of 24 hours a day, daily until symptoms are relieved is recommended for unipolar application.[13,14] There have been no side effects attributed to the use of unipolar magnets at this

extended exposure time.[12,13,34] It is interesting to note that researchers in Japan do not believe that a therapeutic difference exists between north and south poles.[7] Therefore, unipolar design in this country includes not only the north pole but also the south pole.

## Bipolar Application

A second method of application of therapeutic magnetic fields is the use of spatially alternating magnetic poles. Supporters of this design believe that benefits can be gained more quickly and at a lower gauss rating than unipolar application.[13] However, bipolar application is not recommended for an acute injury with an onset of less than 24 hours old because of its greater influence on vasodilatation than the unipolar design.[13] As with unipolar design, the magnet should be directly applied over the involved area, but the strength of the bipolar magnet is recommended to be between 300 and 1300 gauss, considerably less than the unipolar magnet.[13,34] There is a wide variety of recommendations found in the literature for treatment time with the bipolar design. Some suggest duration times of less than one hour, while others recommend 24 hour use.[6,7,13,34] Again, this appears to depend on the specific strength of the magnet that has been chosen by the individual consumer.

Many sources warn against a habituation phenomena which may occur if either unipolar or bipolar design use is continued after symptoms have been relieved.[6,10,13,34] It is recommended that the use of magnetic products be discontinued once the ailment is absent.[34] This avoid the possibility that the

body will become accustomed to the magnetic fields and, in turn, not respond to magnetic therapy.

## Indications

There are a wide variety of suggested indications for which magnetic therapy may be beneficial. The following list includes some of the frequently recommended uses for magnetic therapy found in the literature:[3,6,8,13,14,16]

| | |
|---|---|
| Arthritis | Headaches |
| Carpal tunnel syndrome | Migraines |
| Insomnia | Hypertrophic scar prevention |
| Low back pain | Fractures and pain |
| Menstrual cramps | Fatigue |
| Chronic neck pain | Circulatory problems |
| Sciatica | Environmental stress |
| Temporomandibular joint dysfunction | |

## Contraindications/Precautions

Although there have been no adverse side effects attributed to the use of magnetic products, there are a few precautions suggested with their use. These precautions include not using magnetic devices on the abdomen during pregnancy and not sleeping on a magnetic mattress or pad for more than eight to ten hours.[6,12,13,34] Also, it is suggested to wait 60 to 90 minutes after meals before applying magnetic therapy to the abdomen as to not interfere with peristalsis.[34] Within the United States and Canada, it is recommended that individuals do not apply the positive magnetic pole to any part of the body unless

under medical supervision.[13] This procedure is in existence because it is believed that the south or positive pole can produce seizures, hallucinations, insomnia, hyperactivity, stimulate the growth of tumors and microorganisms, and promote additive behavior.[12,13,34] The use of magnetic devices should be discontinued if skin irritation occurs and should not be applied in areas of open wounds or infections.[12,13] One true contraindication to the use of magnetic therapy is the presence of a pacemaker.[6,7,11-13,34]

Relevance to Physical Therapy

From the indications listed previously, one can clearly understand how magnetic therapy may be implemented into the field of physical therapy. The proposed therapeutic effects of magnetic therapy are quite similar to those that result from many of the modalities currently in use among physical therapists, including ultrasound, diathermy, and hot packs. In cases or situations in which the desired results are not being met through modalities or therapeutic exercise, the physical therapist may suggest magnetic therapy to the patient. The proposed effects of magnetic application should be explained to the patient as well as the uncertainty and lack of concrete evidence currently in existence of the effectiveness of magnetic therapy among various individuals. The fact that these magnetic products are not covered by insurance companies in the United States needs to be made clear to the patient. Therefore, through the information provided by the physical therapist, the patient can decide if he/she wishes to purchase a magnetic product. If the patient does decide to make this purchase, the physical therapist can assist the patient in choosing a product that is suitable

for the symptoms or diagnosis. In cases where the physical therapist is unfamiliar with magnetic therapy, the patient may be referred to a health professional who has a background in this alternative approach to treatment.

CHAPTER VI

CONCLUSION

From the information presented within this literature review, one can

obviously see the controversy over the effectiveness of magnetic therapy.

Although there have been a number of studies performed on the benefits gained

through magnetic application in several foreign countries, little research has

been done within the United States. Therefore, companies and distributors in

the United States are prohibited from making any type of medical claims about

their products. Even in those countries that support the use of magnetic therapy,

such as Japan and Germany, researchers are uncertain of the exact effects

magnetic fields have on the physiological processes of the human body.

Even though the exact effects and outcomes of magnetic therapy are

unknown, individuals throughout the United States are purchasing these

alternative products. Therefore, health professionals need to have some

background information on the proposed effects and uses of magnetic products.

In conclusion, one can see the tremendous need for further research in

the field of magnetic therapy. Studies are needed to determine the exact effects

magnetic fields have on the human body. Additional research must be

completed to define the therapeutic difference between north and south pole

application as well as unipolar and bipolar design. Further areas requiring more

definite guidelines include the strength, location, and duration of magnetic application.  Magnetic therapy is an interesting alternative approach to treatment that appears to have great potential within the health care spectrum.

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