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The Optimal Treatment Time of Dry Cupping Therapy To Induce Changes in Local Blood Flow at the Upper Trapezius

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THE OPTIMAL TREATMENT TIME OF DRY CUPPING THERAPY TO INDUCE CHANGES IN LOCAL BLOOD FLOW AT THE UPPER TRAPEZIUS

EMILY SCHULTZ

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Context: Musculoskeletal neck and shoulder pain is a prevalent condition with nearly two-thirds of the population experiencing it sometime in their lifespan; factors may include activity level, sex, stress, and postural deficits. The treatment varies, but recent focus is on complementary and alternative medicine. Cupping therapy is a type of alternative medicine that involves a cup placed on the skin secured by suction for an unspecified amount of time. This therapy has been around for thousands of years, but there is much speculation around its true mechanisms on the human body; theories indicate that cupping therapy has an effect on blood flow, inflammation, and pain. Additionally, there has not been pre-defined parameters for the treatment of musculoskeletal pain conditions.

Objective: The purpose of this study was to examine if different dry cupping treatment times altered changes in superficial and deep subcutaneous tissue hemodynamics.

Design: Single-blinded, randomized crossover study

Setting: Athletic Training Laboratory

Participants: Thirty-two participants volunteered for this study. Participants were included if they were healthy individuals with non-specific neck pain. Participants were excluded if they had cupping therapy or any treatment performed within the past three months to the neck or shoulder area; history of head, neck, or shoulder injury within the past six months resulting in

medical care; known blood clotting disorder; allergy to lubricant; or the following medical conditions: hypertension, diabetes, cancer, pregnancy, cardiac failure, renal failure, allergic purpura, hernia, psoriasis, eczema, rosacea, varicose veins, phlebitis, hepatocirrhosis, allergic dermatitis, sunburn, open wound, fever, or were taking anticoagulants.

Interventions: Dry cupping therapy for 5, 7.5, and 10 minutes. Participants were randomly assigned to an intervention group using block randomization.

Outcome Measures: Subcutaneous hemodynamics (superficial and deep oxygenated, deoxygenated, and total hemoglobin) were collected and exported using the Near Infrared Spectroscopy (NIRS) Portamon. Change scores were calculated between baseline and immediate post-intervention, immediate and 10 minutes post-intervention, and baseline and 10 minutes post-intervention measurements. Statistical analyses were completed using repeated measures ANOVAs to compare changes in subcutaneous hemodynamics following different treatment times (5, 7.5, and 10 minutes).

Results: There was a main effect for superficial and deep oxygenated, deoxygenated, and total hemoglobin ($p \leq 0.001$). Post hoc analyses revealed that all treatment times increased hemoglobin levels immediately after intervention and maintained this increase over the 10-minute period for oxygenated and total hemoglobin levels.

Conclusions: Dry cupping therapy increases deep and superficial oxygenated, deoxygenated, and total hemoglobin levels at treatment times of 5, 7.5, and 10 minutes. This indicates that clinicians may be able to apply cupping therapy for a shorter period of time and maintain a significant increase in blood flow at the upper trapezius.

KEYWORDS: cupping therapy, neck pain, hemodynamics

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E.S.

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CHAPTER I: INTRODUCTION

Musculoskeletal neck and shoulder pain is prevalent in 16-78% of the general population,[1] with two-thirds of the population experiencing neck pain sometime in their lifespan.[2,3] Several different physiological and psychological factors such as activity level, sex,[8] stress, depression, anxiety, long work hours at a desk, and postural deficits can contribute to neck pain.[2,4] Previous research has demonstrated that general musculoskeletal pain associated with video display terminal work (i.e. working at a computer or monitor) have been reported by 63% of office workers, with 42% of these complaints were isolated to head and neck pain.[5] These factors lead to a condition known as "non-specific neck pain" in which musculoskeletal pain has a postural or mechanical basis, and cannot be attributed to a known injury to the area.[2,6] Traditional treatment for non-specific neck pain can vary depending upon the patient's needs, but options most frequently include exercise, manipulation, mobilization, or drugs such as muscle relaxants, NSAIDs, and analgesics.[2,7]

Aside from traditional methods of treatment, general musculoskeletal pain is the most common reason for seeking therapeutic alternatives to conventional medicine.[8,9] Neck pain is the second most common condition for which complementary therapies are used, and more than half of patients suffering from neck pain use complementary medicine in the United States.[10] Complementary and alternative medicine (CAM) is a group of diverse therapies and products that are not currently considered part of conventional medicine;[11] one form of CAM that may be used for neck pain is cupping therapy.

Cupping therapy is an ancient form of Traditional Chinese Medicine (TCM), and is considered a form of CAM.[12–16] It has recently become incorporated into Western medicine, following a significant rise in interest during the 2016 Summer Olympics in Rio de Janiero[17,18]

and questions arose about its effectiveness in treating and monitoring muscle soreness and injuries.[17] Prior to this, cupping therapy had been a valued tradition in Eastern medicine for thousands of years,[13,14,19,20] dating back to the Bo Shu, an ancient medical book written on silk, that was discovered in the tomb of the Han Dynasty in 1973.[21] Despite its long existing history and integration in many Eastern cultures and populations, there is little research and evidence to support its use in the ever-evolving Western medical systems.

This ancient technique of healing is demonstrated by applying cups to the skin and creating a sub-atmospheric pressure by heat or suction for an unspecified amount of time. Traditional dry cupping therapy applies the use of a glass or bamboo cup and an open flame to create the pressure gradient; modern medicine forms of dry cupping therapy use plastic or silicone cups with a manual hand pump.[22–24] Common areas of the body that cupping therapy may be used on include the neck, shoulders, back, or any part of abundant muscle where the cup is able to adequately provide suction.[14,22–24] Indications for cupping therapy most frequently focus on musculoskeletal pain conditions over the back, neck and shoulders,[17] but it has also been used for other medical ailments such as fibromyalgia and hypertension.[9]

The mechanism of cupping therapy, or way in which it physiologically affects the body has been a long-debated subject, and there is no clear understanding of its true effect on the human body. However, many cultures have claimed different theories behind its usage and some recent research texts have shown potential benefits.[24–27] TCM claims the theory that cupping therapy promotes the flow of qi and energy; cupping rids the body of toxins and "bad" energy that is blocking the flow of qi, and therefore restores the body to its original state of well-being.[24,25,27] Modern medicine views cupping therapy to have a more physiological benefit for the body by initiating the inflammatory response.[20] Some research suggests that the sub-

atmospheric pressure suction promotes blood circulation and improves immunity.[26] The effect of suction releases erythrocytes to the tissues and this excess blood elicits an inflammatory response; neutrophils arrive to the area, followed by macrophages that switch from pro-inflammatory to anti-inflammatory.[20] The activation of this system may induce anti-inflammation and anti-nociceptive effects on the musculoskeletal tissue that can result in a decrease in local inflammation and local pain.[20] Potential benefits may include increased lymphatic and blood flow, increased pain pressure thresholds, and reductions in inflammation and myofascial pain.[28] Along with the advantageous effects, cupping also comes with adverse effects. The most common adverse effects are erythema, edema, and ecchymosis at the application site that typically last 7-14 days post-intervention.[20]

In addition to the unknown mechanism, cupping therapy also lacks defined treatment parameters, especially the length of treatment. Although cupping therapy is continually used in clinics and sports medicine settings, a standardized treatment time has not been developed, nor explored in research. Some studies have recommended 5 to 10 minutes,[20] others have suggested 5 to 20 or 25 minutes,[23,27] and there is other evidence that mentions up to an hour of treatment.[9] These recommendations address treatment across the whole body, but there is a lack of evidence for a standardized treatment time across a specific muscular region that may influence local blood flow.

Therefore, the purpose of this study was to examine if different dry cupping treatment times altered changes in superficial and deep subcutaneous tissue hemodynamics. Researchers measured local hemodynamics at the upper trapezius for pre-intervention testing, then applied dry cupping therapy for 5, 7.5, or 10 minutes (dependent on the patient's random assignment), and finally re-assessed hemodynamics following the cupping interventions. The upper trapezius

was targeted in this study because it is a common site for musculoskeletal neck pain, and serves as a major neck extensor that is often shortened and tight. Researchers hypothesized that as treatment time increased, local blood flow levels would increase as well; thus, the 10-minute dry cupping therapy session would see the most improvement in local blood flow.

CHAPTER II: LITERATURE REVIEW

Anatomy

The neck is part of the axial skeleton and considered the cervical region of the spine; it serves the purpose of connecting the skull to the trunk of the body.[29–31] The shoulders are part of the appendicular skeleton; they are complex, ball-and-socket joints that provide the arms with movement around the trunk.[31–33] Together, these two regions of the body share similar anatomical structures and functions. It is important to have an understanding of this anatomy prior to the assessment or treatment of the body to ensure the overall safety of patients.

Skin

The skin, also known as the integumentary system, is the largest organ in the human body and accounts for nearly 15% of an individual's body weight.[34] It functions as several layers of protection and thermoregulation for the body.[34,35] It is the human body's defense system against the external environment, and plays an important role in the maintenance of homeostasis.[34,35] It is composed of three layers: the epidermis or outermost layer, the dermis or the core of the skin, and the hypodermis or subcutaneous tissue.[34,35]

The outermost layer is the epidermis which is composed of keratinized, stratified squamous epithelial cells.[34,35] This superficial layer is comprised of four or five layers of cells depending on the location in the body.[35] "Thin skin" accounts for most of the skin over the body and contains (deep to superficial) the stratum basale, stratum spinosum, stratum granulosum, and stratum corneum layers; "thick skin" accounts for the palms of the hands and the soles of the feet, and has an additional layer known as the stratum lucidum.[34,35] The epidermis is avascular and consists of keratinocyte cells that contribute to the hardness and water-resistant properties of skin.[35] This layer is consistently renewing itself, shedding dead cells, and regenerating new cells

to protect the underlying tissues.[34,35] The epidermis also consists of accessory structures such as the finger and toe nails, sweat glands, and also hair follicles.[34]

The next layer of skin is the dermis. The dermis is an integrated system of fibrous connective tissue that contains blood and lymph vessels, nerves, and also the accessory structures of sweat glands and hair follicles.[34,35] The dermis serves the purpose of maintaining pliable, elastic, and tensile strength of the skin; this layer comprises the bulk of the skin.[34,35] The dermis is mainly composed of fibroblasts, and collagen fibers;[34,35] these specific cells aid in the strength of the skin and also divide the dermis into two layers: the papillary layer, and reticular layer.[35] The papillary layer connects to the deepest layer of the epidermis, whereas the reticular layer is much more dense and consists of the vast vascular and nerve supply.[35]

Underlying these layers of skin is a buffer layer of subcutaneous fat tissue, also known as the hypodermis. This layer is used for cushioning to internal organs and structures, but also for energy storage and connection to the underlying fascia of bone and muscle.[34,35] The hypodermis is mainly loose connective tissue composed of lipocytes or fat cells that are separated by fibrous tissue made up of blood vessels and collagen.[34,35]

Bone

The cervical spine is an extremely significant region of the body as it serves the purpose of supporting the 10-15 pound weight of the head; in this position it is subjected to stress and strain in daily activities such as sitting, standing, walking, etc.[36] The bony anatomy of the neck consists of seven cervical vertebrae of the spine.[30,31] The first (C_1) and second (C_2) vertebrae perform very unique and important roles in the support of the skull; C_1 is also known as the atlas on which the skull rests and bares the most weight, and C_2 is also known as the axis on which the skull is able to move and connects to the remainder of the spine.[30,35] The last vertebrae of the

neck, C_7, serves as the base of the neck at which it attaches to the thoracic vertebrae.[30] The cervical region of the spine is able to perform six movements: flexion, extension, right and left lateral flexion, and right and left rotation. This region of the body is designed to be highly mobile, therefore the vertebrae are much smaller than the rest of the spine, and the intervertebral discs are much more ligamentous.[31,35,36]

Branching laterally from the spine is the shoulder complex. The bony anatomy of the shoulder complex consists of three bones: the clavicle, humerus, and scapula.[31–33] Together these bones create three joints and one articulation within the shoulder complex: the acromioclavicular joint where the acromion process (point of the scapula) meets the clavicle,[32,33] the glenohumeral joint where the head of the humerus meets the glenoid cavity of the scapula,[32,33] the sternoclavicular joint where the clavicle meets the sternum,[32,33] and lastly the scapulothoracic articulation where the scapula lays over the thoracic region of the spine and ribs.[33] The clavicle and scapula serve the purpose of anchoring muscles of the upper limbs, and also transmitting forces between the axial and appendicular skeletons.[35] The humerus makes up the upper arm; the head of the humerus rests in the glenoid fossa making the ball and socket joint,[35] which is most commonly addressed as the shoulder by most of the general population. The shoulder complex is able to perform nine movements: flexion, extension, abduction, adduction, horizontal abduction, horizontal adduction, internal rotation, external rotation and circumduction.[31–33]

Muscle

Skeletal muscle has the ability to contract and cause movement, but also acts to stop movement such as resisting gravity.[35] Skeletal muscular tissue is highly vascularized, and contains many nerve fibers that initiate and transmit signals between the brain and the muscle telling it to move.[35] This tissue has several layers, similar to skin: epimysium, fascicle,

perimysium, and endomysium. The epimysium is the outermost layer of dense, irregular connective tissue that separates muscles from other tissues and organs in the body, allowing them to move independently.[35] The fascicles are individuals bundles within a muscle that contain several muscle fibers; the perimysium serves the purpose of separating these fascicles.[35] Finally the endomysium is that deepest layer that contains extracellular fluid and nutrients to supply the individual muscle fibers.[35]

The head, neck, and shoulders share similar muscular structures, as the muscles perform several functions and may overlap multiple joints. Muscles that originate from the axial skeleton help to move the head in different directions. This study focuses on the neck and shoulder anatomy that interact and cross through the cervical region, specifically on the lateral and posterior sides.

The major head flexors include the sternocleidomastoid (SCM) and scalenes.[35,37] The SCM is a two-headed muscle located deep to the platysma on the anterolateral surface of the neck.[29,35,37] The SCM muscles originate at the manubrium of the sternum and the medial portion of the clavicle.[29,35,37] They insert at the mastoid process of the temporal bone, and the superior nuchal line of the occipital bone.[29,35,37] The SCM muscles act to flex and laterally rotate the neck.[35,37] The scalenes consist of three muscles (anterior, middle, and posterior) that are located more laterally on the neck, deep to the SCM and platysma.[35,37] The scalenes originate on the transverse processes of the cervical vertebrae.[35,37] They insert on the anterolateral side of the first two ribs.[35,37] The scalenes act to elevate the first two ribs, and they also aid in flexion and rotation of the neck.[35,37]

The major head extensors are the splenius muscles, which are also aided by the trapezius muscles.[35,37] The splenius muscle is a broad, bipartite superficial muscle that extends from the

upper thoracic vertebrae to the skull.[35,37] The splenius muscle originates on the spinous processes of the vertebrae C_7 through T_6.[35,37] It inserts on the mastoid process of the temporal bone and the occipital bone.[35,37] The splenius muscle acts to extend or hyperextend the neck, and they also work in neck rotation.[35,37]

The trapezius muscles consists of three muscles (upper, middle, and lower) that are the most superficial muscles of the posterior thorax; they are flat and triangular in shape, and the upper fibers run inferiorly to the scapula.[29,32,35,37] The trapezius muscles originate at the occipital bone, and the spinous processes of C_7 through T_{12} [29,32,35,37]. They have a continuous insertion along the acromion and the spine of the scapula.[29,32,35,37] The trapezius muscles act to stabilize, raise, retract, and rotate the scapula; they also function in neck extension.[29,35,37]

The shoulder complex uses several muscles to aid in the nine major movements of the joint; the muscular anatomy is extensive, but only few muscles interact at both the shoulder and cervical regions. Such muscles include the trapezius muscles and the levator scapulae.

The levator scapulae is located on the posterior and lateral side of the neck, deep to the trapezius muscle.[35,37] The levator scapulae muscle originates on the transverse processes of C_1 through C_4.[35,37] It inserts on the medial border of the scapula just superior to the spine of the scapula.[35,37] The levator scapulae acts to elevate and adduct the scapula.[35,37]

Nerve Innervation

Each muscle is innervated by a nerve or groups of nerves in order to receive and transmit impulses. This is also known as the peripheral nervous system; the nerves within muscular tissue communicate back to the nerves in the spinal cord.[35] Two specific types of nerves help with signal transmission throughout the body: cranial nerves, and spinal nerves. The cranial nerves (12) are attached to the brain and are primarily responsible for the sensory and motor functions

of the head and neck.[35] The spinal nerves (31) are connected to the spinal cord and are responsible for the function of the rest of the body.[35]

The SCM muscles are innervated by the accessory nerve (cranial nerve XI), and branches of cervical spinal nerves C_2 and C_3.[35,37] The scalenes and the splenius are innervated by the cervical spinal nerves.[35,37] Additionally, the trapezius muscles are innervated by the accessory nerve (cranial nerve XI), as well as spinal nerves C_3 and C_4.[32,35,37] The levator scapulae is innervated by the cervical spinal nerves and the dorsal scapular nerve (C_3-C_5).[32,35,37] Cranial nerve XI, or the accessory nerve, enters the skull through the foramen magnum and exits the skull through the jugular foramen with the vagus nerves, and supplies two large neck muscles.[35,37] It supplies motor fibers to the trapezius and SCM muscles, which together move the head and neck, and convey proprioceptor impulses from same muscles.[35,37]

The cervical spinal nerves, also known as the cervical plexus, contains mostly branches that are cutaneous nerves that supply only the skin, but there are deeper motor branches that supply muscular structures.[35,37] Nerves C_1 through C_5 supply innervation to deep muscles of the neck and also the scalenes, levator scapulae, trapezius, and SCM muscles.[29,35,37]

The brachial plexus, although it does not supply any nerve innervation to the muscles discussed in the cervical region, does pass through the cervical region and shoulder complex.[29,35] It is important to be aware of the brachial plexus when performing treatment to the neck or shoulder region.

Vasculature

The circulatory system supplies the entire human body with oxygenated blood and nutrients, while also eliminating de-oxygenated blood from different areas.[35] The circulatory system stems from the heart where blood is consistently pumped in and out to perform daily

functions. There are two important blood vessels that carry out these roles: arteries, and veins. Arteries are blood vessels that carry oxygenated blood away from the heart to muscles, organs, and other tissues within the body.[35] Arteries are then broken down into smaller vessels known as arterioles and capillaries that are able to reach tissues and exchange blood and nutrients.[35] Veins are blood vessels that carry de-oxygenated blood to the heart from those muscles and organs.[35]

The neck and upper shoulder regions are highly vascularized areas. Stemming from the aortic arch there are multiple arteries, and stemming from the superior vena cava there are multiple veins to note that run through the neck and shoulder region.[35,37] It is important to keep these vascular structures in mind when performing treatment in the neck and shoulder region; it is often precautioned and contraindicated to perform any treatment directly over an artery or vein.[19,26]

The common carotid arteries ascend through the lateral neck and branch into internal and external carotid arteries.[29,35,37] These arteries supply oxygenated blood to tissues of the head and brain. The upper limbs of the body are supplied entirely by branches stemming from the subclavian arteries. The subclavian arteries supply branches that run through the neck and cervical spine, but following those branches, each subclavian artery course laterally between the clavicle and the first rib to enter the axilla, where it becomes the axillary artery.[32,35,37] The axillary artery then descends through the arm and branches off to supply forearm structures.[35,37]

There are also several veins that cross through the neck and shoulder region that help drain the deoxygenated blood from those tissues. The jugular veins drain the superficial scalp and face structures that are supplied by the external carotid arteries.[35,37] Both the right and left external jugular veins descend through the lateral neck, pass over the SCM muscles, and empty into the subclavian veins.[35,37] The subclavian veins receive drainage from the axillary veins that

service the upper limbs; this blood is then emptied into the brachiocephalic veins, and right into the superior vena cava.[35,37]

Lymph

Lastly, there is also lymphatic circulation to note in the cervical and upper extremity regions. The lymphatic system is closely intertwined with the blood circulation system. At the capillary level, both blood and lymphatic capillaries interact to exchange nutrients.[35] The lymphatic capillaries act to return excess tissue fluid to the bloodstream, return leaked proteins to the blood, and carry absorbed fat from the intestine to the blood.[35,37] There are a number of lymphatic vessels all over the body, but particularly at the neck and shoulder region there are two main ducts that help drain fluid into the veins.[35,37]

On the right side, all lymphatic fluid is drained by the right lymphatic duct into the internal jugular veins and subclavian veins.[32,35,37] On the left side, all lymphatic fluid is drained by the thoracic duct into the internal jugular veins and subclavian veins.[32,35,37] There also lymph nodes present; cervical nodes are located along the lateral side of the neck, as well as axillary nodes are located near the axilla.[35,37]

The Healing Process

There are three specific stages of the musculoskeletal healing process: acute inflammatory response, fibroblastic repair and regeneration, and maturation-remodeling.[31,38] The acute inflammatory response phase occurs immediately following an injury to the tissue, up to 72 hours.[31,38,39] The purpose of this phase is to increase blood flow to the area, mobilize, and transport cells to initiate healing.[31,38] During this phase, leukocytes, including neutrophils and macrophages, flood the injured area; blood clotting begins to occur, so there is immediate vasoconstriction, followed by vasodilation of increased blood flow and inflammation, as well as

increased cellular permeability.[31,38,39] The repair and regeneration phase begins 48 hours after injury, up to 6 weeks.[31,38] The purpose of this phase is to form new collagen fibrous tissue.[31] This phase interacts closely with the acute inflammatory response, as the macrophages switch from pro-inflammatory to anti-inflammatory characteristics; scar tissue begins to be laid down in a haphazard nature and inflammation begins to subside.[31,38–40] Lastly, the remodeling phase begins anywhere from 3 weeks after injury, and can take up to a year to become fully complete.[31,38] The purpose of this phase is to increase the organization of the new collagen fibers.[31] This phase works to organize and tighten the scar tissue and restore function to the tissue.[31]

Focus for therapeutic modalities and treatment methods lies heavily on the acute inflammatory response phase by reducing the inflammation and controlling the amount of pain and swelling present at the site of injury.[31] Rest, cryotherapy, compression, elevation, and electrical stimulation are among methods that are used to control the acute inflammatory response.[31] Inflammation is necessary for the healing process to begin and continue working to repair the tissue; it specifically dilutes and inactivates toxins, provides nutrients to cells, and provides antibodies for infection.[31,38] These therapeutic methods and tools are used to control the inflammation, not eliminate it; excess inflammation can be detrimental to the healing process, but no inflammation can also be detrimental.

Musculoskeletal Neck Pain

Neck and shoulder musculoskeletal pain typically occurs in middle and older age populations.[1,2] According to Chi et al.,[1] neck and shoulder pain is prevalent in 16%-78% of the general population;[1] more specifically it has been reported that two-thirds of the population will experience neck pain in their life.[2,3]

A study from the World Health Organization, from 2000 to 2012, reported that neck pain is the second leading cause of years lived with a disability;[8] although the Global Burden of Disease published a study that mentioned neck pain is globally the fourth largest complaint in regards to years lived with a disability.[41] Kim et al.[42] stated that the lifelong prevalence of neck pain in adults (ages 18+) ranges from 14.2%- 71%;[42] additionally Lauche et al.[4] reported that the average lifetime prevalence of neck pain is 48.5%.[4] Neck pain typically resolves within 3-6 months,[4] but it can progress to chronic conditions, with reports of 25%-60% of patients developing chronic neck or back pain within the first year.[42] Furthermore, neck pain in the general working population will persist and re-occur with ranges of 50%-85% of people reporting neck pain 1-5 years later.[41]

Neck pain is dominant in high activity age groups 35-49, and it is more common among women.[2–4] Physiological and psychological factors such as stress, anxiety, depression, long work hours at a desk, and postural deficits can contribute to neck pain.[2,4] A study from Kim et al.[5] demonstrated that symptoms associated with video display terminal work, for instance working at a computer or monitor, have been increasingly reported.[5] Specifically, 63% of office workers complain of musculoskeletal pain, with 42% of them suffering from head and neck pain.[5] These factors lead to a condition known as “non-specific neck pain” in which the pain has a postural or mechanical basis and cannot be correlated to a specific injury to that area.[2–4,43]

The prevalence of neck pain is directly associated with escalated medical costs and negative impact of productivity, which can potentially increase long term absences from work.[43] The Journal of Chinese Medical Sciences reported that nearly 80% of all visits to general practitioners involve at least one complaint of pain.[9] Particularly, 75% of Americans have experienced chronic or recurrent pain that is costing 200 billion dollars annually.[9]

Treatment

Traditional treatment for non-specific neck pain can vary dependent upon the patient's needs, but options most frequently include exercise, manipulation, mobilization, or drugs such as muscle relaxants, NSAIDs, and analgesics.[2,7] It has been indicated that manipulation and or mobilization combined with at least two therapeutic modalities, including exercises, is beneficial for pain management and functionality.[44]

Aside from traditional methods of treatment, general musculoskeletal pain is the most common reason for seeking therapeutic alternatives to conventional medicine.[8,9] More specifically, neck pain is the second most common condition for which complementary therapies are used; and more than half of patients suffering from neck pain use complementary medicine in the United States.[10] In a study published in 2002, 74.6% of adults over the age of 18 used complementary and alternative medicine (CAM); moreover, 53.5% of 18-29 year-olds used CAM.[11] The most common uses for treatment were back pain, neck pain, and anxiety and depression.[11,45] 28% of people stated their reason for seeking alternative treatment was because they thought conventional medicine would not help them; additionally, 13% of people said they felt conventional medicine was too expensive.[11] Complementary and alternative medicine includes a group of diverse therapies and products that are not currently considered part of conventional medicine.[11,45,46] One alternative form to traditional methods of medicine, that can be commonly used for neck pain, is cupping therapy.

Cupping Therapy

History

Cupping therapy is an ancient form of Traditional Chinese Medicine (TCM) that has been practiced for over 2000 years.[12,14,16,21,47] It is a popular treatment method in Chinese, Korean,

Japanese, and Saudi Arabian cultures;[13] particularly, it is an important therapeutic modality in China, but has been gaining recognition elsewhere.[48] It is now practiced worldwide and among different cultures to manage health problems.[9,14] This ancient technique has notably become a popular form of treatment for soft tissue injuries.[28]

Cupping therapy has been practiced in Middle-eastern cultures dating back to Hippocrates in 400 BC.[14,19,20,49,50] Dry cupping therapy is often practiced in the Far East, whereas wet cupping therapy is practiced more in the Middle East and Eastern Europe.[49,51] It was not until the ancient Egyptians first embraced cupping that it had made its way to the Western world.[49]

The earliest confirmed record of cupping therapy comes from the Bo Shu, an ancient book written on silk; this text was found in the tomb of the Han Dynasty in 1973.[21] It is part of the Mawangdui Silk Texts, a set of Chinese philosophical and medical works written on silk, that were buried in a tomb sealed in 168 BC.[49] Although, this is the earliest mention of cupping therapy, many other research texts consider Eber's Papyrus to be the cornerstone of cupping therapy's history. Eber's Papyrus is an ancient medical text dating back to 1550 BC.[9,14,19,20,23,26,50,52]

Cupping therapy is an ancient technique of healing[26] and frequently used as a treatment method for blood diseases, rheumatic conditions, and general physical and mental well-being.[49] Cupping therapy has been employed for facilitating the circulation of qi and blood, and removing blood stasis using cupping devices through suction and negative pressure in Korea.[5,14]

Cupping therapy is a significant part of complementary and alternative medicine (CAM).[14,15,51] CAM is becoming more popular with the public and gaining more credibility within biomedical health care.[49] Mainstream healthcare is increasingly interested in CAM[49] as it

is taking on a more important role in human health and welfare.[9,43] Slightly more than 1/3 of the US population has used CAM,[49] with much of that interest after the 2016 Summer Olympics when was athletes were seen with circular bruises on their back and shoulders.[17,18]

Mechanism

Despite the long history and recent renewal of interest there is little known about the efficacy and safety of cupping therapy.[17] It has been proposed as an effective treatment for pain,[49] whereas other research suggests that the mode of action to reduce pain is unclear.[53] The effect on pain reduction has not yet been fully elucidated, but different mechanisms are attributed to cupping such as metabolic and neuronal hypotheses;[12] these hypotheses state that cupping may induce pain reduction due to decreased muscle activity and local vasodilation, or altered pain signals.

The medical field has stated there is no clear identified mechanism of action for cupping therapy because there is no reliable scientific data clarifying the exact mechanism of therapeutic effects,[23,26] although various texts suggest theories to support its use. Despite these uncertain stances on the mechanism of action, recent research has indicated that the suction created by negative pressure may induce hyperemia and hemostasis [25]; this placement over selected acupoints may result in a therapeutic effect.[48]

Cupping therapy involves the use of a hollow vessel being attached to the skin by suction in order to prevent and cure diseases.[27] This suction can impose a tensile stress on the subcutaneous tissues which can result in the surface tissues and deeper layers being drawn into the cup.[54] Cupping therapy creates a vacuum on the skin, ensuing negative pressure and resulting in capillary rupture; the skin of the localized area becomes flushed and may show petechiae and ecchymosis.[1] The lowered pressure causes a pressure differential between the skin and the

underlying blood vessels, this elicits an almost immediate visible vasodilation of the superficial capillaries which produces the localized hyperemia.[20]

Postulated modes of action include: interruption of blood circulation and congestion, as well as stopping the inflammatory extravasations from the tissues can affect the autonomic nervous system and help reduce pain.[8] Cupping therapy is applied to increase blood and lymph circulation, and to relieve painful muscle tension.[4,10,15,52]

A proposed mechanism states that the sub-atmospheric pressure suction promotes peripheral blood circulation and improves immunity.[26] Early studies found that cupping therapy could increase blood flow in the local area;[1] this increased blood flow in the muscle may be one of the mechanisms that demonstrates cupping affects localized pain symptoms.[20] The effect of suction releases erythrocytes to the tissues and this excess blood elicits an inflammatory response; neutrophils arrive to the area, followed by macrophages that switch from pro-inflammatory to anti-inflammatory.[20] The activation of this system may induce anti-inflammation and anti-nociceptive effects on the musculoskeletal tissue that can result in a decrease in local inflammation and local pain.[20] Another suggested mechanism states cupping might influence ROM as it increases local circulation, which promotes tissue elongation and decreased muscle tension.[28]

In an attempt to understand the mechanism of cupping therapy, there have been a number of purposed theories indicating the means of cupping therapy treatment. Cupping has similarities to acupuncture and acupressure, that being all are among different approaches of treatment for pain in many Eastern cultures; so some researchers have accepted the mechanism for those treatments to be the same for cupping therapy.[23,26,49] In this instance, the most relevant hypothesis behind the effects of acupuncture analgesia is the neural mechanism theory; this

states that treatment stimulates small nerves in muscles, which then send signals to the spinal cord and activates the release of chemical transmitters that block pain signals.[23]

The TCM theory states that cupping therapy is aimed at regulating the flow of qi and blood in the channels; pain is usually caused by stagnation of qi and blood, thus removing the stagnated qi and blood will relieve the pain.[24,25,27,43] The aim of cupping is to extract blood that is believed to be harmful from the body, which in turn rids the body of potential harm from symptoms that reduce the well-being of the body.[14,49] The rationale for its use is not fully understood, but it has been described as a detoxification process by which waste matter and toxins are removed, and as harmonization process for the imbalance of qi.[42]

On the contrary, the biomedical point of view says that there is mechanical stimulation due to the negative pressure in the cup that activates the local tissue metabolism, intensifies phagocytosis, and promotes a healing response.[27] Metabolic hypotheses suggest that cupping decreases an increased muscle activity which results in pain reductions, including effects of visible redness of the skin and local vasodilation have been reported to improve microcirculation.[53] Neuronal hypotheses assume that cupping influences chronic pain by altering the signal processing at the level of the nociceptor, the spinal cord, and also the brain.[23,51,53]

Another approach in the debate of the mechanism of cupping came in 1920. Epstein proposed the "counter-irritation" theory; this theory indicates cupping therapy transfers discomfort and pain from one site of the body to another site, thereby curing the original site.[22,23]

Lastly, the psychosomatic theory indicates that cupping therapy is purely a placebo effect.[22] A placebo effect is described as a beneficial effect produced by a treatment, in this case cupping therapy, that cannot be attributed to the treatment itself, and therefore must be due to the

patient's belief in the treatment; the patient has an expectation the treatment will work, so it works.[55]

Application of Cupping Therapy

The World Health Organization (WHO) defined cupping therapy as: the application of suction by creating a vacuum.[1,9] Cupping therapy uses fire or air suction to exhaust the air within the cups to create negative pressure so the cups could be adhered to the skin area.[18,42,54,56] Traditional methods include fire in a cup or jar, and attaching it on the dermis of the affected part of the body.[1] Modern methods include applying plastic or silicone cups over the skin to create negative pressure by a manual hand pump for an unspecified amount of time.[52]

Classifications of Cupping Therapy

Literature most commonly classifies two types of cupping therapy: wet and dry.[19,50–52] Additional research has explored more methods of cupping such as retained, flash, moving, medicinal, and needling cupping.[48] Cupping therapy can also be broken down into categories based on: technical, power, method, materials, area treated, and other methods.[52] The most applied technique is dry cupping specifically for lumbar and cervical regions.[12] Dry cupping therapy can also be known as static or retained cupping; it is non-invasive with no bloodletting.[19,50,52]

Types of Cups

The main process of cupping therapy, or the traditional way, is to use glass or bamboo; [8,17,21,48,57] some research references the use of animal horns.[27] Traditional cupping applies the use of glass cups with fire to initiate the pressure gradient; modern cupping applies the use of plastic cups with a manual pump.[22–24] It is increasingly performed with plastic cups,[12] as well as disposable cups are used due to their high sterilization.[12] Whether it be glass, bamboo, plastic, or

rubber cups, they are applied to the skin to create a vacuum over the target area.[9] The size of the cups used in therapy may range in diameter from 38 to 50mm.[23,24] It has been observed that maximum stress was found in larger cups, whereas there was minimum stress in smaller cups.[23]

Treatment Parameters

Cupping therapy is typically performed on a painful area or desired acupressure point.[8,21,51] A survey of Korean doctors showed that 96% used cupping for musculoskeletal issues;[5] additionally, 94% reported the most frequent treatment areas to be the neck and shoulders [5]. Common areas for cupping include the back, chest, abdomen, buttock, and other areas of abundant muscle;[14,22–24] it is important to note to avoid areas with lots of hair, little muscle tissue, and small surface areas as these could lead to the cup falling off or not creating enough suction to affect change in the tissue.[19]

The treatment time is varied across many research articles with no clear consensus. One article has stated to place cups on the site for 5-25 minutes on adults, or 5-15 minutes on children.[27] Other research has indicated 5-10 minutes[20] or 5-20 minutes across the general population.[23] Another study had suggested the use of cupping on the skin for 15 minutes up to one hour.[9] On average, cupping therapy is applied in at least five sessions for about 8 minutes with an interval of 3-4 days between each session;[12] researchers have suggested that at least five sessions is needed for any significant effects to appear.[12]

Another variable that is undefined is the strength of suction. Suction strength is not standardized in the treatment of cupping therapy, but a study by Moura et al.[12] has demonstrated a general guideline for amount of pressure: 2 pumps is considered light pressure, 3-4 pumps is considered medium pressure, and 5 or more pumps is considered strong pressure.[12] Medium pressure has been indicated for painful conditions.[12]

Indications and Contraindications

Cupping therapy is used for a variety of ailments, but few are supported by evidence.[28] Various therapeutic functions include: dispelling exogenous pathogens, relieving swelling, alleviating pain, warming channels to expel the cold, promoting qi and blood circulation, accelerating healing and regulating body temp.[27] Cupping therapy can be applied to extensive curable diseases such as pain, cardiovascular disease (CVD), immune system diseases, metabolic diseases, migraines, low back pain (LBP), fibromyalgia, shoulder pain, and chronic neck pain.[13]

There are reported benefits for reducing local chronic pain symptoms[16] such as low back pain (LBP), neck and shoulder pain (NSP), headaches, migraines, knee pain, facial paralysis, carpal tunnel, hypertension, asthma, and rheumatoid arthritis.[9,17,19,21,23,25,42] Additionally, there have been studies that have explored the effects on fibromyalgia and knee osteoarthritis,[18] as well as other diseases such as herpes, cough and dyspnea.[48] The most common indications for dry cupping therapy include local myofascial pain, specifically neck pain (NP) and LBP; effects on other diseases have been investigated, but the evidence is limited.

Precautions of cupping therapy include: avoid uneven or hairy areas, choose a proper body position and size of cup, do not place over areas of dermatitis, ulceration, swelling, or artery or heart, not advisable on abdominal, sacral, or breast regions, and do not use on patients with bleeding disorders.[27] Contraindications include: pregnancy, women menstruating, cancer, bone fractures, muscle spasms, deep vein thrombosis (DVT), and ulcers.[19,23,49,50] Additionally, cupping should not be applied directly on veins, arteries, skin inflammation, skin lesions, eyes, lymph nodes, varicose veins, open wounds, and/or fractures.[19,26,50]

Benefits

Previous research has demonstrated that cupping therapy may effect soft tissues by decreasing muscle tension, and facilitating elongation due to the effects of increased blood flow.[28] It has also been noted that cupping therapy effectively treats pain and enhances a patient's well-being.[52] Common effects of cupping therapy include: increase of pain pressure thresholds, reduction of inflammation,[13,26] local tissue stretching, releasing of myofascial and scar tissue, decreasing skin stiffness, pain reductions, and improved blood flow and oxygenation.[54]

Cupping therapy has shown to increase local blood flow to the desired area by causing rupturing of the capillaries on the skin's surface; this is thought to increase blood flow by bringing oxygenated blood and nutrients to the damaged tissues. Another study suggests that the acute effects might be related to an interruption of microcirculation in the tissues underneath the cupping glass, cutting off oxygen supply during the application.[17]

One study that used cupping therapy for anterior knee pain, concluded there was an increase in active and passive ROM, as well as a reduction in pain, and increase in well-being scores.[49] There were statistically significant differences in passive and active ROM, VAS scores, well-being VAS scores before and after cupping immediately after, 1 week post-, 2 week post-, and 3 week post-intervention.[49] Additionally, the pain perceived by patients was significantly lower than baseline scores.[49] Pain reductions can be attributed to rationale that cupping therapy can elicit the release of endorphins, serotonin, or cortisol.[49] Biological effects in conjunction with psychological uses of cupping induce a feeling of physical and psychological well-being.[49]

Another study by Liu et al.[56] demonstrated that following a cupping therapy session of 10 minutes with a pressure of 0.04MPa, blood flow increased at several sites on the back

immediately after cup removal.[56] Blood flow exhibited a trend at 5 minutes, 10 minutes, 15 minutes, and 20 minutes post-intervention by continually decreasing.[56]

Chi et al.[1] used fire cupping at three acupoints on the neck for 10 minutes; results showed significant differences in neck and shoulder pain (NSP) indexes between the intervention and control groups after cupping.[1] The study determined cupping therapy can cause vasodilation and stimulate blood circulation to increase metabolism and accelerate the elimination of waste and toxins from the body.[1] They also concluded cupping therapy increases blood flow to the cupped region and the patient may experiences warmth as a results of vasodilation.[1]

Various other studies demonstrated similar results. Kim et al.[5] performed cupping therapy at 6-10 tender points on the posterior neck and upper trapezius for 10 minutes with a pressure of 3-5 pumps.[5] Their results demonstrated significantly improved neck pain after 1 week and 4 weeks [5]. Emerich et al. performed 15 minutes of cupping therapy at the upper trapezius as well as the contralateral low back for 15 minutes.[53] Their results determined an immediate increase in PPT in all neck pain.[53]

Lauche et al.[4] performed cupping therapy for 10-20 minutes (depending on color of marks) every 3-4 days; results demonstrated there was a significant difference in VAS pain scores and PPT.[4] Yuan et al.[3] determined that cupping therapy was significantly more effective than waitlist patients for pain and disability.[3] Also, the results showed a significant reduction in pain and disability compared to standard medical care.[3]

Adverse Effects

There are no major side effects of cupping therapy aside from the minimal discomfort during the therapy.[49,50] Common adverse effects include: erythema, edema, and ecchymosis or bruising at the site of application.[1,14,19,23,24] Additionally, there is the typical petechiae formed in

the circular shape.[53] Over time the increased vascular pressure in the vessels can cause rupture of the capillaries with resultant petechiae, purpura, or ecchymosis.[20]

Other minor side effects that have been reported include lightheadedness; as cupping therapy encourages blood flow to the region, there is a hotter and warmer sensation as a result of the vasodilation.[49,50] With the use of glass cups and fire, there have been reported risks of burn and scar formation ranging from mild to moderate in severity.[9,26,52] Furthermore, post-inflammatory hyperpigmentation and keloid formation have been noted.[13] The most severe adverse effects reported are anemia and hemorrhagic stroke,[13] although these side effects are rarely seen.

CHAPTER III: METHODOLOGY

Study Design

This was a single-blinded, randomized crossover study in which each participant completed all three intervention therapies. Additionally, the researcher was blinded to the interventions for each participant. The independent variables were cupping treatment time (5, 7.5, and 10 minutes) and measurement time-points (baseline, immediate post-intervention, and 10-minutes post-intervention), and the dependent variable was subcutaneous hemodynamics (superficial and deep oxygenated, deoxygenated, and total hemoglobin).

Participants

Thirty-two participants volunteered for this study. All participants were healthy individuals with non-specific neck pain; demographics are detailed in Table 1. Exclusion criteria included: cupping therapy or any other therapeutic treatment performed within the past three months to the neck or shoulder area; history of head, neck, or shoulder injury within the past six months resulting in medical care; known blood clotting disorder; allergy to lubricant; or the following medical conditions: hypertension, diabetes, cancer, pregnancy, cardiac failure, renal failure, allergic purpura, hernia, psoriasis, eczema, rosacea, varicose veins, phlebitis, hepatocirrhosis, allergic dermatitis, sunburn, open wound, fever, or were taking anticoagulants. All participants signed informed consent and the study was approved by the university institutional review board.

Participants were asked to refrain from any strenuous physical activity, as well as consuming any performance enhancing and energy substances, or any drugs or alcohol 24 hours prior to the start of pre-intervention testing. Participants were allowed to consume ≤ 400 mg of caffeine[58] within 24 hours prior to pre-intervention testing. These exclusion criteria and

instructions helped to control for confounding variables, such as physical activity, rehabilitation, modality use, injury or disease, and consumption of uncontrolled substances, that may have altered blood flow prior to pre-intervention measurements.

Table 1: Participant demographics

	Descriptive Statistics	
Physical Characteristics	Mean	SD
Age (years)	21.69	2.78
Height (cm)	171.53	9.49
Weight (kg)	72.93	12.85

Note: n=32 (14 males and 18 females, 28 right-handed and 4 left-handed)

Instrumentation

Near Infrared Spectroscopy (NIRS) (Portamon, Artinis Medical Systems, The Netherlands) was used to measure subcutaneous hemodynamics (local blood flow). NIRS is a non-invasive, continuous method used to examine oxygenated, deoxygenated, and total hemoglobin levels in musculoskeletal tissue.[59–65] NIRS is a well-established and validated technique that monitors the changes in chromophore (color) concentrations in a variety of tissues throughout the body using infrared light.[63,66] NIRS utilizes the relative transparency of tissues to measure levels of hemoglobin and myoglobin; additionally, the continuous wave allows for distinction between oxygenated and deoxygenated levels.[59,63,65] Unfortunately, the wavelength that NIRS functions at does not allow for distinction between myoglobin and hemoglobin.[59,63,67] The advantage of using NIRS to measure regional blood flow is that it is non-invasive and does not restrict ongoing activities (physical activity, exercise), and it measures levels in real time.[63,64]

Biomagnetic Chinese Cupping Therapy Cups (Kangzhu 24-Cup Set, ISO9001 quality certified) were used for all dry cupping therapy interventions. This cupping set included 24 plastic cups of various sizes, with a manual hand pump. One specific cup was used across all patients with an inner diameter of the cup at 5cm. This cup was used because it fit the upper trapezius musculature the best and allowed for proper placement throughout the interventions.

Procedures

Prior to beginning the assessments and measurements, the instruments used in this study were calibrated and examined to ensure there were no broken or missing parts. Each participant was assessed with these instruments for baseline testing of subcutaneous hemodynamics and intervention of dry cupping therapy.

Prior to initial screening, participants were asked to wear athletic, loose fitting tops and/or a sports bra that adequately exposed the posterior neck and shoulder region; males were able to remove their shirt for the treatment if comfortable. Additionally, participants with long hair that might intrude the treatment area were asked to pull their hair up into a rubber band. Upon arrival, participants were asked to rest in a chair for five minutes before baseline testing began. Descriptive statistics were recorded including sex, height, weight, and hand dominance; participants were also screened for exclusion criteria at this time. The participants were eligible for the study if they were free from current known injury or disease of the neck and shoulder region.

In order to determine the treatment location, the participants were instructed to lay prone on a treatment table with their head resting in a face pillow. The researcher began palpating the posterior neck and shoulder musculature, specifically the borders of the upper trapezius from the sub-occiput to the spine of the scapula on the dominant side of the patient. The treatment area

was identified as the midpoint of the upper trapezius muscle; this treatment area remained the same across all participants. The midpoint of the dominant upper trapezius was selected as the treatment area for consistency across all participants; also, this allowed proper placement of the NIRS device and the cup.

The NIRS device was placed on the patient's skin and centered on the pre-determined treatment area; the device's borders were marked on the patient's skin with permanent marker to ensure consistent placement for post-intervention measurements. The NIRS Portamon was secured to the patient using athletic tape over top of the device; additionally, a light absorbing cloth was used to cover the device to block outside light from interfering with the NIRS measurements. Local hemodynamics were measured for two continuous minutes allowing for hemoglobin levels to stabilize over a short period of time. This data included superficial and deep oxygenated, deoxygenated, and total hemoglobin levels that were collected as a baseline measurement.

Interventions

Prior to beginning the study, participants were required to choose a day and time that worked best for them and the researcher to participate and complete all measurements and interventions. This schedule remained the same across all three weeks.

Participants were randomly assigned to the three dry cupping therapy interventions: 5 minutes, 7.5 minutes, and 10 minutes. Block randomization was used to ensure each participant enrolled in every treatment group; one intervention per week over a three-week course. The researcher remained blinded to the treatment time, so following completion of baseline testing, the primary researcher removed themselves and a separate clinician came in to complete all interventions. All interventions appeared to take a total of 10 minutes.

The clinician applied a single cup to the patient's skin directly over the pre-determined treatment location (midpoint of the upper trapezius). The cup was secured to the patient by pumping the manual hand-pump three times. If the cup fell off during the allotted treatment time, the time was stopped, the cup was re-applied with three pumps, and the time started again; this occurred for three participants. Once the intervention was completed, the clinician removed the cup from the patient's skin by pulling on the release valve. At this time, the primary researcher returned to complete post-intervention testing.

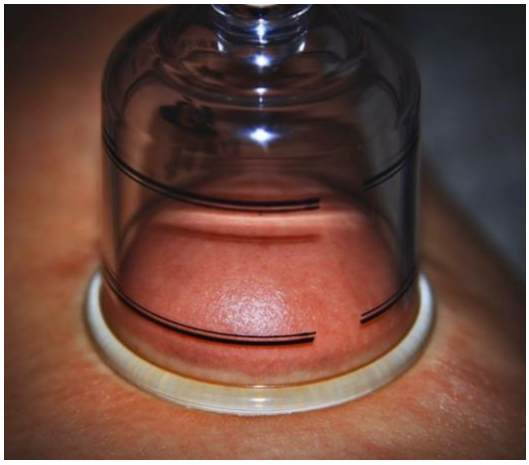

Figure 1. Cupping therapy

Post-intervention measurements began immediately following removal of the cup. Hemodynamics were measured for 10 continuous minutes using the NIRS Portamon unit. During this time, the researcher informed the patient of possible adverse effects of the dry cupping intervention, especially the possibility for erythema, edema, and ecchymosis. The participants returned the same day and time one week later for their second treatment, and so on for their third treatment.

Statistical Analyses

Change scores were calculated for each variable (superficial and deep oxygenated, deoxygenated, and total hemoglobin) from immediate post-intervention to baseline, 10 minutes

post-intervention to immediate post-intervention, and 10 minutes post-intervention to baseline. Repeated measures ANOVAs were used to assess differences across intervention time-points. Post-hoc analyses were examined for significant findings. Alpha was set *a priori* at $\alpha = .05$. Bonferroni corrections were utilized due to the amount of analyses run and the significant p-value was set at .008.

Results

Due to unusable data, dropouts, and outliers, there were 32 participants in the 5 minute session (n=0 excluded), 30 in the 7.5 minute session (n=2 excluded), and 29 in the 10 minute session (n=3 excluded). There was a significant main effect that showed a change in superficial and deep oxygenated, deoxygenated, and total hemoglobin ($p \leq 0.001$). Post hoc analyses revealed that all intervention times increased hemoglobin levels immediately after intervention and maintained this increase over the 10 minute post-intervention time period for oxygenated and total hemoglobin levels. There was no significant difference in change scores from immediately after intervention to 10 minutes after intervention. Tables 2-4 provide change score means and standard deviations for each treatment time.

Table 2: Subcutaneous hemodynamics means and standard deviations (μm) following 5 minute interventions

Hemoglobin Levels	Change scores		
	Immediate post - Baseline	10 minute post – Immediate post	10 minute post - Baseline
Superficial Oxy	31.41 ± 21.98*	-1.73 ± 8.12[a]	29.68 ± 19.68*
Superficial DeOxy	2.01 ± 7.90*	0.38 ± 2.78	2.39 ± 7.60*
Superficial Total	33.42 ± 28.27*	-1.35 ± 10.36	32.07 ± 25.48*
Deep Oxy	28.01 ± 19.35*	-1.51 ± 7.17	26.50 ± 17.61*
Deep DeOxy	6.19 ± 21.71*	-2.34 ± 22.45	3.85 ± 11.80*
Deep Total	30.51 ± 26.32*	-1.50 ± 8.05	29.01 ± 24.27*

Note: n=32. Oxy= Oxygenated, DeOxy=Deoxygenated, Post= post-intervention.

[a]Negative values indicate there was a decrease in hemodynamics.

*Significantly different than 10 minute post- Immediate post ($p<0.008$)

Table 3: Subcutaneous hemodynamics means and standard deviations (μm) following 7.5 minute interventions

Hemoglobin Levels	Change Scores		
	Immediate post - Baseline	10 minute post – Immediate post	10 minute post - Baseline
Superficial Oxy	41.22 ± 27.76*	-2.09 ± 5.68[a]	39.13 ± 27.58*
Superficial DeOxy	7.38 ± 11.38*	0.30 ± 2.17	7.68 ± 11.07*
Superficial Total	48.60 ± 38.08*	-1.83 ± 6.51	46.78 ± 37.71*
Deep Oxy	37.32 ± 23.99*	-2.07 ± 5.64	35.25 ± 23.91*
Deep DeOxy	5.40 ± 9.34*	0.21 ± 2.27	5.61 ± 9.15*
Deep Total	42.72 ± 32.26*	-1.86 ± 6.72	40.86 ± 32.15*

Note: n=30. Oxy=Oxygenated, DeOxy=Deoxygenated, Post= post-intervention.

[a]Negative values indicate there was a decrease in hemodynamics.

*Significantly different than 10 minute post- Immediate post ($p<0.008$)

Table 4: Subcutaneous hemodynamics means and standard deviations (μm) following 10 minute interventions

Hemoglobin Levels	Change Scores		
	Immediate post - Baseline	10 minute post – Immediate post	10 minute post - Baseline
Superficial Oxy	33.99 ± 27.52*	-5.14 ± 16.58[a]	28.85 ± 22.20*
Superficial DeOxy	4.17 ± 11.77*	-1.31 + 8.35	2.86 ± 9.02*
Superficial Total	37.85 ± 37.41*	-6.15 ± 24.48	31.71 ± 29.31*
Deep Oxy	31.69 ± 24.19*	-6.09 ± 16.58	25.60 ± 20.19*
Deep DeOxy	3.83 ± 11.82*	-2.51 ± 8.33	1.32 ± 9.72*
Deep Total	35.17 ± 34.30*	-8.56 ± 24.47	26.61 ± 28.03*

Note: n=29. Oxy=Oxygenated, DeOxy=Deoxygenated, Post= post-intervention.

[a]Negative values indicate a decrease in hemodynamics.

*Significantly different than 10 minute post- Immediate post ($p<0.008$)

CHAPTER IV: DISCUSSION

Current research is divided on supporting the use of dry cupping therapy to effectively treat musculoskeletal conditions in the body. Some studies have concluded that they are unable to make a definitive stance on its practice,[12,21,28] whereas other studies support its use and claim that it may be able to positively affect the body.[1,5,10]

This study found a significant difference in oxygenated, deoxygenated, and total hemoglobin levels following dry cupping therapy at the upper trapezius muscle. The results show an increase in hemodynamics following each treatment time: 5, 7.5, and 10 minutes. The greatest changes were seen in oxygenated and total hemoglobin levels; although significant increases were found for deoxygenated hemoglobin, they were minimal compared to increases in oxygenated and total hemoglobin levels. Additionally, these increases were sustained over the 10 minutes following intervention. Looking at Tables 2-4, it is clear that local hemodynamics increased from baseline to immediate post, as well as baseline to 10 minutes post. There were no significant changes from immediate post to 10 minutes post; these results reiterate that local blood flow stabilized and maintained the initial increase over 10 minutes. This displays the short-term effect of dry cupping therapy indicating it may be an effective treatment at directly increasing local blood flow, especially oxygenated blood to the upper trapezius. Previous research agrees with these findings that dry cupping therapy has a direct influence on skin blood flow.[56]

With evidence that local hemodynamics increase similarly across treatment times, clinicians may be able to treat patients effectively for a shorter duration. Dry cupping therapy performed for 5 minutes at the upper trapezius resulted in similar increases as 10 minutes of treatment. These results do not support the researcher's original hypothesis that 10 minutes of

dry cupping therapy would yield the best results in terms of increase in local blood flow. These treatment parameters for dry cupping therapy at the upper trapezius can serve as guidelines for clinicians moving forward in their daily applications. Clinicians can apply these results directly to their practice to help increase blood circulation at the upper trapezius for their patients; in addition, they will be able to maximize their time and treat patients more efficiently.

In addition to the main effects on blood flow, the participants did not experience any severe adverse effects that deterred them from continuing the study. These findings agree with previous research that shows positive outcomes from dry cupping therapy stating that there are no known negative side effects to cupping therapy; those studies that show negative side effects are very rare.[1,23] Normal adverse effects can be expected such as edema and ecchymosis, otherwise dry cupping therapy can be considered a safe treatment.[1,23]

The proven increases in local blood circulation following dry cupping therapy may also have an effect on a patient's local pain, inflammation, and ROM values; there have been previous studies that have explored the effects for treating pain conditions. A study from Chi et al.,[1] supports the efficacy of cupping therapy to specifically treat neck and shoulder pain.[1] The study goes on to suggest that cupping therapy provides significant and effective relief of neck and shoulder pain when compared to control groups.[1] Two additional studies supported these claims stating that cupping therapy is regularly observed to be effective at improving pain and function of the neck, as well as increasing the quality of life for the patients.[5,10] Further research is necessary to determine if the treatment parameters found in this study may also be effective in reducing pain and inflammation, in addition to the evident increases in blood flow at the upper trapezius.

This study focused on determining if different treatment times for dry cupping therapy at the upper trapezius affected blood flow, therefore there was only a single treatment applied to the participants. Despite this study concluding that a single treatment does increase local blood flow, previous research shows that repeated trials or serial treatment of dry cupping therapy seems to be more effective in treating chronic, non-specific neck pain.[4] Additionally, although previous studies have demonstrated cupping therapy may be beneficial for pain related conditions,[1,5,10] the low quality of original studies suggests that we cannot draw any conclusions.[25]

Limitations

This study was not without limiting factors. The first limitation was the small sample size. This study recruited 32 participants, but due to dropouts and outliers there were 32 participants in the 5 minute session, 30 in the 7.5 minute session, and 29 in the 10 minute session. The second limitation was there was no true control group. This was a crossover study in which the subjects served as their own control; however, this made it difficult to compare hemodynamic changes among the participants. The human body has different physiological responses to dry cupping therapy, therefore the change scores had wide standard deviation values. Also, this study aimed to close the gap on optimal treatment time of dry cupping therapy in those with non-specific neck pain, but the interventions were only completed on the dominant side of each subject, not the area of most pain; this allowed the NIRS device to be on a flat surface. Another limitation was this study only examined the short-term effects of dry cupping therapy, and it was applied as a single treatment, not as a serial treatment. A final limitation was the Coronavirus (COVID-19). Due to circumstances created by the virus outbreak, additional data collection was unable to continue.

Future Research

Improvements in the mechanism of cupping therapy have been made, but further research is needed. There is a lack of high quality, well-designed random controlled trials (RCTs); therefore, more high quality studies with larger sample sizes are needed to assess and validate the true therapeutic efficacy of cupping therapy. Additionally, treatment parameters such as frequency and treatment duration should be investigated to determine standardized protocols and to improve clinician care. Considering that different parameters have different effects on cupping therapy, a future study designed to show a time-effect relationship between cupping parameters and blood flow change could explain the cupping therapy mechanism to guide clinical practice.[56]

Future studies need to employ or manipulate the standardized treatment parameters used in this study to continue investigating the optimal delivery to improve pain and ROM.[28] It is clear from this study that cupping therapy has the ability to increase blood flow to the treated area, but it is still unclear how cupping therapy affects ROM and pain. Additionally, other areas of the body need to be explored in order to determine how dry cupping therapy affects local blood flow in those regions. Lastly, future studies need to determine the long term effects of cupping therapy. These necessary avenues of research will allow clinicians to use cupping therapy effectively on their patients to yield the best outcomes.

CHAPTER V: CONCLUSION

Dry cupping therapy is a form of alternative medicine that is becoming more popular in usage for musculoskeletal pain and other conditions. There are many theories behind its effects on the human body, one of those being its ability to increase blood flow. This study tested the theory of whether dry cupping therapy increases blood flow, and more specifically which treatment time yielded the greatest effect. The study concluded that dry cupping therapy increases deep and superficial oxygenated, deoxygenated, and total hemoglobin levels at treatment times of 5 minutes, 7.5 minutes, and 10 minutes. The greatest changes can be seen in oxygenated and total hemoglobin levels, indicating that there are higher amounts of oxygenated blood in the region following cupping therapy. Additionally, it was determined that cupping therapy results in similar increases following both 5 minutes and 10 minutes of treatment; this did not support the original hypothesis. This may indicate that clinicians are able to apply a shorter treatment and still provide their patients with a significant increase in blood flow to the upper trapezius. These treatment parameters give clinicians a guideline to maximize their time, and also treat more efficiently. This study shows that dry cupping therapy is beneficial in increasing local blood circulation at the upper trapezius for individuals with non-specific neck pain.

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