A Study of The Effect of Splinting on Pain during Tip Pinch for Osteoarthritis of the First Carpometacarpal Joint

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A Study of The Effect of Splinting on Pain during Tip Pinch for Osteoarthritis of the First Carpometacarpal Joint

Leana Tank

In partial fulfillment of the graduation requirements of the Masters in
Occupational Therapy

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A Study of The Effect of Splinting on Pain during Tip Pinch for Osteoarthritis of the First Carpometacarpal Joint

By

Leana Tank

MASTER OF SCIENCE THESIS

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RESEARCH COMMITTEE APPROVAL

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Member                     Date
ABSTRACT

The following research project focused on the effect of a prefabricated neoprene first carpometacarpal splint on osteoarthritis pain with tip-pinch, strength measurements of tip-pinch and functional performance. The following questions were explored throughout this study:

1. There will be a significant decrease in mean pain levels when the subject's hand is splinted as compared to mean pain levels when the hand is not splinted.
2. There will be a significant decrease in mean pain levels for the second session as compared to the first.
3. There will be a significant increase in mean tip pinch strength measurements when the subject's hand is splinted as compared to mean tip pinch strength measurements when the subject's hand is not splinted.
4. There will be a significant increase in mean tip pinch strength measurements for the second session as compared to the first.
5. There will be a significant improvement in function as measured by a decrease in mean QuickDASH scores on the second session as compared to the first.

Data for this study was collected using quantitative and qualitative data. Ten female participants over the age of 52 were enrolled in the study. Participants tip pinched a pinch gauge with and without the splint, recording pain levels with
pinching and strength of pinch. The participants wore the splint for an average of
two to eight weeks and then returned to perform the same tests and answer a
qualitative question about their experience with the splint. Statistical analysis was
performed using VAS pain scores and strength of tip-pinching scores. A functional
measure, the QuickDASH was used to measure functional improvements. The
researchers also asked participants a qualitative question about the splint’s
comfort, convenience and effectiveness as well as asking for any suggestions. The
results of the study supported the use of splinting for reducing pain when tip
pinching at the first CMC joint (p<.001). Splinting also appeared to stabilize the
first CMC joint, improving tip pinch measurements (p=.0015). Functional
performance also improved between the first and second sessions (p=.031). In the
qualitative section, participants seemed to appreciate the splint’s comfort and
effectiveness and suggested that the splint would benefit from a more breathable,
waterproof material, as it tended to become easily soiled and smelly. This study
offers a supplement to previous evidence for the effectiveness of splinting in
treating pain, instability, and functional deficits associated with osteoarthritis of
the first CMC joint.
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5. To Mary Kleis, MA, OTR, CHT for her willingness to provide and enroll participants in the study.

6. To Hely and Weber Orthopedic Inc. for the donation of the splints used in this study.
Definition of Terms

Osteoarthritis- “A chronic degenerative condition in which the cartilage around joints fails to regenerate. The loss of articular cartilage causes the bone surfaces to rub together resulting in thickened bone tissue at the joint, bony spurs, (osteophytes) and restricted joint movement. OA is most prevalent among the aged and is often painful and the progression irreversible” (Marieb, 2005).

First Carpometacarpal Joint- “The first carpometacarpal joint is located at the base of the thumb. The base of metacarpal I joins with the trapezium carpal bone of the wrist. Together they form a ‘saddle joint’ which allows for a wide range of motion including thumb opposition” (Maireb, 2005).

Thumb opposition- “The ability to touch the thumb to the tips of the other fingers of the same hand” (Marieb, 2005).

Articular surfaces- “Smooth cartilage covers the opposing bone surfaces, absorbing compression placed on the bone and protecting it from damage” (Marieb, 2005).

Analgesics- Pain relieving medication

Joint Protection- Principles employed to protect joints from further destruction. These principles include: avoiding stressful activities, energy conservation, maintaining functional strength and flexibility, and using assistive devices (Neumann, 2003).

Joint deviation- Poor alignment of a joint causes subsequent bones to move out of their proper position.

Short Opponens- A static splint that protects the hand and thumb joints, but does not constrain the wrist (Neumann, 2003).
**Long Opponens**- A static splint that supports multiple joints, including the wrist and focuses on protecting the entire thumb region, except for the IP joint, in most cases (Neumann, 2003).

**Resting Splint**- A splint designed to keep joints in proper position while sleeping or resting (Paternostro-Sluga et al, 2004).

**Working Splint**- A splint designed to protect joints from stress while performing functional activities (Paternostro-Sluga et al, 2004).

**Neoprene**- A soft, flexible, manmade material often used as a splint.

**Rheumatoid Arthritis**- An autoimmune disorder which causes the immune system to attack the body’s own tissues. This leads to inflammation, stiffness and pain particularly within the joints (Marieb, 2005).

**Tip pinch**- A type of pinching movement in which the thumb and forefinger press together at the tips of the digits.
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CHAPTER ONE

Introduction

Background

Osteoarthritis (OA) affecting the carpometacarpal (CMC) joint of the thumb is a common and painful condition. The CMC joint is located at the base of the thumb, where the first metacarpal bone meets the trapezium carpal bone. Studies report that 8% to 12% of the general population and as many as 33% of postmenopausal women are affected by the degeneration of the CMC joint (Haara et al., 2004). Osteoarthritis of the CMC joint is characterized by an erosion of the ligaments which protect and stabilize the articular surfaces of the joint, causing joint instability, pain and limited functional use of the hand, especially during pinching activities (Neumann & Bielefeld, 2003). Left untreated, osteoarthritis of the CMC joint can lead to severe deformities of the hand (Paternostro-Sluga & Steiger, 2004).

There are several approaches to treating OA of the CMC joint. Occupational therapists generally direct the more conservative approaches to treatment including joint protection, assistive devices, strengthening exercises and splinting (Egan and Brosseau, 2007). Splinting of the CMC joint is a common form of treatment, especially in the early stages of OA (Weiss et al., 2004). The primary goals of splinting are: pain reduction, an increase in stability, reduction in joint deviation, and improved function due to a decrease in pain (Paternostro-Sluga et al., 2004). There are numerous splint designs in use, including resting and working splints, long and short opponens, and splints made of various soft or hard materials (Paternostro-Sluga et al., 2004). Although splinting is a common practice, recently conducted literature reviews regarding the splinting of CMC
osteoarthritic joints have shown a lack of clinical research in this area (Paternostro-Sluga et al., 2004). However, studies have shown that particular CMC splints are effective for controlling pain (Weiss et al., 2004). It is important to continue to research the effectiveness of CMC joint splinting in order to understand how to better relieve pain and thus improve the functional abilities of those with osteoarthritis.

A midwestern company has designed a splint that attempts to support the first CMC joint during functional activities (See Appendix A). The splint is a prefabricated hand based neoprene prototype (See Appendix B for letter of permission to use splint). It is not yet available on the market. The splint is made out of soft, flexible neoprene fabric and may be wrapped around the hand, in an attempt to stabilize the first CMC joint and wrapping between the thumb and forefinger. It minimally impedes other joints of the hand or wrist. The thumb fits through a hole in the material, which may be adjusted to cover the MP joint as well. The splint may be trimmed for a custom fit to any size of hand and is made for the left or right hand. It is hoped that this splint will be effective in diminishing CMC joint pain during activities for those with arthritis.

Problem Statement

Occupational therapists are concerned with promoting functional outcomes, and many occupational therapists are well acquainted with splinting for the relief of symptoms related to OA of the CMC joint. Research is needed to support the effectiveness of particular splints in relieving joint pain and thus facilitating functional use of the hand with decreased pain. Clear, controlled, and specific studies documenting the effectiveness of particular CMC splint use in reducing CMC joint pain would be a
valuable resource for practitioners who are looking for effective treatments (Egan et al., 2007).

**Purpose Statement**

The researchers wish to explore whether or not the application of a prefabricated neoprene hand based first CMC splint reduces pain upon pinching for those with OA of the first CMC joint. The researchers will also determine if the use of the splint increases tip-pinch measurements on a pinch gauge and improves a participant’s ability to complete their activities of daily living (ADLs) due to pain relief. The researchers will also collect feedback on the splint users satisfaction with the splints’ comfort, convenience and effectiveness.

**Research Questions**

- Does proper application of a prefabricated neoprene hand based CMC splint reduce the level of CMC joint pain during tip pinching for people with arthritis?
- Is pain during tip pinch less when wearing the specialized CMC splint than pain while pinching without the splint?
- Is tip-pinch strength greater when wearing the specialized CMC splint then when pinching without the splint?
- Does wearing the splint over a period of weeks increase tip-pin strength?
- Does wearing the splint over a period of weeks decrease pain levels during functional tasks and while pinching?
- Are splint users satisfied with the splints’ comfort, convenience and effectiveness?
Significance to Occupational Therapy

According to the literature, there is a need for studies supporting the effectiveness of CMC splinting. Colditz (2000) stated, “only one recent article looks at the effectiveness of thumb CMC immobilization splinting. Descriptions of the splint designs recommended as part of the nonsurgical treatment, if included at all, are usually vague” (p.228). A recent literature review addressing OA of the CMC joint found that “it is difficult to find an evidence-based guide for OA of the CMC” (Egan et al., 2007, p.70). Another review of the literature found “only two clinical trials regarding splinting of CMC I osteoarthritis that are prospective and controlled. Both studies support anecdotal evidence that patients with osteoarthritis of the first CMC joint achieve pain relief with splinting” (Paternostro-Sluga et al., 2004, p.236). According to Paternostro-Sluga et al., “this lack of evidence is in contrast to the widespread clinical practice and numerous doctors and therapists using splint treatment” (p.236). In the interest of upholding a standard of evidence-based practice, it is important to gather empirical evidence to support the use of splinting. It is also necessary to better understand which splints work effectively with certain types of patients. Clinical trials can add to the body of knowledge in this area.

Research in this area is also needed because osteoarthritis is a common and painful condition affecting a growing population of elderly persons. Osteoarthritis is recognized as a widespread source of disability for the aging population, which has a significant impact on the economy (Grant, 2005). As more people become affected by OA of the CMC joint, it will become necessary to have information available about the
various splinting options and their benefits. By discovering the effectiveness of particular splints, it is hoped that the public will benefit from having more information available as to which splints are effective for managing pain.
CHAPTER TWO

Review of the Literature

Introduction to Topics of Review

In order to determine the effectiveness of a particular thumb carpometacarpal (CMC) splint for osteoarthritis it is important to fully understand the nature of osteoarthritis and the particular ways which the disease affects the first CMC joint. A working knowledge of the anatomy of the first CMC joint as well as the stages of disease progression is also of importance. A familiarity with splinting techniques and with the particular studies involved in splinting of the first CMC joint will provide a sound foundation from which to judge the merit of new splints. Comprehensive knowledge of arthritis, osteoarthritis, the first CMC joint, and splinting of the first CMC joint is essential when carrying out a study on the effectiveness of splinting for OA of the first CMC joint. Careful examination of existing literature reveals a need for additional studies on the effectiveness of splinting for the first CMC joint, and provides guidance for future studies. A thorough review of the literature will include the topics of: arthritis, the first CMC joint, splinting the first CMC joint, and significant studies pertaining to the splinting of the first CMC joint.

The use of splinting lends itself well to the biomechanical and rehabilitation models within the discipline of occupational therapy. According to Reed and Sanderson (1999), arthritis and other orthopedic conditions typically have biomechanical aspects that should be considered. The use of splinting to improve range of motion and joint stability involves biomechanical concepts. The rehabilitation model focuses on working
towards a productive goal. According to Reed and Sanderson, the goal of the rehabilitation model is to "decrease limitations of structure and function in the body" (p. 223). This is a primary goal of splinting the first CMC joint for individuals with osteoarthritis, therefore the rehabilitation model is applicable in this area as well. The biomechanical and rehabilitation models are the dominant frames of reference when looking at splinting the arthritic first CMC joint.

**Arthritis**

Arthritis is a common and painful condition affecting over 35 million people in the United States alone (Helmick, Lawrence, Pollard, Lloyd & Heyse, 1995). Arthritis is a disease affecting the joints of the human body. Human joints are simple and durable in construction, designed for years of wear and tear. Bones are capped with smooth, shock absorbing cartilage, which prevents bones from rubbing against one another. Surrounding and lubricating the joint is the synovial membrane, which is responsible for making and releasing synovial fluid. The synovial membrane lines the joint capsule, which is comprised of a thick, fibrous material attaching the bone at each side of the joint. Ligaments stabilize and protect the joint. Muscles hold the joint together and attach with tendons to the exterior of the joint capsule. Small, fluid filled sacs called bursae assist in reducing friction between joints (Hunder, 1999). Arthritis may damage a single part of the joint or it may affect the entire joint.

Arthritis expresses itself differently in every individual and there are over 100 different types of arthritic conditions (Hunder, 1999). Each condition has its own etiologies, characteristics and treatment options. Some of the categories of arthritic conditions include: osteoarthritis, gout, rheumatoid arthritis, seronegative arthritis,
connective tissue disorders, infective arthritis, and arthritis caused by systemic and metabolic diseases (Stein, 2004). There are several features that assist in distinguishing between the various types of arthritis. Arthritis may be inflammatory or non-inflammatory. Inflammatory arthritis involves pain, redness, warmth and swelling of soft tissue. Non-inflammatory arthritis often involves stiffness and occasional pain, without the swelling or redness (Stein, 2004). Symptom onset may be acute or chronic. Acute symptoms appear quickly, sometimes overnight. Chronic symptoms may appear gradually over time, with periods of relief (Stein, 2004). The number of joints involved and the location of involvement also aids in classifying arthritis. Some forms of arthritis affect only one joint or particular area of the body. Other forms affect many different joints (Stein, 2004). Arthritis is a general term for a number of specific disease processes. For the purposes of this study, osteoarthritis will be the primary form of arthritis considered.

Osteoarthritis

Definition

Osteoarthritis is one of the most common forms of arthritis. Osteoarthritis (OA) is defined by the Arthritis Foundation and the National Institute of Aging as, “a group of overlapping distinct diseases,” which affect the entire joint including subchondral bone, ligaments, capsule, synovial membrane, and periarticular muscles. Osteoarthritis may be the result of mechanical and biological influences, leading to damage and loss of articular cartilage, osteophytes, and subchondral cysts. Common symptoms include: joint pain, tenderness, limited range of motion, crepitus, and inflammation (Flores & Hochberg, 2003). Osteoarthritis is an ancient disease; it has been documented in 2 million year old
“ape man” skeletons and Egyptian mummies (Dieppe and Rogers, 1989). It is often thought that osteoarthritis is simply a natural part of the aging process. In actuality, the OA disease process produces completely different types of musculoskeletal changes from the normal aging process (Altman, Alarcon and Appelrouth, 1990). OA is a disease that increases in prevalence and severity with age, but it is not an inevitability of growing older (Altman et al., 1990).

It is important to differentiate OA from rheumatoid arthritis. Rheumatoid arthritis (RA) is a chronic systemic disease that causes inflammation and swelling of the synovial lining of joints (Fleming, Crown and Corbett, 1976). While OA generally begins after the age of 40, RA may appear as early as age 25. OA generally develops over an extended period of time. RA often develops quickly and progresses rapidly. While inflammation is not an inherent feature of OA, RA is characterized by swelling and inflammation. People with RA may have symptoms of general fatigue, sickness, weight loss and fever. People with OA generally do not experience these symptoms (Cook, 1999). Fleming et al. also noted that a major distinction of RA is that the joints affected bilaterally and symmetrically, with the dominant side being more severely affected. OA usually affects one or two isolated joints, while RA may affect many different joints throughout the body. OA and RA are separate diseases that share some similarities and may at times occur simultaneously. It is important to understand the differences between the two diseases.

Prevalence of Osteoarthritis

The effect of OA on an individual, and on the United States as a whole is substantial. According to Burkholder, (2000) “OA is the most common cause of disability
in the United States” (p. 79). General OA most frequently involves the joints of the hand, cervical and lumbosacral spine, knees and hips (Felson, 2003). OA is more prevalent in women than in men, and seems to affect women more severely (Hart, Doyle and Spector, 1999). OA usually begins to appear between the ages of 40 to 66 years (Bayliss & Ali, 1978). It is estimated that 44-70% of people in the US over the age of 55 would show radiological evidence of OA if tested (Fisher, Pendergast, Gresham and Calkins, 1991). The pain and stiffness associated with OA may lead some individuals to early retirement and incur costly medical expenses. In 1999, OA cost the country about $178.9 billion dollars in medical bills and lost productivity (Yelin, 2003). By the year 2020, it is predicted that the number of people with OA will rise by 57%, due to the aging of the US population (Helmick, Lawrence, Pollard, Lloyd & Heyse, 1995). Clearly, OA is a disease that exercises a significant impact on society. The development of effective treatments for OA will be crucial for dealing with the future multitudes of individuals who will require relief from arthritis pain.

**Classification**

In regards to the hand, OA can be classified into three subgroups according to etiology, distribution, and treatment (Burkholder, 2000). Primary OA originates in the interphalangeal joint cartilage of the fingers and appears to be caused by an “intrinsic defect of the joint cartilage” (Estes et al., 2000, p. 109). The cartilage becomes unable to protect the joint from the forces of daily use, leading to mild inflammation and pain. The exact cause of this defect is unknown although genetics appear to be a factor (Estes et al., 2000). It is believed that secondary OA is caused by trauma and physical factors. Some of these factors include poor joint alignment due to trauma or inborn trait, metabolic
disease, infection, trauma, or physical factors (Estes et al., 2000). Trauma may have been chronic or acute. Chronic trauma includes repetitive movements done for extended periods of time such as typing or sewing. Acute trauma such as a broken bone or sprain may also contribute to future joint weakness (Estes et al., 2000). Many of the causes of secondary OA are preventable as they involve voluntary motions producing stress on the interphalangeal joints. The repetitive motions essentially wear out the joint and interfere with the ability of cartilage to absorb the shock of movement (Estes et al., 2000).

The third category of OA is called erosive inflammatory OA because it involves a sudden onset of swelling and deformity, usually of the distal and proximal interphalangeal joints. Erosive inflammatory OA develops quickly and causes rapid degeneration of the joints and is marked by periods of increased inflammation (Burkholder, 2000). It is useful to think of the symptoms of OA as falling along a spectrum of severity, with erosive inflammatory as the most severe form (Burkholder, 2000). Recent studies have questioned the inclusion of erosive inflammatory OA as a part of the OA spectrum and some believe it to be a completely separate disease process (Dieppe & Lohmander, 2005). The separate categories of OA have also been called into question because improved understanding has led to the conclusion that nearly all cases of OA are probably influenced by both genetic and mechanical factors (Dieppe & Lohmander, 2005). Development of knowledge on the topic is constantly changing the way people characterize OA.

_Disease Progression_

OA generally evolves along a course of several observable phases of degeneration. Healthy cartilage is essential to joint integrity, as it covers and protects the
ends of the bone. Healthy cartilage is smooth and flexible and absorbs the shock of joint motion and cushions the bone ends (Cook, 1999). With the onset of OA, the formerly smooth cartilage weakens and the surface becomes pitted. A loss of elasticity weakens the cartilage’s ability to withstand injury or stress (Ehrlich, Mankin, Jones and Crispin, 1975). Eventually, portions of the cartilage may wear away, exposing the bone and causing pain when one bone rubs upon another. The loss of cartilage may also cause the joint to deviate from its normal position. The constant pressure upon the bone will cause the ends to thicken and form bony spurs and osteophytes. Fluid filled cysts may appear at the joint and fragments of loose bone and cartilage may irritate the joint capsule (Ehrlich et al., 1975). The process of OA soon becomes self perpetuating, as mechanical stress leads to joint deterioration, which compromises the joint’s ability to deal with stress, leading to an increase in stress, inflammation, and the release of damaging enzymes. In the most extreme cases, physical deformity, and pain make use of the joint nearly impossible (Estes et al., 2000).

Symptoms

People diagnosed with OA frequently experience a number of symptoms, manifesting in varying degrees and combinations. Radiographs are frequently used to diagnose OA. Professionals are able to distinguish the signs of OA joint degeneration by viewing a radiograph of the joint. However, it is interesting to note that studies have shown that many people with radiographic evidence of OA do not experience symptoms. Also, people may experience symptoms without showing radiographic evidence (Felson, 2003). As a consequence, radiographs are not necessarily good indicators of a person’s actual experience of OA. Pain is the signature symptom of OA and is the reason why
many eventually seek medical advice (O’Reilly & Doherty, 2003). Pain is typically aggravated by joint use and relieved by rest. The experience of pain for those with OA is strongly correlated with feelings of anxiety and depression (O’Reilly, Muir and Doherty, 1999). Another common sign of OA is joint stiffness and tenderness. Stiffness is often experienced after long periods of immobility, such as in the mornings. Joint deformity and instability is a clear sign of advanced OA and is often experienced in the hands. Deformity is caused by cartilage loss, bone loss, and osteophyte formation (Nalebuff, 1968). With the presence of either joint stiffness, pain, and deformity comes a natural reduction in range of motion. Soft tissue swelling and bone remodeling contribute to the joints’ loss of flexibility and this often leads to a decrease in functional abilities (Nalebuff, 1968). Joints may also lock while functioning, due to loose bodies of cartilage or bone fragments within the joint (Nalebuff, 1968). Muscles and ligaments around the bone may become weak due to lack of use or tenderness at the site of insertion (Nalebuff, 1968). With the destruction of cartilage, subsequent bone upon bone contact produces a grinding, creaking sensation that can be felt upon joint movement. This sensation is called “crepitus” (Tiger, 1986). Joint damage may cause warmth and swelling to occur, although inflammation is not always present with OA (O’Reilly et al., 2003). OA expresses itself differently in every individual. There are limitless possible combinations of symptoms in varying levels of severity and in different locations on the body.

Etiology

The exact cause of OA is constantly under debate and is currently attributed to a combination of factors. Risk factors can be categorized into three different areas, systemic factors, intrinsic factors, and extrinsic factors (Felson, 2003). Systemic factors
refer to the individual characteristics of a particular person, including age, gender, genetics, and nutrition. Intrinsic factors involve characteristics of the joint itself that may make it susceptible to OA. Extrinsic factors involve outside influences acting on the joint, including obesity, and overuse (Cicuttini, Baker and Spector, 1996). It is currently believed that one or more of these factors interact to influence OA disease progression.

Age and gender are the most influential systemic variables, with disease prevalence rising with age. Generally, a greater proportion of women develop OA than men (Zhang et al., 2002). The aging process often produces changes in joint cartilage, affecting the joint's ability to cope with joint stress. Collagen becomes increasingly rigid as the strands become more cross-linked and total water content decreases (Hardingham, Venn and Bayliss, 1991). Chemical changes on a cellular level also may lead to rapid degeneration of joint tissue (Hardingham et al., 1991). OA is highly prevalent in women over the age of 50, which leads some to believe that the hormonal changes of menopause play a role in the development of the disease (Hannan et al., 1990). According to a study by Hannan, Felson, Anderson, Naumark, and Kannel (1990), estrogen loss has been indicated to be a significant risk factor for OA and some forms of estrogen replacement therapy have been found to be effective in limiting disease progression. Genetics also plays an important role in determining the onset of OA, as the disease appears to show an inheritable pattern. Heritability is greater for specific joints, as the proportion of hand and hip OA attributable at least partially to inheritance is over 50% (Spector, Cicuttini, Baker, Loughlin and Hart, 1996). OA has also been linked with deficits in vitamin C and studies have also shown vitamin D to have a protective effect for OA (McAlindon et al., 1996).
Age, gender, genetics, and nutrition all play a role in determining the onset and progression of OA.

Joint construction and environment determine the intrinsic risk factors for OA. Some people are born with joint abnormalities or develop them over time. Deformity predisposes the joint to wear and tear, leaving it vulnerable to OA degeneration (Swanson & deGroot Swanson, 1983). In the hand, natural joint hypermobility has been strongly linked with the development of OA, probably due to joint instability and increased exposure to shear forces (Moulton, Parentis, Kelly, Jacobs et al., 2001). Injuries to the joint from fractures, sprains, and other injuries have been linked to the development of OA, even if the injury occurred earlier in life. The injury alters joint mechanics, increasing the stress in certain areas, which, over time, increases risk for developing OA (Roos, Adalberth, Dahlberg and Lohmander, 1995).

Extrinsic factors are of great interest to the therapist because they are the most easily controlled. Obesity has been linked with the development of OA, particularly in the knees (Cicuttini et al., 1996). Obesity increases the load on the knee joints, accelerating the breakdown of cartilage. Obesity has also been linked with hand OA, which leads some to believe that obesity may also be a systemic factor, as the hands would not theoretically suffer a significant increase in mechanical wear and tear. One explanation for this is that excess adipose tissue acts to elevate hormonal levels in the body, which may lead to OA (Cicuttini et al., 1996). Repeated joint use and occupational activities involving repetitive movements have been found to increase risk for OA. Farmers, jackhammer operators, miners, and textile workers have all been found to have high rates of OA, most likely due to daily heavy use of particular joints (Croft, Coggon,
Crudas and Cooper, 1992). It is important to take into consideration the occupations of those who are diagnosed with OA.

**Pain and Osteoarthritis**

Pain is the dominant symptom of OA and its onset is the reason why many finally seek medical advice (O'Reilly et al., 2003). Studies on hand OA amongst the elderly have shown that pain plays a larger role in determining the extent of disability than reduced motion or strength (Kazis et al., 1983). A study done by Kazis, Meenan & Anderson (1983) found that patient pain is one of the most important variables in determining therapeutic effectiveness in rheumatic diseases. The researchers used the Arthritis Impact Measurement Scales to estimate physical disability, psychological status and pain for patients with rheumatic diseases. The researchers found that pain makes a significant (p < .001) contribution to patient overall health assessments, as well as being highly (p < .001) associated with physical disability (Kasiz et al., 1983) The pain associated with OA is difficult to predict and varies greatly among individuals. The source of pain is often debated, as cartilage has no pain receptors. Some theories of pain sources include activation of pain fibers in the joint capsule, microfractures of the subchondral bone, bursitis, and inflammation of tendons at the site of insertion (Kraus, 1997). Pain can also be caused by sharp osteophytes pinching and irritating the joint capsule or ligaments (Kraus, 1997). Muscle guarding due to the anticipation of pain may also lead to pain in the cervical spine for those with hand OA (Melvin, 2003). Pain is influenced by more than physical factors alone. Pain is the subjective experience of an individual and can be influenced by illness history, disease duration, psychosocial factors, and culture (Kasiz et al., 1983). It is important to remain mindful of the subjective nature
of pain. Self-report is the most widely used way clinicians use to identify and assess pain. Some common self-report measures are The Descriptive Pain Intensity Scale, 0-10 Numeric Pain Intensity Scale, and the Visual Analog Scale (Engel, 2003). Pain is a complicated phenomenon and there are many aspects to its manifestation.

Goals of Occupational Therapy

Occupational therapists use various techniques to accomplish specific goals for people with OA. Individuals with OA are commonly treated by occupational therapists in inpatient and outpatient settings (Grant, 2005). The major goals of occupational therapy for those with OA involve maintaining or improving functional independence. This can be done by reducing pain, stiffness, and inflammation, eliminating aggravating factors, maintaining or increasing range of motion, and reducing stress on joints (Melvin, 2003). Occupational therapists work to achieve these goals by providing adaptations that aid in activities of daily living, managing pain, education, providing work adaptations, splinting, teaching joint protection principles, ergonomics, hand therapy, exercises, and advising on ways to improve quality of life (Grant, 2005). Occupational therapists exercise a broad scope of practice within the area of OA and are able to assist individuals to deal with the many ways which OA affects their lives.

Osteoarthritis of the First Carpometacarpal Joint

Prevalence

OA commonly affects the joints of the hand, and most frequently occurs in the trapeziometacarpal (CMC) joint (Melvin, 2002). The trapeziometacarpal joint is referred to in the literature as the basal joint complex of the thumb, the first CMC joint, or the thumb CMC joint. OA of the CMC affects a greater number of females than men, and
usually appears after menopause (Neumann, 2003). The CMC joint is located at the base of the thumb and is one of the most functionally important joints of the hand because it allows for thumb opposition (Pellegrini, 2001). Primary OA affects the CMC joint in 65% of cases, while erosive arthritis affects the joint in roughly 40% of cases (Kellgren and Moore, 1952). The population based Framingham study (2002) found symptomatic hand OA to be a common disease among the elderly that limits several functional daily activities (Zhang et al.). OA of the thumb typically results in pain, especially with pinching and grasping activities. Weakness, osteophyte formation, swelling, and crepitus may also be a problem (Neumann et al., 2003). When addressing the CMC joint, it is important to understand the structure and complex forces at work within the hand.

*Joint Anatomy*

Thumb opposition is a unique feature of the human hand. The design of the basal joint complex allows the human hand considerable flexibility and functionality. The flexibility of the thumb comes at the cost of stability, leaving it vulnerable to injury and degeneration (Pellegrini, 2001). The first CMC joint is the most functionally important basal joint, as well as the most frequently affected by OA (Poole & Pellegrini, 2000). The first CMC joint is a biconcavoconvex articulation and is supported mainly by soft tissue, allowing for a large range of motion (Poole et al., 2000). The joint is formed by the articulation between the base of the first metacarpal and the distal side of the trapezium. The first CMC joint is a saddle joint, which means that the surface is similar to the front to rear shape of a horse’s saddle (Neumann et al., 2003). The primary motions allowed by the CMC joint are palmar abduction and adduction, flexion and extension, opposition, and reposition (Neumann et al., 2003). The bones of the joint itself provide little stability,
allowing increased dexterity and movement. The ligaments and joint capsule provide most of the joint stability (Neumann et al., 2003).

The CMC joint is surrounded by a large and loose joint capsule, which allows for a larger range of motion (Neumann et al., 2003). There are five major ligaments supporting the CMC joint, maintaining dynamic stability. These are the anterior oblique, ulnar collateral, intermetacarpal, posterior oblique, and radial collateral ligaments (Neumann et al., 2003). These ligaments control the direction and amount of movement at the joint. They also maintain normal joint alignment, and control forces produced by active muscles (Neumann et al., 2003). The palmar, also called the "beak" ligament is believed to play a large role in stabilizing the metacarpal during lateral pinch activities (Poole et al., 2000). Muscles produce great forces on the CMC joint. Cooney and Chao (1977) estimated that activities requiring 4 to 5 kg of tip pinch force would create 10 to 15 kg of force at the CMC joint, and up to 30 kg of force for a strong key pinch. Pinching activities place particular strain on the joint so that even a low stress activity such as brushing teeth may produce significant stress on the joint (Neumann et al., 2003). It is important to consider the muscles, ligaments, and bone structure when discussing how OA affects the CMC joint.

Causes of Degeneration

OA affects the CMC joint in a particular, often predictable, way. OA of the CMC often begins with joint instability and ligamentous laxity, which may be either precursors to OA or a part of the disease process (Neumann et al., 2003). Classic CMC degeneration leaves the thumb fixed with CMC adduction, MP hyperextension, and IP joint flexion. This produces a "zig zag" type of deformity, which involves all of the joints of the
thumb. In essence, the connected joints of the thumb collapse in alternating directions (Neumann et al., 2003). The CMC joint becomes enlarged and prone to subluxation, which gives the joint a "squared" appearance (Melvin, 2002, p. 1649). Over time, the deformities become more greatly pronounced, and severely interfere with hand function, especially grasping and pinching activities (Melvin, 2002).

There are several different ideas about the cause of degeneration of the first CMC joint. Kovler, Lundun, McKee & Agur (2004) described two major theories of CMC-OA etiology and performed a study exploring the validity of these theories. Many believe that ligamentous laxity plays a large role in determining susceptibility to OA of the first CMC joint (Kovler et al., 2004). It has been observed that OA of the CMC joint is often found in those with degeneration of the palmar beak ligament, leading to abnormal laxity of the ligaments surrounding the joint, resulting in greater shear pressures on the anterior of the joint (Kovler et al., 2004). Studies have suggested that the ligament insertion zone may be selectively sensitive to estrogen related compounds, shedding light on the gender related aspects of the disease (Pellegrini, 2001). Another theory for CMC degeneration noted by Kovler et al. is joint impingement. Proponents of joint impingement believe that the rotation of the first metacarpal on the dorsoradial aspect of the trapezius during pinch and grip activities leads to reduced surface area on the joint and increased stress, leading to early degeneration (Kovler et al., 2004). The researchers examined the articular surfaces of the trapezium and metacarpal in the hands of twenty-five cadavers in order to discover patterns of wear which supported either theory. The findings of the study supported the joint impingement model, which suggests that damage to the CMC joint is primarily caused by friction on joint surfaces during motions requiring the metacarpal to
rotate on the trapezium to a large degree (Kovler et al., 2004). Moulton et al. (2001) studied the trapeziometacarpal joints of cadavers and found that the center of pressure for those with OA was focused on the palmar aspect of the joint, leading to degeneration in that area. The Kovler et al. study also examined structural differences of the trapezium between males and females and found that the articular surfaces of female joints are significantly smaller than those of men (Kovler et al., 2004). This finding suggests that females experience greater forces on their joints due to decreased surface area, increasing their chances for cartilage damage and OA (Kovler et al., 2004). Some other proposed causes for OA of the CMC joint are variations in anatomy, hormonal changes, occupation related mechanical stresses, and genetic predisposition (Pellegrini, 2001). It may be safe to assume that the genesis of OA of the CMC joint may be influenced by a combination of these factors.

Categories and Stages

Several clinicians have attempted to categorize the stages of degeneration of the first CMC joint. The most generally accepted classification system was developed by Eaton and Glickel in 1987. The Eaton and Glickel system relies primarily on radiographic evidence; however, each stage can also be identified by several clinical correlates (Carr & Frieberg, 1994). Stage one is identified on the radiograph of the hand by a slight widening of the joint space, normal articular surfaces, and less than a third CMC joint subluxation. Upon clinical examination, the joint may have some swelling and hypermobility, but no deformation will be apparent (Carr et al., 1994). Stage two radiographs will show osteophytes of less than 2 mm in diameter, and at least one-third joint subluxation. The hand may have minimal crepitus and less hypermobility (Carr et
Stage three radiographs will show osteophytes greater than 2 mm in diameter and a slight narrowing of the joint space. The joint will show over one third subluxation, and subchondral sclerosis may be apparent. Clinical effects will involve crepitus, stiffness, and tenderness at the trapeziometacarpal joint. Less than a third of patients will show signs of deformity at the joint (Carr et al., 1997). Stage four radiographs will show a very narrow joint space, with large osteophytes and a large amount of subluxation. The dorsoradial facet of the trapezium will show signs of erosion. As this is the most extreme stage of OA of the CMC, the patient may experience pain over the entire CMC joint, along with visible subluxation of the first metacarpal (Carr et al., 1997). Cartilage changes must be observed in order to diagnose OA (Melvin, 2002).

Because radiographs do not always accurately reflect the level of severity of OA, it is important to be able to assess the severity of OA through direct observation and testing (Carr et al., 1997). Other common methods for assessing the degeneration of first CMC joint involve noting the presence or absence of crepitus, the use of a “grind test”, and noting the presence of pain with pinching activities (Glickel, 2001). The “grind test” was developed by Swanson and deGroot-Swanson (1983) and involves metacarpal compression and rotation and is used to locate pain or crepitus for the trapeziometacarpal joint. In general, clinicians rely on both radiographs and clinical evidence in diagnosing OA of the CMC joint.

It is of interest to note that rheumatoid arthritis (RA) may affect the first CMC joint in a similar pattern as OA. In 1968, Nalebuff classified four major deformities of the rheumatoid thumb. The subluxation and subsequent collapse of the OA thumb correlates well with Nalebuff’s type III deformity, also referred to as the “swan neck” deformity.
Nalebuff's type III thumb deformity involves hyperextension of the first MCP joint and flexion of the IP joint, and is caused by the subluxation of the CMC joint due to weakened ligaments (Nalebuff, 1968). The type three deformity found in the rheumatoid thumb may benefit from the same types of treatments as the osteoarthritic CMC joint, as they suffer from the same pathomechanics (Nalebuff, 1968).

There are a number of wrist problems which may be confused with OA of the CMC joint. It is important to be able to differentiate between OA of the CMC joint and deQuervain's tenosynovitis, wrist synovitis, carpal tunnel, ganglion cysts, or a scaphoid fracture (Glickel, 2001). It is important to differentiate between conditions because the treatments for each condition are different (Melvin, 2002). Clinicians are usually able to differentiate between OA of the CMC joint and deQuervain's by the location of the tenderness. Tenderness found with OA will be located at the trapeziometacarpal joint, while deQuervain's will produce tenderness at the tip of the radial styloid process (Glickel, 2001). Radiographs of the joint and finding the precise location of the pain should provide enough evidence to distinguish between closely related wrist problems (Glickel, 2001).

**Functional Effects**

Advancement of OA of the CMC joint may eventually lead to significant functional difficulties. A stable and pain free thumb is necessary for optimal hand function (Neumann et al., 2003). Pain of the first CMC joint is generally increased upon pinching and grasping activities, especially lateral or chuck pinch (Poole et al., 2000). Many daily activities involve lateral pinch, including teeth brushing, turning a key, opening a car door, picking up a book, or sewing (Poole et al., 2000). Many people with
OA of the first CMC joint experience a weakness of grip strength, which causes them to drop objects with greater frequency. In a study by Kjeken et al., (2007) the participants listed a total of 801 occupational performance problems due to hand OA. The most common areas of functional loss described were household management, functional mobility, personal care, and active recreation (Kjeken et al., 2007). Studies of individuals with rheumatoid arthritis have found that a reduction in ability to participate in recreation is linked to the development of symptoms of depression (Kjeken et al., 2007). Pain and functional difficulties are often the largest factor in compelling individuals to seek medical care (Poole et al., 2000). Clearly, individuals with OA of the hand often experience significant functional consequences.

Relatively few studies have assessed the impact of OA on functional activities. The Framingham study (2002) assessed the prevalence of OA of the hand, and its impact on functional activities (Zhang et al., 2002). The researchers used survey questions about major joint complaints, hand radiographs, grip strength measurements, a self-reported functional limitation questionnaire, and an observed evaluation of functional performance to determine the impact of OA on functional activities. The prospective cohort study of 1,041 elderly subjects found that those diagnosed with hand OA had difficulties mainly with tasks requiring pinching, such as writing, handling small objects, and carrying a 10 lb. bundle (Zhang et al., 2002). The study also reinforced the prevalence of OA of the hand, finding symptoms in 13.2 % of the men and 26.2 % of the women over the age of 70 (Zhang et al., 2002). Another study performed by Bellamy et al. (2002) addressed rhythmic variations in hand arthritis pain, stiffness and dexterity throughout the daily cycle. Bellamy et al. found that arthritis pain does fluctuate on a predictable daily basis,
with pain and stiffness levels the lowest and dexterity levels the highest in the late afternoon. These findings may be helpful when planning daily activities, structuring assessment times, and timing drug treatments (Bellamy et al., 2002). An awareness of the functional effects of OA of the CMC is important when considering therapeutic options.

_Splinting the First Carpometacarpal Joint_

_Splinting Goals_

Conservative management of OA of the first CMC joint usually involves splinting. According to Weiss et al. (2000), the major goals of splinting for OA of the CMC joint are pain relief, and increasing stability, strength and function. Splinting protects the joint capsule and synovial lining from stress, allowing the body to focus on reducing inflammation. Often, muscles surrounding a painful joint will spasm, producing deformities and excess pain. Splinting breaks this cycle, allowing these muscles to relax (Callinan & Mathiowetz, 1995). Splints can be made from a variety of materials and forms. Although splinting has been shown to produce beneficial effects, there is little agreement on the best materials or types of splints (Callinan et al., 1996). The success of splinting is often decided by individual client needs and preferences (McKee & Rivard, 2004).

Splinting of the first CMC joint is unique because often the joint is affected by decreased stability. The therapist must achieve joint stability while at the same time maintaining joint mobility (Colditz, 2002). For this reason, immobilization splinting is often chosen (Colditz, 2002). It has been found that splints which immobilize the first CMC joint as well as the thumb MCP joint are effective for eliminating patient self
reported pain at the thumb CMC joint (Swigart, Eaton, Glickel and Johnson, 1999). The splint material is molded around the first CMC joint, stabilizing it in the position of palmar abduction, which allows mobility of the fingertips (Colditz, 2000). Stabilizing the first CMC joint in a position opposite of the direction of the deformity may help maintain the normal mechanics of the joint (Biese, 2002). A study on the effect of joint position on basal joint loading of the thumb done by Moulton et al. (2001) confirmed that MCP joint flexion effectively unloads the palmar surface of the trapeziometacarpal joint for any stage of OA. The study described splinting as a possible way to slow the progression of disease by directing joint forces away from the palmar aspect of the trapeziometacarpal joint onto a healthier area of the joint (Moulton, Parentis, Kelly & Jacobs, 2001). Moulton et al. describe splinting as an important early intervention for dealing with OA.

**Splint Types**

In general, two splint lengths are used when splinting for OA of the first CMC joint, the short opponens and long opponens. The short opponens splint is hand based, and covers the first CMC joint, wrapping around the palm and between the thumb and second metacarpal (Weiss et al., 2000). The long opponens splint covers both the first CMC as well as the thumb MP joint, and extends down the arm, effectively immobilizing the wrist (Weiss et al., 2000). In a controlled study performed by Weiss et al. (2000), the effectiveness of both short and long opponens splints were measured and compared on pain relief, functional performance, pinch strength and radiographic improvement for subjects with OA of the CMC joint. A 10-cm visual analogue scale was used to assess pain. Patients were required to tip pinch a pinch gauge, and the force of the pinch was
recorded. Participants were also asked to use a self-rating scale of 22 ADL functions to assess whether functional performance improved with splint use. Patients were also asked about which splint they preferred, and rated their satisfaction. Subjects were randomly assigned to wear a short or long splint for one week whenever they felt symptoms. They then wore the other type of splint for one week. The participants completed all measurements upon each visit to the clinic. The study revealed that both splints decreased pain, improved functional abilities, and reduced subluxation of the first CMC joint \( (p=.001) \) (Weiss et al., 2000). Subjects preferred the short opponens splint \( (p=.01) \) and cited easier application, superior cosmesis and increased function as reasons (Weiss et al., 2000). None of the splints appeared to affect pinch strength, although the researchers proposed that if the splint had been worn for a longer period, pinch strength may have been improved (Weiss et al., 2000). The order in which the splints were applied may have affected the outcome of the study, although the researchers were careful to ensure that the order was randomized. Another limitation may have been patient compliance, as there is no way to ensure exactly when and how long the participants wore the splints (Weiss et al., 2000). However, this study is useful as it demonstrates the effectiveness of both long and short splints for treating OA of the CMC joint, and also indicates the short hand based splint as the preferred type of splint (Weiss et al., 2000).

**Splint Materials**

Splints can be constructed using a variety of materials. Hard splints may be constructed from plaster of paris, fiberglass, thermoplastics, silicone, and many other materials (Callinan et al., 1996). Soft splints may be made from a variety of materials including, neoprene, Neoplush, Velcro, foam, leather, molestick, and coban tape (Biese,
2002). There is little consensus regarding the best materials for splint construction, and choice generally depends on client factors (Callinan et al., 1996). Some clients may have delicate skin, requiring a softer material to prevent skin breakdown (Biese, 2002). Neoprene has the potential of causing an allergic reaction in some and it is wise to consider allergies in any decision regarding splint material (Biese, 2002). Joint swelling and deformity may prevent the use of rigid materials (Callinan et al., 1996). Soft splints vary in levels of flexibility and can be modified by adding metal or thermoplastic components (Biese, 2002). Either soft or hard splints may be used to support the first CMC joint.

An often-cited study by Callinan and Mathiowetz (1996) sought to compare soft and hard resting hand splints on their effectiveness in relieving pain, levels of patient compliance and user preference for those with rheumatoid arthritis. A total of 39 Subjects served as their own controls as they wore each type of splint for a period of 28 nights. The soft splint was a cotton padded wrap with a custom-fabricated thermoplastic insert and the hard splint was constructed out of thermoplastic (Callinan et al., 1996). Subjects were asked to report on pain levels, functional ability, grip strength, and time wearing the splint. The subjects were also asked to rate the splints for comfort, appearance, cleanliness, warmth, durability, ease of application and perceived benefits, as well as which splint they preferred (Callinan et al., 1996). The Arthritis Impact Measurement Scale was used to assess the impact of the disease on functional tasks. The researchers developed a pain localization diagram, and subjects used it to identify the specific location of their pain. Grip strength was assessed using a Jamar Dynamometer and subjects used a daily diary to record the time they spent wearing the splint. Participants
rated the splints on a variety of elements using a subjective splint rating form. The study found that both soft and hard splints significantly decreased arthritis pain relative to the pretest (p<.001). Splinting compliance was significantly higher for the soft splint, and 56% of the subjects preferred the soft splint to the hard splint at the end of the study (Callinan et al., 1996). No significant difference in grip strength was found between the means. The findings of this study suggest that, while hard and soft splints can be effective for relieving arthritis pain, subjects may be more inclined to wear soft splints and may prefer them due to improved comfort and better pain relief (Callinan et al., 1996). Patient preference and compliance is important to take into account because splints will only work if they are used consistently, and if the benefits provided by the splint outweigh the drawbacks (Callinan et al., 1996). Client centered splinting has been recommended by many experts (McKee et al., 2004). A client-centered approach to splinting will always involve the consideration comfort, cosmesis, and convenience when fitting an individual with a splint (McKee et al., 2004).

*Customized and Prefabricated Splints*

Splints may be differentiated by construction. The splint may be either custom fitted to the hand by a therapist, or prefabricated, which means that the splint was manufactured in a specific size or shape. Professionals do not agree on which type of splint is better for relieving pain (Weiss et al., 2004). Weiss et al. performed a study in 2004 comparing the effectiveness of a custom-made short opponens splint versus a prefabricated short opponens splint on pain relief, CMC stability, functional effects, client satisfaction and preference. Pain levels were measured using a visual analogue scale for subjects tip pinching a pinch gauge. Tip pinch was also used to record strength
measurements. Subjects rated splint satisfaction using a 10 cm VAS scale. They also used a self-rating scale to indicate whether their function during 22 ADL tasks during the previous weeks was “easier” or “harder” or “the same” while wearing the splint. The custom made splint was made out of thermoplastic and the prefabricated splint was made out of neoprene fabric. The study was comprised of 25 subjects diagnosed with osteoarthritis of the first CMC joint. The subjects were randomly assigned to wear either the custom or prefabricated splint the first week, and the other splint the next week. Subjects completed questionnaires during their first visit, after the initial splint and after the final splint. Subjects were requested to wear the splint any time they felt symptoms and to keep track of the number of hours the splint was worn (Weiss et al., 2004). Thumb pain decreased significantly (p<.001 for the PFN and p=.002 for the CMT) while wearing each of the splints. The study found that the prefabricated neoprene splint provided greater pain relief and allowed for more improved function. Subjects preferred the neoprene splint over the custom splint, citing that it “provided greater support and pain relief while allowing more motion” (Weiss et al., 2004, p. 405). It is interesting to note that neither splint significantly increased the strength of pinch as compared to not wearing the splint. The evidence supporting the use of prefabricated neoprene splints is helpful, however there were a number of problems with this study. The neoprene splint supported both the CMC and MP joint, while the custom fitted splint supported only the CMC joint. This may have affected the results of the study (Weiss et al., 2004). Also, it would have been more useful if the custom and prefabricated splints had been made out of similar materials. Thermoplastic is a much firmer material than neoprene, and this may have been a confounding variable. However, the study is valuable in that it demonstrates
that splinting the first CMC joint is an effective way to reduce pain and increase joint stability (Weiss et al., 2004).

**Critical Review of the Literature**

Berggren, Davidsson, Lindstrand, Nylander & Povlsen (2001) completed a seven year prospective study on the effectiveness of conservative treatment for OA of the first CMC joint, and the need for surgery. The researchers treated 33 patients awaiting joint replacement therapy with a combination of splinting, technical accessories, and advice on completing activities of daily living. After seven months of conservative treatment, 70% of participants no longer required surgery. Within the seven years after the study, only two of the remaining nineteen patients desired surgery. This study gives support to the use of splinting and other conservative measures to the management of OA of the first CMC joint.

Swigart et al. (1999) performed one of the earliest studies on the efficacy of splinting the osteoarthritic first CMC joint. The researchers were unable to find any earlier quantitative or qualitative studies on the results of splinting (Swigart et al., 1999). The researchers wanted to know if splinting the thumb CMC joint was effective for relieving the symptoms of arthritis and reducing the need for surgical treatment (Swigart et al., 1999). The study also looked at the effectiveness of splinting for the different stages of OA CMC joint degeneration. They used Eaton and Glickel’s classification criteria to diagnose the stage of CMC OA degeneration experienced by each participant (Swigart et al., 1999). The study enrolled 114 patients (130 thumbs total) to wear a long opponens splint continuously for three to four weeks. The subjects were then slowly “weaned” off the splint over a period of three to four weeks (Swigart et al., 1999, p. 86). Subjects were
asked via postal questionnaire between 39 and 74 months later about the level of symptom relief provided by the splint, any changes in functional abilities, and whether they had undergone reconstructive surgery of the CMC joint (Swigart et al., 1999). Subjects were divided into two groups. Group A had thumbs with a classification of stage I and II of the disease. Group B had thumbs at stages III or IV. The study found that 62% of those surveyed experienced some relief from symptoms (Swigart et al., 1999). Although not statistically significant, a greater percentage of the patients in group A experienced symptom relief as compared with group B, leading to the conclusion that splinting may be more effective for earlier stages of OA (Swigart et al., 1999). Of the 114 original study participants, 24 eventually elected surgery (Swigart et al., 1999). One significant limitation of this study was that patients data was collected an average of 54 months after treatment, leading to a high attrition rate and impairing the participant’s ability to recall their experiences (Swigart et al., 1999). Nevertheless, this study was significant in that it demonstrated splinting as an effective way to reduce the symptoms of arthritis of the CMC joint, and may also be helpful in postponing or reducing the need for surgery (Swigart et al, 1999).

Buurke, Grady, deVries & Baten (1999) performed a study comparing three types of thenar eminence orthoses in a prospective randomized cross-over pre-experimental study. The thenar eminence is the mass of muscles at the base of the thumb, and the thenar eminence orthoses is designed to immobilize the first CMC joint during activities (Buurke et al., 1999). The three orthoses tested were the Gibortho, Uriel, and Sporlastic. The Gibortho is made of a firm elastic material, the Sporlastic is made of thin thermoplastic and is semi-rigid, and the Uriel is made from supple elastic material
The researchers wished to determine the perceived value of each orthoses using pain at the thenar eminence, pinch force, a VAS for function, comfort and cosmesis, and interview questions as measures (Buurke et al., 1999). The sequence of orthoses application was determined by drawing lots. An occupational therapist ensured proper fitting of the orthoses and instructed participants on wearing it properly for four weeks. After four weeks, the participant returned, researchers collected data on the splint in use and fitted the participant with the next splint. The participants repeated the procedure until all splints had been worn. The study found that eight out of ten patients benefited in their daily lives from using some form of thenar eminence orthoses (Buurke et al., 1999). Participants rated the Uriel splint as the most useable and preferred it over the others. Some of the reasons cited were less restricted movement and ease of use. The firmer splints were also found to cause pressure sores and discomfort in many of the participants (Buurke et al., 1999). There was no difference in pain relief for all three splints (Buurke et al., 1999). None of the splints appeared to change the force of pinch, three-point grip or lateral grip. The study is significant in that it demonstrates the effectiveness of splinting for relieving pain at the first CMC joint. It also provides support for client preference of a more elastic splint. One of the limitations of this study was its small sample size, as it included only ten individuals (Buurke et al., 1999).

Judy Colditz OTR is well regarded for her knowledge of CMC joint problems and splinting. She proposes a hand based custom molded thermoplastic splint that stabilizes only the first CMC joint, leaving the wrist and thumb MP joint free (Colditz, 2000). In her experience, this type of splint sufficiently relieves pain at the first CMC joint without impeding the function of the hand (Colditz, 2000). Her splint prevents motion of the first
metacarpal in relation to the other metacarpals, stabilizing the joint in palmar abduction (Colditz, 2000). This appears to prevent metacarpal tilting, which causes pain during thumb function (Colditz, 2000). One benefit of this splint is that it allows pinching, fingerling, gripping and handling activities, which may increase patient compliance (Colditz, 2000). Because the splint is small, it is difficult to provide an accurate fitting. Close attention must be paid to the precise positioning of the CMC joint, accurate molding, and the even distribution of pressure (Colditz, 2000). Colditz recommends that the patient wear the splint continuously for two to three weeks. Afterwards, it can be worn during repetitive thumb use or to reduce symptoms (Colditz, 2000). Colditz claims to have successfully used this splint for more than 20 years for patients with first CMC arthritis (Colditz, 2000). Her experience in the field makes her a valuable reference, although a controlled study with quantifiable results would strengthen her recommendation of this type of splint.

A few researchers have attempted to review the accumulated evidence for splinting the CMC joint. Paternostra-Sluga et al. (2004) found only two clinical trials involving splinting of the first CMC joint for OA that were both prospective and controlled. The researchers found a number of studies that were not controlled, as well as clinical reviews and reports about new splints (Paternostra-Sluga et al., 2004). The studies all supported the notion that splinting the first CMC joint provides pain relief for those with OA (Paternostra-Sluga et al., 2004). Egan and Brosseau (2007) completed a systematic review of the evidence for splinting for first CMC joint OA using multiple database searches. The researchers included all studies, regardless of design, and then synthesized the data in order to make recommendations for occupational therapy.
interventions (Egan & Brosseau, 2007). The author’s search resulted in 15 relevant articles, six of which actually met inclusion criteria. From the evidence gathered in the articles, the researchers concluded that splinting may provide pain relief for CMC OA, although they found no evidence supporting one type of splint over another. The researchers recommended a client centered approach to splinting, due to the variety of client preferences represented in the data (Egan et al., 2007). The researchers recommended further high quality randomized controlled studies to support the effectiveness of splinting for pain relief. Studies should include details such as stage of disease, diagnostic information, and long-term follow up (Egan et al., 2007) They also recommended research on client centered splinting.

Summary of Literature as it Relates to Proposed Study

A common theme throughout the literature was a lack of high quality controlled studies supporting the use of splinting for the first CMC joint. A recent review of therapies for OA of the hand by Towheed (2005) found “a remarkable paucity of published clinical research pertaining to the clinical impact, epidemiology, and therapy of the condition” (p. 455). The study cited a lack of case definition and a lack of standardized outcome assessments as two major problems with the previous research (Towheed, 2005). Egan and Brosseau discovered through comprehensive review that, “there have been few systematic reviews of research on the effectiveness of splinting in arthritis” (2007, p. 70). The study recommended using patient waiting lists as controls in order to improve the quality of the data obtained from splinting research (Egan et al., 2007). Paternostro-Sluga (2004) stated that, in regards to splinting, “the lack of evidence is in contrast to widespread clinical practice” (p. 236). After an extensive review, the
researchers concluded that, “extensive scientific evidence is lacking” in regards to splinting (Paternostro-Sluga, 2004, p. 253). It is clear from the literature that further research in the area of splinting for the relief of symptoms related to OA is required and desired by many professionals.

There is a clear demand for studies on the effectiveness of splinting for OA of the first CMC joint (Egan et al, 2007). Research tends to recommend a short opponens style splint in treating OA of the first CMC joint, as it appears to adequately address pain relief, improve ADLs, and limit subluxation of the joint (Weiss et al., 2000). Colditz recommends a hand-based splint that stabilizes the trapeziometacarpal joint in a position of palmar abduction, without impeding the use of the fingers (2000). Although the data is far from conclusive, some studies support the use of prefabricated soft splints in treating the symptoms of OA at the first CMC joint (Weiss et al., 2004). Callinan et al. found that patients preferred soft splints over hard splints and that the use of soft splints increased patient compliance with splint wear (1995). The specialized CMC joint soft splint to be used in the study follows many of the recommendations made by the literature it is a prefabricated soft splint which immobilizes the first CMC joint without constraining the other joints of the hand, theoretically reducing pain and allowing for hand function. Based on the literature review, it would be practical to run a controlled study on the effectiveness of a prefabricated neoprene hand based splint for OA of the first CMC joint, using pain relief and ADL functioning as primary outcomes. A study of this type would further enhance knowledge about the effectiveness of splinting for pain relief as well as provide evidence for using a particular style of splint.
CHAPTER 3
Methodology

Study Design

The researchers wished to explore whether or not the application of a specialized first CMC splint reduces pain and increases tip pinch strength upon pinching for those with OA of the first CMC joint. The researchers looked at the ability of the splint to improve a participant’s ability to complete their activities of daily living (ADLs) through pain relief. The majority of the study was devoted to quantitative research, as the literature calls for further controlled and quantitative study in this area (Egan & Brosseau, 2007). The study included independent and dependent variables, and focused on data that is measurable and easy to analyze. Independent variables were defined for how many days the splint was worn between sessions, how many waking hours per day the splint was worn, how many nights the splint was worn, and age of participant. The primary variable of interest was whether the participant was wearing the splint or not when pinching. Dependent variables were reported pain measures, tip pinch strength measures and a functional outcome measure (See Appendix A for an example of tip-pinch). In the interest of increasing the depth of knowledge in the area of splinting, qualitative data was also collected from the participants. The researchers included a small amount of qualitative research in the form of an open-ended question about the splints’ effectiveness. The use of quantitative and qualitative data allowed for a more comprehensive exploration of the topic of study and a mixed methods approach.

The research was conducted using a pre-experimental one group pre-test post-test design. A pre-experimental design was implemented because the study uses a sample of
convenience, with no control group. A one group pre-test post-test design works well for this study because researchers may not ethically withhold splint treatment from a control group. Also, the use of only one type of splint, as well as resource constraints makes randomization impossible. Data was also collected on the amount of time the splint was actually worn.

Qualitative data collected included demographic information as well as open-ended questions about participant’s experiences with the splint. Quantitative data included the participant’s age, Eaton and Glickel Level of CMC joint degeneration (one through four), and duration of pain, and whether the affected hand is dominant or nondominant and right or left. Qualitative participant demographics included gender, whether the affected hand is dominant or nondominant and right or left, participant occupations and leisure activities. Participants were asked to report their current pain medication usage. At the end of the study, participants were questioned on the advantages and disadvantages of the splint, as well as how they felt about the splint’s comfort and cosmesis. The qualitative research is intended to supplement the quantitative research findings and add to the scope of the study.

Participants

Participants were recruited from a local community hospital, volunteers were also recruited using a flyer posted in the community. The flyer described the nature of the study and the selection criteria (See Appendix C). Participants were clients who had been diagnosed by a physician as having osteoarthritis of the first CMC joint. In general, the population was comprised of older adults, due to the nature of osteoarthritis. The study used a sample of convenience because the sample included clients who happened to have
appointments at the clinic and were willing to participate in the study, or responded to the flyer as volunteers. The number of participants was dependent on the amount of referrals received by the hospital for CMC osteoarthritis during the time period of the study, and the number of responses to the flyer. Twenty to thirty participants were expected. The study was performed in the context of the outpatient hospital hand therapy clinic and also community locations where the researchers met with volunteers (See Appendix B for letters of permission from the hospital). All measurements were taken in either the clinic during the clients’ scheduled appointment, or at a location chosen by the participant to meet with the researcher. Ideally, the splint was used during the participant’s daily activities for a period of two to six weeks. Follow up data was collected upon the participant’s next scheduled appointment at the clinic. For volunteers, a future time to collect follow up data was agreed upon at the initial session.

Instrumentation

Several instruments were used to collect the data for this study. Standard demographic questions were asked of each participant (See Appendix D). A 10 cm visual analogue scale was used to measure pain at the first CMC joint while pinching a standardized pinch gauge with tip pinch with and without the splint (See Appendix D). The pinch gauge also measured tip-pinch strength with and without the splint. The Quick DASH (Disabilities of the Arm Shoulder and Hand) questionnaire was used to measure improvements in function before and after splint use (See Appendix E). Several open-ended questions were developed to gather data about participant’s feelings about the splint (See Appendix D). The researchers attempted to create as large a sample size as possible in order to increase the power of the tests.
Participants were asked to give standard demographic information. Data was taken on participant’s gender and age, as well as which hand is affected, dominant or nondominant, left or right. Participants were asked about their primary occupations or leisure activities, as well as their current work status. Participants were asked to note any other conditions affecting the hand. The participant’s level of hand osteoarthritis deterioration, as defined by Eaton and Glickel, and length of time since symptoms of osteoarthritis developed was recorded if it was known. Participants also reported their current pain medication usage. Participants noted their current pain medication usage on each testing occasion. Data was also collected at a subsequent visit on the amount of time the splint was actually worn during the weeks in between clinic visits and the length of time between visits.

The 10 cm visual analogue scale (VAS) was chosen to measure participant’s pain level at the first CMC joint while completing a pinching activity. The validity of the use of the VAS for measuring chronic and experimental pain was confirmed by Price, McGrath, Rafii & Buckingham in 1983. Ohnhaus and Adler (1975) performed a study comparing the VAS to a Verbal Rating Scale and found that the VAS to produces a more accurate reflection of what the patient is actually feeling. Joyce, Zutshi, Hrubes and Mason (1974) determined that the VAS is a more accurate reliable and sensitive measure of chronic pain than a Fixed Interval Scale. According to Kahl and Cleland, (2005) the VAS is considered one of the best measures of pain intensity. The VAS consists of a 10 cm vertical or horizontal line, defined by extremes of “no pain” to “extreme pain.” The participant is asked to identify their pain level by placing a mark on the line at their perceived level of pain intensity (Kahl & Cleland). The researchers then measure the area
between “no pain” and the mark made by the patient to the nearest millimeter. According to Scudds (2001) the VAS is considered a uni-dimensional outcome measure because it measures only pain intensity, as opposed to a multi-dimensional measures which also assesses pain behaviors, coping strategies and psychological factors. One of the major advantages of the VAS is that it provides continuous data, which allows for the use of more powerful parametric statistics. This is very helpful for research purposes as parametric data provides stronger statistical analyses (Kahl & Cleland). Flaherty (1996) recommends the VAS for its simplicity and ease of use. It is helpful for those with poor vocabulary skills, as it does not rely on complex terminology. Flaherty describes clinician error in measurement and poor scale reproductions as some possible drawbacks to the VAS. After performing a literature review of several pain scales, Kahl and Cleland found the VAS to be “a strong, clinically useful, reliable and valid measure of pain intensity” (p. 125). The VAS’ high validity and reliability, simplicity, and widespread use made it an excellent measurement tool for this study.

In order to measure changes in functional abilities that may be attributed to the pain relief from the splint, the researchers have chosen to use a shortened version of the DASH (Disabilities of the Arm, Shoulder and Hands) Questionnaire, which was developed by the Institute for Work & Health and the American Academy of Orthopaedic Surgeons in 1996 (Hudak, Amadio & Bombardier). The DASH itself is a 30-item questionnaire that evaluates symptoms and functional effects of nearly any disability affecting the upper extremities (Beaton et al., 2001). According to a study performed by Beaton et al., the DASH exceeded standards for test-retest reliability. The researchers also found reliability for convergent and known-groups. The study also provided
evidence for the responsiveness of the DASH to change, specifically for changes before and after treatments. In a study performed by Adams et al. (2005), the DASH was used to measure hand function for those with rheumatoid arthritis. The researchers found that the DASH was well liked by participants, who described it as easy to comprehend and not overly time consuming. The researchers determined that the DASH was an effective tool for measuring the functional ability of those with rheumatoid arthritis.

The shorter version of the DASH, the QuickDASH, was developed by Beaton et al. (2005) in an effort to “minimize the burden on the respondent and therefore minimize missing data” (p. 1038). The goal of the developers was to make the test as short as possible without sacrificing the quality of the measurements. A study was performed on three possible variations of a shortened version, and the measurement that maintained the most similarity to the original DASH, as well as reliability and construct validity, was chosen as the preferred shortened version (Beaton et al., 2005). The Quick DASH is an 11-item questionnaire that provides a score on a 100 point scale, with 100 indicating the greatest level of disability (Beaton et al., 2005). Only one missing item may occur without compromising the results of the test (Beaton et al.). According to the findings of Beaton et al. (2005), “the QuickDASH performs comparably with the DASH, with little loss of reliability, validity, or responsiveness (r=0.98)” (p. 1045). This makes it an ideal outcome assessment for the purposes of this study, as it is efficient, simple, and has excellent measurement properties.

A pinch gauge was used to measure pinch strength, and to control for the amount of force and type of pinch used by the study participants. The researchers asked all of the participants to use a tip pinch to ensure that everyone pinched in the same manner. The
pinch gauge also measured the strength of pinch, in order to look at whether or not splinting improves pinch strength by alleviating pain and stabilizing the joint. A B&L pinch gauge was used because this type of gauge was found to be the most valid and reliable, with the highest calibration accuracy by Mathiowetz, Weber, Volland and Kashman in 1984. Mathiowetz et al. demonstrated the high test-retest reliability and inter-reliability of the pinch gauge when standardized positions are used. Mathiowetz, Kashman, Vollan, Dowe, and Rogers (1985) developed normative measures for tip pinch for adults. For men between the ages of fifty and seventy, tip pinch means ranged from 14.0 to 18.3 pounds. For women between the ages of fifty and seventy, tip pinch means ranged from 9.3 to 12.5 pounds. The researchers ensured that the pinch gauge used for the study was properly calibrated, so that measurements were accurate.

Participants were asked one open-ended question about their experiences with the splint after wearing it for a period of weeks. Participants were asked to, “please describe your experience with the splint in the following areas: comfort, convenience and effectiveness. Please give any suggestions you may have.” This question is for the purpose of gathering qualitative data about the splint, by obtaining the direct perspective of the participant. The qualitative data was intended to inform and strengthen the rest of the study.

**Procedures**

A sample of convenience was obtained from a local community hospital outpatient hand clinic and from volunteers who responded to a flyer posted in the community. The sample included individuals who were referred to the hospital for treatment of a diagnosis of OA of the first CMC joint and who were willing to participate
in the study as well as respondents to the flyer. The researchers hoped to obtain as many participants as possible, but this was mainly be determined by the rate at which individuals are referred to the hospital, which fluctuates throughout the year (See Appendix B for letters of permission). Due to the unpredictability of the sample, professional clinicians at the hospital were trained in the guidelines for patient selection and the administration of a prepared form and in the proper application of the splint (See Appendix F for clinician instructions). Potential participants were informed about the nature of the study, and were made aware that upon completion of the study, the splint was theirs to keep as compensation for their time and effort. Participants were asked to sign a consent form and their records were kept confidential, as the data collected was not connected to any identifying information (see Appendix G).

In the event that a participant was affected by CMC degeneration in both hands, the clinician randomly selected which hand to use in the study. A pre-made randomized list of either dominant or nondominant hand selection was used to determine which hand to use in the study. At the end of the study, these participants were given the option to take home a splint for the other affected hand if they wished.

Circumstances did not allow for time between visits to be controlled for the participants who responded to the flyer. Community participants did not significantly differ from participants from the hand clinic in demographics or length between visits, as the researchers had little control over the number of weeks clinic participants wore the splint between visits in either setting.

Prior to splint application, each participant was asked to tip pinch a pinch gauge with the affected hand as hard as they can just prior to the point of pain, and then to mark
on a VAS their pain level upon pinching. The clinician documented the force reading on
the pinch gauge after each pinching trial. The clinician gave the participant clear and
detailed instructions about how to complete the VAS. The participant was then taught
proper application of the specialized CMC splint. With the splint, the participant was
asked to again tip pinch the pinch gauge as hard as they can just prior to the point of pain
and record their pain level on a VAS scale. The participant was asked to complete the
QuickDASH questionnaire, which asked questions about the participants’ current
functional status.

The participant was instructed to wear the splint at night and for as much time
during the day as possible until their next appointment at the hospital. The clinician
ensured that the participant knew how to properly apply the splint by having the
participant demonstrate its application.

Upon the participant’s next scheduled appointment, which was between two to six
weeks later, the participant was asked to again tip pinch the pinch gauge, “as hard as they
can just prior to the point of pain without the splint.” They completed the VAS scale to
measure their current pain level with pinching. The participant then tip pinched the pinch
gauge while wearing the splint, and marked their pain level on the VAS. The pinch gauge
measurement was again documented for each pinching trial. The participant again
completed the QuickDASH to assess any change in functional ability in the past weeks of
splint wear. The participants responded in writing to a four-part question about their
experience with the splint.

During the second assessment, data was collected on how many nights the splint
was worn, and how many hours per day the splint was typically worn. This information
was assessed by asking the participants to recollect how many nights the splint was
typically worn in a seven-day period, and how many waking hours were spent wearing
the splint during a typical day. The period of time between visits was also calculated in
days. The participant was then be thanked for their participation, and the splint was theirs
to keep. All data collected during the study was kept in a secure area in the clinic and all
data was labeled with a code to identify the participant until the final measurements were
collected. The data was then separated from any identifying information. The research
remained open to new participants for a period of six months.

Data Analysis

The researchers analyzed the data using several hypotheses:

1. There will be a significant decrease in mean VAS pain score when the
   subject’s hand is splinted as compared to mean VAS pain score when
   the hand is not splinted.

2. There will be a significant decrease in mean VAS pain score for the
   second session as compared to the first.

3. There will be a significant increase in mean tip pinch strength when
   the subject’s hand is splinted as compared to mean tip pinch strength
   when the subject’s hand is not splinted.

4. There will be a significant increase in mean tip pinch strength for the
   second session as compared to the first.

5. There will be a significant decrease in mean QuickDASH scores on
   the second session as compared to the first.
The data recorded by the study was analyzed using SPSS. Multiple linear regression and paired t-tests were performed. Descriptive data was provided on the age, gender, work status, duration of pain and occupations of the participants. This data was displayed in a descriptive data box. Descriptive data was provided on how many days, waking hours and nights the splint was actually worn. This data was displayed using a descriptive data box as well. Mean, standard deviation and range were calculated for VAS scores before and after splint-wear, strength of tip-pinch and for QuickDASH scores.

The researchers looked for relationships between splint application and pain levels as recorded by the mean VAS scores. A multiple linear regression was run to check for the effects of the co-existing independent variables, age and QuickDASH trial one scores, on mean VAS scores after splint application during the initial visit. QuickDASH trial one scores were included in each multiple linear regression in order to control for differences in baseline functional ability between participants. If a multiple linear regression did show that a co-existing variable had an effect on mean VAS pain levels, the p-values of the multiple linear regression were reported. If none of the co-existing variables were found to have a significant effect on mean VAS scores, a paired-t test was used to check for a significant decrease in mean VAS pain scores after splint application. Conditions were checked using histograms and no severe problems were found with the conditions. Because the data was found to be normal, paired t-test was appropriate for the data that measured a pre and post test situation. A significance level of alpha=.05 level was used to determine statistical significance for all tests.
For the data collected upon the second visit, a multiple linear regression was initially used to check for the effect of multiple co-existing variables (length of time between sessions, hours per day the splint was worn, nights per week the splint was worn, age and QuickDASH trial one scores) on mean VAS scores after splint application. Two separate multiple linear regressions were used to test for the effects of the variables mentioned above for comparisons between session one and two mean VAS pain scores without the splint and once again for session one and two mean VAS pain scores with the splint. The use of multiple linear regression allowed the researchers to control for the variation in amount of time the splint was actually worn by the participants. It also determined if the amount of time the splint was worn had any influence on mean VAS pain scores. If a multiple linear regression did show that a co-existing variable had an effect on mean VAS pain levels, the p-values of the multiple linear regression were reported. For any test that did not show the variables to have a significant effect on mean VAS pain scores, a paired t-test was used to look for a significant decrease in mean VAS pain scores between pre and post-tests. A significance level of p= .05 was used to determine statistical significance.

Strength of tip-pin scores were analyzed using the same method as VAS pain scales. Statistical analyses were performed on strength of pinch for session one scores taken with and without the splint, session two scores with and without the splint. Analysis was also completed using non-splinted scores for both sessions one and two and splinted scores taken for sessions one and two. A multiple linear regression was run for each group of variables to check for the effects of co-existing variables (length of time between sessions, hours per day, nights, age, QuickDASH trial one scores) on mean
strength of tip-pinch. If a multiple linear regression did show that a co-existing variable had an effect on mean strength of tip-pinch, the p-values of the multiple linear regression were reported. For any regression that did not show a significant effect for co-existing variables, a paired-t test was run to determine if mean strength of tip-pinch increased significantly with splint application. A p=.05 was used to determine statistical significance. Tables displayed p-values for t-tests and multiple linear regressions for VAS pain scores and strength of pinch.

The changes in mean QuickDASH scores between the first and second sessions were analyzed using a paired t-test with a significance level of p=.05 to determine statistical significance. Prior to the paired t-test, a multiple linear regression was run to check for the effects of the length of time the splint between sessions, the number of hours per day and nights the splint was worn, and age.

The qualitative question about the splint’s effectiveness, comfort, and convenience was analyzed for recurring themes. Data analysis was completed according to the format in Charlotte Royeen’s “A Research Primer in Occupational and Physical Therapy (1997). The basic process of data analysis as described by Royeen is reducing data into summary forms, identifying patterns and themes, counting patterns and themes, rating the importance of patterns and themes and clustering patterns and themes by groups. Once the process of data analysis is complete, the data is to be interpreted through inductive reasoning, reflective remarks, developing propositions and giving possible explanatory effects (Royeen, 1997, p.198). Qualitative questions were used to learn about participants’ firsthand experiences with the splints, and to obtain information that may not be obvious using quantitative measurements.


**Limitations**

There were several limitations apparent within this study. The researchers relied on a sample of convenience, which limited the generalizability of the study, as the subjects were not randomly selected. Unfortunately, the sample size was dependent on the clinics' referrals and community volunteers, and there was no assurance that a large number of subjects will be available. While it was initially hoped that 30 subjects would be acquired, a total of 10 participants were actually enrolled, limiting the statistical power of the study. Ideally, the study would have included a control group of subjects who would not receive the splint, however it is ethically unsound to withhold a treatment that may be potentially helpful. As there was no comparison group, subjects served as their own control, with the data collected before splint use as a baseline measurement.

One of the potential risks to the participants in the study was that, if the splint was improperly applied, it could have been counterproductive to the treatment of the joint. Ensuring that the participants were thoroughly educated on proper splint application minimized this risk. Having the participant demonstrate proper splint application to the clinician before taking the splint home provided security against this risk. The clinician demonstrated proper splint application at least two times to the participant, and repeated the demonstration as many times as needed to ensure participant competence. Participants were instructed to discontinue using the splint if they experienced any increase in pain. They were also instructed to remove the splint for routine skin care and cleaning. Threats to participant privacy were be minimized by keeping any identifying information off of the data collection forms. An assigned participant number was used to
identify the participants during their first and second assessments. The data collected in this study was not sensitive and would not be personally damaging if discovered. However, every effort was made to protect the identity of the participants.

Another limitation of the study was that the researchers had little control over the period of weeks in between clinic visits, so there was no way to control for the duration of time the splint was used. It was expected that the amount of time would vary from two to six weeks, and in reality, the splint was worn an average of 29 days, with two participants failing to return for the second visit. For these subjects, data was available from the initial visit, but researchers were unable to incorporate the data from the QuickDASH or to look for changes in pain and pinch strength after a period of weeks. Researchers took into consideration the various lengths of time subjects spent wearing the splint when analyzing the data in an effort to control for the variations.

Another limitation of the study was that the researchers did not have access to radiographic information for the subjects, which would have been helpful in determining a subjects’ level of CMC OA, and observing improvement. The Researcher attempted to gather any data about a subjects’ level of CMC OA from the doctor’s referral, but this data was unavailable for all participants. The researcher relied on the compliance of several different clinicians who were administered the tests and recorded data. Although measures were taken to carefully train clinicians on the administration of tests and to make the testing process as simple as possible, there was some amount of clinician error, such as failing to enter patient ages on two occasions. Researchers ensured that the VAS was exactly 10 cm long, as the scale was liable to become distorted during the process of
making copies. Although this study contained several limitations, the researchers were aware of the listed potential problems and made every effort to maintain a quality study.
CHAPTER FOUR

Results

Characteristics of Participants

Ten participants were enrolled in the research study; two of the participants completed only the initial session and eight participants completed the entire study. All of the participants were female with an age range of 52 to 81. Eight subjects were fitted with splints for their dominant hand while two were fitted with splints for their non-dominant hand. Eight subjects were fitted with splints for their right hand, and two were fitted with splints for their left. Two of the subjects had been experiencing symptoms of CMC joint pain for less than six months, and the other eight had been experiencing symptoms for more than a year. Because only two participants had experienced CMC symptoms for less than six months, only two splinted their non-dominant hand and only two splinted their left hands, these variables were not included in any of the multiple linear regressions. Three of the subjects were currently working full-time, two worked part-time and five subjects were either retired or not working. Please refer to Table 1 for a summary of participant characteristics.
Table 1.

*Participant Characteristics (N=10)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Number of Participants</th>
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<tr>
<td>Splinted Hand Dominance</td>
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</tr>
<tr>
<td>Nondominant</td>
<td>2</td>
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<tr>
<td>Right or Left Hand Splinted</td>
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<td>Right</td>
<td>8</td>
</tr>
<tr>
<td>Left</td>
<td>2</td>
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<td>Duration of Symptoms</td>
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<td>2</td>
</tr>
<tr>
<td>More than Six Months</td>
<td>8</td>
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<tr>
<td>Work Status</td>
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</tr>
<tr>
<td>Part Time</td>
<td>2</td>
</tr>
<tr>
<td>Retired/ Not Working</td>
<td>5</td>
</tr>
</tbody>
</table>
Participant work occupations included: retirees, an artist, secretary, cosmetologist, nurse, retail, sales, and postal clerk. Primary leisure activities included: gardening, computer work, walking, pottery, weight lifting, knitting, kayaking, art, travel, and shopping. Three participants had other conditions affecting their hand function such as: fibromyalgia, Dupuytren's, and De Quervain's tenosynovitis. Three participants reported taking Ibuprofen as a prn, one reported taking aleve as a prn, one reported using advil as a prn, one reported taking altraset, one reported using loratab and celebrex, another participant reported using celebrex and one reported taking aspirin to relieve pain. One participant reported using herbal supplements and pain cream in addition to Ibuprofen and two participants reported that they did not use pain medication. Only one participant made any changes in medications from their first session to their second, and the change was the addition of an herbal supplement. Participants reported wearing the splint an average of 3.7 nights out of a 7-night week. Participants reported wearing the splint an average of eight waking hours each day. The length of time the between sessions ranged from 14 to 59 days with an average of 29 days between the sessions.

Study Results

For each of the tests used in this study, conditions were checked to ensure that parametric tests were appropriate for the data set. Residual plots were obtained and checked and no problems were seen with the conditions. For the paired t-tests, histograms were checked and the differences in the data were found to be approximately normal.
Parametric tests were used to test the data within this study since no concerns were identified.

*Visual Analogue Pinch Test Scores*

For the participants in this study, the mean VAS scores for the first session without the splint was 3.58 cm on a 0-10 cm scale, with 0 = No pain and 10 = Extreme pain. For each session, mean VAS scores decreased when subjects pinched the pinch gauge with the splint. The average score with the splint was 2.71 cm. The mean VAS score for the second session without the splint was 2.35 cm and with the splint was 1.91 cm.

The researchers compared the mean VAS scores for the first session with and without the splint. A multiple linear regression was run to check to see if splinted VAS scores were effected by the following variables; non-splinted VAS scores, age, and QuickDASH trial one scores. An R squared of .934 showed that 93.4% of the variation in mean VAS scores when splinted can be explained by the items in this model. None of the co-existing variables (age and QuickDASH trial one scores) were found to have a significant effect on mean VAS scores when splinted. A paired t-test was then used to compare mean non-splinted VAS scores and mean splinted VAS scores for the first session. A significant relationship (p = .026) suggested that mean VAS pain levels decreased when the subjects’ hands were splinted, suggesting that pain when pinching decreases with splint application.

The researchers looked at mean VAS scores for the second session, comparing the scores from the non-splinted and splinted pinch gauge test. A multiple linear regression
was used check for the effects of non-splinted VAS scores and co-existing variables, (length of time between sessions, age, how many nights the splint was worn, how many days the splint was worn, and QuickDash trial one scores), on splinted VAS scores from the second session. During the second session, mean non-splinted VAS scores had a significant effect on mean VAS scores with the splint, (p<.001). This suggests that pain when pinching decreases when a person pinches with splint on, particularly when the splint has been worn over an extended period of time. Length of time between sessions was shown to have a significant effect on mean splinted VAS scores for the second trial (p=.006). A larger sample size would be needed to further explore the relationship between length of time between sessions and mean splinted VAS scores.

The researchers compared mean VAS scores for sessions one and two, when the subjects pinched the pinch gauge with the splint on. A multiple linear regression was used to check if splinted VAS scores for session two were affected by VAS scores for session one with the splint, age, length of time between sessions, how many nights the splint was worn, how many hours a day the splint was worn and QuickDASH trial one scores. The model showed a significant relationship between mean VAS scores with the splint for the first and second sessions, (p=.0045) suggesting that participant mean pain levels with pinching decreased between the first and second sessions when they were wearing the splint. The model also showed a significant interaction between session one splinted mean VAS scores and age, (p=.006) and also between session one splinted mean VAS scores and length of time between sessions (p=.018). A larger sample would allow this interaction to be explored more fully.
The researchers compared mean VAS scores taken when the subjects pinched the pinch gauge with the splint off for both sessions one and two. Multiple linear regression was used to check if non-splinted VAS scores for session two were affected by non-splinted VAS scores for session one, length of time between sessions, age, the number of nights the splint was worn and waking hours the splint was worn. None of the variables mentioned above were found to have a significant effect on VAS scores for session two without the splint. According to a paired t-test, no evidence of a significant decrease in non-splinted mean VAS scores between sessions one and two was found (p=.0885). One possible explanation for this result is that the splint is required to be on when pinching if the client is to experience decreased pain because pain does not seem to decrease when the splint is not in use.

The splint used in this study appears to decrease mean pain with tip-pinches when participants pinch while wearing the splint. Mean pain does not appear to decrease when participants pinch the pinch gauge without the splint, even after wearing the splint for a period of weeks. One possible reason for this is that the splint is only effective for supporting the joint when it is worn. When the splint is taken off, the joint is no longer supported, and the pain returns. Table 2 displays the p-values from each regression and t-test performed for VAS pain levels. The results of the mean VAS pain score tests support the use of a prefabricated neoprene splint for reducing pain at the first CMC joint when completing a tip-pinches.
Table 2.

*Summary of One Sided T-Tests and Multiple Linear Regressions for VAS pain level with pinching (N=8)*

<table>
<thead>
<tr>
<th>Variables</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial One VAS: No splint and With splint</td>
<td>p=.026*</td>
</tr>
<tr>
<td>Trial Two VAS: No splint and With splint</td>
<td>p&lt;.001*</td>
</tr>
<tr>
<td>Trials One and Two VAS: With splint</td>
<td>p=.0045*</td>
</tr>
<tr>
<td>Trials One and Two VAS: No splint</td>
<td>p=.0885</td>
</tr>
</tbody>
</table>

*Note. * Indicates significance
**Strength of Tip Pinch Scores**

For the participants in this study, the mean strength of tip-pinch for the first session without the splint was 4.8 lbs. With the splint, the mean strength of tip-pinch was 6.8 lbs. The mean strength of tip-pinch on the second session was 6.61 lbs without the splint, the mean score with the splint was 7.55 lbs.

A multiple linear regression was used to check for the effects of length of time between sessions, daytime hours the splint was worn, number of nights per week the splint was worn, age and QuickDASH scores on each of the tested independent and dependent variables involving strength of tip-pinch. None of the variables listed above were found to have a significant effect on mean tip-pinch strength, so the researchers used a paired t-test to look for an increase in mean tip-pinch strength in each of the sessions. Mean tip-pinch strength increased significantly during the first session when the splint was worn while pinching as compared to pinching with no splint (p=.0015). During the second session, mean tip-pinch strength increased significantly when the subjects pinched while wearing the splint as compared to pinching without the splint (p=.045). Mean tip-pinch strength did not increase significantly between the first and second sessions, when the subject’s hand was splinted, but mean strength did increase significantly when the subject’s hand was not splinted (splinted: p=.259, not splinted: p=.0285). Table 3 displays p-values from each regression used to analyze pinch strength. This suggests that wearing the splint between sessions may have supported the CMC joint, decreasing pain with pinching, allowing the joint to tolerate a greater degree of tip pinch force. A larger sample is needed to fully explore this concept.
Table 3.

*Summary of p-values from Paired T-Tests for Strength of Tip-pin (N=8)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial One VAS: No splint and With splint</td>
<td>p=.0015*</td>
</tr>
<tr>
<td>Trial Two VAS: No splint and With splint</td>
<td>p=.045*</td>
</tr>
<tr>
<td>Trials One and Two VAS: With splint</td>
<td>p=.259</td>
</tr>
<tr>
<td>Trials One and Two VAS: No splint</td>
<td>p=.0285*</td>
</tr>
</tbody>
</table>

Note: *Indicates significance
QuickDASH Scores

The QuickDASH is an 11-item questionnaire that measures the physical function and symptoms of people with disabilities of the arm, hand, and shoulder. Each item is scored from 1 to 5, with a higher number indicating a greater degree of disability. The total score is then converted to fit 0-100 scale with a higher number indicating a greater degree of disability. For the participants in this study, QuickDASH scores on the first session ranged from 31.81 to 72 with a mean of 45.74. Scores from the second session ranged from 11.36 to 54.54, with a mean of 32.61. A multiple linear regression was run to check for the effect of mean QuickDASH session one scores, length of time between sessions, number of nights the splint was worn per weeks, age, and hours per day the splint was worn on QuickDASH session two scores. None of the co-existing variables (length of time between sessions, number of nights the splint was worn per weeks, age, and hours per day the splint was worn) were found to have a significant effect on mean QuickDASH trial two scores. A paired t-test was then used to compare mean QuickDASH scores for the first and second sessions. Mean QuickDASH scores decreased significantly by the second session, (p=.031) suggesting that, on average, participants experience improved hand function after wearing the splint for the period of time between sessions.

Qualitative Data

After completing the study, participants commented on their experience with the splint in the areas of comfort, convenience, effectiveness, and gave their suggestions. Data analysis was completed according to the format in Charlotte Royeen’s “A Research Primer in Occupational and Physical Therapy,” (1997). According to Royeen, the basic
process of data analysis is reducing data into summary forms, identifying patterns and themes, counting patterns and themes, rating the importance of patterns and themes and clustering patterns and themes by groups. Once the process of data analysis is complete, the data is to be interpreted through inductive reasoning, reflective remark, developing propositions and giving possible explanatory effects (Royeen, 1997, p. 198). Comments were organized by theme into four categories: comments about comfort, comments about convenience, comments about effectiveness, and suggestions. Comments were further classified as being either negative or positive about the splint. Positive and negative comments for each category were counted and comments that remarked on similar topics were identified. Seven comments on splint comfort were positive and four were negative. Three comments supported the splint’s convenience, while five of the comments in this area were negative. Five comments affirmed the splints effectiveness and two comments negatively described the splints effectiveness. A number of helpful recommendations were given as well.

The majority of comments on splint comfort were positive. Most people simply stated that the splint was comfortable, one participant stated that it became more comfortable after the splint “broke in.” Two comments directly contradicted one another, one saying, “I wish it would support the wrist a little,” the other saying, “it really supports the wrist while working.” One participant commented that the splint began to itch after wearing for a while. One participant found the splint painful because she also had Dupuytrans and the splint interfered with the condition. Itchiness and conflicting conditions seemed to be the most common problems related to comfort, but the majority of participants found the splint acceptably comfortable.
Participant comments suggested that the splint could be improved by making it more convenient to apply and wear. Two participants found the splint “very convenient” and “easy to put on.” One found it, “too hard to put on.” Another participant stated that, “the Velcro catches on everything.” Two participants discussed the dilemma of engaging in activities such as hairdressing or kitchen work and being unable to use the splint because it becomes dirty easily. Doing some activities, such as hairdressing, required participants to take the splint on and off many times, which can be inconvenient. Many times they were unable to use the splint during activities requiring them to use their painful thumb because the splint would become wet or dirty. One participant said that the splint washes and dries easily. Results on splint convenience were mixed.

Participant comments supported splint effectiveness. One participant said that she “looked forward to wearing it.” Another wore it during spinning class and found it “very effective... if she wore it consistently.” One participant found it to be effective at times, but other times it seemed to increase the pain. One participant stated the splints effectiveness as “minimal.” Most participants found the splint to be effective, with one participant stating, “you won’t get it back!”

Participants had a number of suggestions to improve the splint. Participant suggestions are displayed in Table 4. One participant suggested that any exposed Velcro be covered to prevent things sticking to it. Some suggested a more breathable or washable material as the splint became smelly quickly and needed to be washed often. More water resistant material would allow the splint to be worn during messier activities. Two comments suggested that the splint should be easier to put on. Application and splint material were the two main themes of participant suggestions.
Table 4.

*Participant Suggestions from the Qualitative Section*

<table>
<thead>
<tr>
<th>Themes</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>Design pull strap to come off of the Back.</td>
</tr>
<tr>
<td></td>
<td>Find a way to cover the Velcro.</td>
</tr>
<tr>
<td></td>
<td>Make it easier to put on.</td>
</tr>
<tr>
<td></td>
<td>Difficult to take on and off.</td>
</tr>
<tr>
<td>Splint Material</td>
<td>Had to wash often.</td>
</tr>
<tr>
<td></td>
<td>Smelly after wearing it for a while.</td>
</tr>
<tr>
<td></td>
<td>Make it plastic for messiness.</td>
</tr>
<tr>
<td></td>
<td>Inconvenient when doing messy activities.</td>
</tr>
<tr>
<td></td>
<td>Washes easily and dries quickly.</td>
</tr>
</tbody>
</table>
In general, participants gave positive comments about the splint and participants felt that the splint was helpful to them. Participants seemed most satisfied with the splint's comfort and effectiveness, and gave suggestions about ways to make the splint more convenient. One common suggestion was for the splint to be made more breathable and resistant to water, making it useful during messier activities. Participants also were interested in making the splint easier to apply. Participants had both positive and negative comments about the splint, with many helpful suggestions.

Conclusion

The results of the study support the effectiveness of the splint for reducing pain with tip-pinch, increasing tip-pinch strength, and improving hand function. Mean VAS pain score decreases when participants pinch with a tip-pinch while wearing the splint on both sessions. However, mean pain scores did not show evidence of a significant decrease when participants tip-pinched without the splint. Length of time the splint was worn and age of participants were found to have a significant effect on mean VAS pain scores. Mean measures of tip-pinch increased when participants pinched with the splint on the first and second sessions. However, mean strength of tip-pinch did not show evidence of a significant increase when splinted scores from the first and second session were compared. A decrease in mean QuickDASH scores between the first and second sessions suggested an improvement in hand function when the splint was worn over a period of weeks. Participants seemed to believe the splint to be comfortable and effective, but not always convenient. They suggested more breathable, washable material, and simpler application. Although a small sample size and external variables limit the
generalizability of the study, the results follow the trend of past studies in supporting the use of a prefabricated neoprene splint for treating the symptoms associated with first CMC osteoarthritis.
CHAPTER FIVE

Discussion and Conclusions

Introduction

The purpose of this study was to determine the effectiveness of the application and wearing of a hand based neoprene carpometacarpal splint for reducing pain, increasing tip pinch strength, and improving function at the first CMC joint while pinching a pinch gauge and participating in activities involving the upper extremities. Past studies have supported the use of splinting to reduce first CMC joint pain and improve function, however, research that supports a specific splint type or material is lacking (Weiss et al., Callinan et al., Callinan and Mathiowitz, Swigart et al., Buurke et al., Egan and Brosseau). The researchers used several hypotheses within the study:

1. There will be a significant decrease in mean pain VAS score when the subject’s hand is splinted as compared to mean pain VAS score when the hand is not splinted.

2. There will be a significant decrease in mean pain VAS scores for the second session as compared to the first.

3. There will be a significant increase in mean tip pinch strength when the subject’s hand is splinted as compared to mean tip pinch strength when the subject’s hand is not splinted.

4. There will be a significant increase in mean tip pinch strength for the second session as compared to the first.

5. There will be a significant decrease in mean QuickDASH scores on the second session as compared to the first.
The researchers looked at pain measurements before and after splint application as measured by a VAS. VAS measurements were taken at an initial session and a subsequent session a number of weeks later. Tip pinch strength was also measured at each session, with and without the splint. The QuickDASH, a functional measure, was given to participants at the first and second sessions. Participants were also asked qualitative questions on the second session about the splint’s comfort, effectiveness and convenience.

The results of this study are in keeping with previous research supporting the use of splinting for treating the painful first CMC joint. The results showed a decrease in the mean VAS pain scores when pinching the pinch gauge with the splint as compared to without the splint on both the first and second sessions. This is consistent with the results of Weiss et al., Callinan et al., and Buurke et al. in that all three studies supported the use of a thumb CMC splint for relieving arthritis pain at the first CMC joint. Mean tip pinch measurements increased when participants applied the splint for both the first and second sessions. Mean non-splinted tip pinch measurements also increased on the second session as compared with non-splinted tip pinch measurements on the first session. These findings are not in line with previous research, which has not supported an increase in tip-pinch strength due to splinting Weiss et al., 2004, Weiss et al., 2000). QuickDASH results showed an increase in functional performance in tasks requiring hand use after participants wore the splint for a number of weeks. The study by Weiss et al. (2004) reported similar results when subjects wearing a prefabricated neoprene splint reported improved function after one week. But for a few differences, the results of this study fit nicely into the body of research on the topic of degenerative first CMC joint splinting.
The biomechanical frame informs the results of this study, as the splint appears to provide the appropriate support to the CMC joint as evidenced by decreased pain and increased measurement of tip pinch. The study results lend further support to the effectiveness of splinting for pain relief, joint stability and functional improvement.

*Visual Analogue Scale Pain Results*

One of the most interesting findings of the study was noted during the second session when the splinted trial was compared to the nonsplinted trial (p<.001). This result supports the notion that wearing the splint consistently over a period of time may lead to a decrease in pain at the thumb joint. One possible reason for this outcome is that the joint is stabilized during function, reducing inflammation and the process of degeneration (Colditz, 2002). The only co-existing variables which appeared to have an effect on pain levels were the length of time between visits and age of participant. Length of time between visits affected comparisons of splinted and non-splinted VAS scores for the second session, and splinted VAS scores from the first and second session. It is possible that the length of time the splint was worn between sessions had an influence on the splints’ effectiveness for reducing pain. Because the time between sessions was not controlled and because of the small sample size, further research is needed to better explore this possibility.

Age also had a significant effect of the comparison between mean splinted VAS scores from the first and second session. It is possible that participant age had an effect of the splint’s effectiveness; for example, the process of degeneration may have been more advanced in older participants. However, this cannot be confirmed because the Eaton and Glickel levels of degeneration were not available for the participants. A study with a
larger sample size and including Eaton and Glickel levels would be able to better explore this area.

There was no evidence to support a decrease in mean pain level when non-splinted trials for session one and two were compared. This may be explained by the fact that the CMC splint is designed to support the first CMC joint during activities, but not improve joint integrity or reverse the course of arthritis (Weiss et al., 2000). It was not expected that participants’ pain would improve when their hands were not splinted because the splint is only effective when it is working to stabilize the joint. When the splint is removed, the joint may revert to instability and pain. However, the results of the study are unclear because mean strength of tip pinch increased for the non-splinted first and second session comparison. The apparently contradiction may be due to a small sample size, as the VAS score was close to significant (p=.0885) and a larger sample may have shown significance. The lack of decrease in pain for non-splinted trials does not contradict the hypothesis of the researchers.

*Tip Pinch Strength*

The results of the tip-pinchof tests yielded some expected and some surprising results. The significant increase in mean tip pinch strength when pinching after splint application was surprising because most of the previous studies in this area found similar splints to have no impact on force of pinch (Weiss et al., 2000; Weiss et al., 2004; Buurke et al., 1999). Weiss et al., (2000) predicted that if a CMC splint was worn for longer than the one week prescribed in that particular study, an increase in mean pinch strength could potentially be seen. Mean tip pinch strength showed particular improvement (p=.028) during the second session non-splinted trial, as compared with the first session non-
splinted trial. However, this result is contradictory as the same comparison in regards to pain suggested that mean pain scores did not decrease. It is possible that tip-pinch strength increased without also decreasing pain, although past studies have suggested the opposite result, with pain decreasing and pinch strength remaining unchanged. (Weiss et al., 2004; Weiss et al., 2000). These results may have clinical significance in that clients may see greater improvements in client CMC joint stability if they wear the splint continually over an extended period of time. Wearing the splint may have decreased joint inflammation, allowing for a greater tip-pinch measurement, even when not wearing the splint. The results were ambivalent, however, because mean tip pinch measurements did not increase significantly when the participants’ hands were splinted on the second session as compared with mean tip pinch measurement when splinted on the first session (p=.259). Also, because of the discrepancy between tip-pinch measurements and pain of pinch without the splint, results should be viewed with an awareness of the possibility that the external variables and the small sample size had a skewing effect. A larger sample would allow for greater exploration of the relationship between first CMC splinting and tip-pinch measurement.

Quickdash Results

The significant decrease in mean QuickDASH scores on the post-test as compared with the pre-test suggests that people can improve their functional performance of tasks requiring hand use when they wear the splint for the number of weeks in between test sessions. It is important to connect a splint’s ability to decrease pain with its’ capacity for improving function. Function is a primary goal of occupational therapy intervention and it is of great importance that interventions are shown to have a functional outcome. This
is especially true within the rehabilitation frame of reference, which emphasizes returning a client to the fullest possible physical, mental and emotional function with the use of assistive technology or equipment such as the splint used in this study (Schultz-Krohn and Pendleton, 2006). Participants in this study consistently reported that their CMC arthritis caused significant problems when participating in leisure, self care, and work occupations. Many of the participants had jobs or hobbies that would be potentially affected by CMC arthritis, such as: clerical work, knitting, artist, gardening, weight lifting and kayaking. An increase in hand function translates into an increased ability to participate in meaningful activities. While the results of this study point to an increase in hand function for splint wearers, the study is limited by low sample size and confounding variables. The results of this study require further validation including further studies with a larger sample that controls for the length of time the splint is worn between visits.

**Qualitative Results**

Participants were able to give direct feedback on their experiences with the splint in the qualitative section of the study. Participants appreciated the comfort of the neoprene splint, which supports the results of previous study findings that participants seem to prefer soft splints over hard splints (Callinan et al., 1996; Buurke et al., 1999). Participants offered conflicting information about the ease of splint application. This discrepancy could be attributed to individual expectations and aptitudes for learning splint application. The most frequent criticism of the splints was their tendency to become soiled as well as the problem of being unable to wear the splints during messier tasks. It may be beneficial for splint manufacturers to look into using a breathable, water resistant material that retains soft splint qualities for making the splint.
Clinicians should take note that the splint did not work well for participants who had an additional diagnosis affecting the hand, whether it was Dupuytren's or trigger thumb, participants reported discomfort while wearing the splint. In a study comparing short and long opponens CMC splints conducted by Weiss et al., (2000) eight subjects had concurrent problems affecting the hand. Interestingly, six of those participants preferred the long opponens splint over the short opponens. It is possible that a long opponens splint offers more wrist support when a client with more than one diagnosis. Future studies may wish to address this question.

Limitations

There were several limitations in the completion of the study that bear mentioning. A small sample size was the most limiting factor of this study, although previous studies have used similar sample sizes (Buurke et al., 1999). It is also interesting to note that even with a small sample size, significant evidence for the splint's effectiveness was found. It is often difficult for studies with small sample sizes to produce significant results, and the significance found in this study suggests that a larger sample would produce similar findings. Due to the use of several clinicians for data collections, small errors in data collection were made and information such as age of participant was missing from several tests. This limited the already small sample size even further, decreasing the scope of the study.

Because of the scheduling priorities at the hand clinic, the researchers were unable to control the amount of time the participants wore the splint between visits. Multiple linear regression was able to control for this to some extent, although the length of time the splint was worn was found to have a significant effect on pain levels in some
circumstances. The study did not control for how many hours the splint was worn during the day, although data was collected on this and multiple linear regression found it to have no significant impact on pain scores, tip pinch strength, or functional outcomes. There is a chance that participant bias affected the scores because participants were not blind to the conditions of the test and were aware of the aims of the study. The nature of the study made it very difficult to blind participants to conditions, and previous studies have used similar study designs. In spite of the limitations of this study, the results offer fairly clear support for the effectiveness of splinting to control pain, increase tip-pinch strength and increase function for the arthritic first CMC joint.

Conclusion

This study offers a supplement to previous evidence for the effectiveness of splinting in treating pain, instability, and functional deficits associated with osteoarthritis of the first CMC joint. Future research should focus on recruiting larger samples in order to better explore the effects of length of time the splint is worn, age, and stages of CMC joint degeneration. Perhaps studying the relationship between the length of time the splint is worn consistently may show that long periods of consistent splint use increases the effectiveness for reducing pain. Age was a variable that appeared to have an influence on pain in this study. It may be beneficial to correlate age and level of joint degeneration in order to explore the whether or not there is a relationship between age and Eaton and Glickel level of joint degeneration. Age, and Eaton and Glickel level could then be explored in relation to splint effectiveness for reducing pain. It would also be interesting to look more closely at the relationship between splinting and tip pinch strength because the results of this study varied from previous studies in that tip pinch strength appeared to
increase upon splint application. Coexisting conditions are often seen along with OA of the CMC joint, and it would be helpful to know if a particular kind of CMC splint was more effective than others in the treatment of clients with multiple hand conditions. The study is unique in that it explores the effectiveness of one particular splint, a hand based prefabricated neoprene splint, by evaluating its ability to decrease pain, improve function, strengthen tip-pinch and by also involving input and comments from the participants. In conclusion, clinicians and therapists should continue to consider soft splints as an effective alternative for treating first CMC joint arthritis.
References


limitations and participation restrictions in women with hand osteoarthritis:

Patients' descriptions and associations between dimensions of functioning. *Annals of Rheumatic Diseases, 64*, 1633-1638.


Stein, M., & Taylor, G. (2004). In *The encyclopedia of arthritis* (pp. 11-12). New York:
Facts on File Inc.


Appendix A
Prefabricated Neoprene First Carpometacarpal Splint Used in Study

Right hand palmar surface

Right hand dorsal surface

Right hand Tip pinch

Right hand side view
ORTHOPEDIC & SPORTS MEDICINE

CONFIDENTIALITY AGREEMENT

Leana Tank and Jeanine Biese, Med, OTR, CHT agree that in consideration for being shown or being provided with access to any confidential information relating to Weber Orthopedic Inc. business, work, data, developments, inventions (including a new CMC splint developed by Weber) or trade secrets, they and their associates will maintain all such information in confidence, and will not use or disclose same to any third person, without the written consent of an officer of Weber Orthopedic Inc.

Weber Orthopedic Inc. understands that there will be students, patients, patient family members, as well as participating clinicians and committee members (referred to as associates in the preceding paragraph) participating in a confidential study of the splint under the supervision of Leana Tank and Jeanine Biese. Weber Orthopedic Inc. makes an exception for those students, patients and patient family members as a third person in the preceding paragraph to use the splint and discuss the splint among the participants in the CMC study. It is understood by all parties that if information concerning the Weber splint is shared or discussed, without Weber's written consent, with other persons not participating in the study, that will constitute a violation of this agreement which could be harmful and cause damage to Weber Orthopedic Inc. Leana Tank and Jeanine Biese agree to caution all of the participants mentioned regarding the above.

Leana Tank
Date 5-7-07

Jeanine Biese, Med, OTR, CHT
Date 5-7-07

For Weber Orthopedic Inc.

Jim Weber, President
Date 5-7-07

P.O. Box 832 Santa Paula, CA 93061-0832
California: (800) 221-5465 National: (800) 654-3241 Fax: (800) 559-5975
Memo to: Leana Tank, OTS and Jeanine Biese, OTR, CHT, Med  
From: Holland Community Hospital  

Primary investigators, Leana Tank, OTS and Jeanine Biese, OTR, CHS, Med have the permission of Holland Community Hospital, pending the approval of the Grand Valley Human Subjects Review Board, to enroll participants for the Study of The Effect of Splinting on Pain during Pinch for Osteoarthritis of the First Carpometacarpal Joint from the hospital outpatient clinic. Holland Community Hospital understands that hospital clinicians will be thoroughly trained by Leana Tank in the implementation of the study and will be acting as individual investigators in this study. Hospital clinicians will not share the identities of the study participants or the splint used in the study with anyone not participating directly with the research study. Holland Community Hospital has full knowledge of the nature of the research and are allowing the primary investigators to carry out the study on the hospital grounds.

Mary Knies, OTR  
8/28/2007  
date
Authorization To Release/Obtain Medical Information

Please check all appropriate boxes.

<table>
<thead>
<tr>
<th>Last Name</th>
<th>First Name</th>
<th>Date of Birth</th>
<th>MR#</th>
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</tbody>
</table>

Maiden Name / AKA | Phone Number

I hereby authorize Holland Hospital to □ disclose and/or □ obtain the following information contained in my medical record from (date) ___________ to (date) ___________.

Name of person/organization to whom disclosure is to be released/obtained from:

Name: Leana Tank (Grand Valley OT Program)

Address: 549 Giddings St, Grand Rapids, MI 49504

Specific Information Authorized for Release

| □ E.R. Reports | □ Operative Report | □ Treatment Plan/Planning |
| □ Discharge Summary | □ Rehab Services Report / O.T., P.T., Cardiac | □ Psychiatric History & Physical |
| □ History & Physical | □ Pathology Report(s) / Lab | □ Psychiatric Evaluation |
| □ EKG(s) | □ Mail/Verbal Ac# | □ Psychiatric Discharge Summary |
| □ XRay Reports/Film, Digital, CD | □ Billing Records | □ Psychiatric Testing |
| □ Progress Notes | | □ Complete Medical Record |

Other, For Study

Purpose of Disclosure

□ Attorney/Legal □ Insurance/Workers Comp. □ Personal Reasons □ Treatment

I understand that this will include information relating to:

• Acquired Immunodeficiency Syndrome (AIDS) or Infection with HIV (Human Immunodeficiency Virus), AIDS related complex (ARC).
• Sexually transmitted diseases, Tuberculosis, Hepatitis, Communicable diseases and Infectious disease.
• Treatment for Alcohol and/or Drug Abuse
• Behavioral Health Services

Release of Information

1. I understand that this authorization extends to all medical records of other providers to the extent indicated above; this may include any information about substance abuse treatment, behavioral health services, communicable diseases and infectious disease, including sexually transmitted disease, HIV infection, acquired immunodeficiency related complex, venereal disease, hepatitis or tuberculosis.

2. I understand that I may inspect or copy the information to be disclosed and may, upon inspection, refuse to sign the authorization or may revoke this authorization at any time if already signed by sending a written revocation to the Medical Records Department at Holland Hospital. I understand that the revocation will not apply to information that already has been released in response to this authorization. Unless otherwise revoked, this authorization will expire on the following date, event or condition: _________________________. If I fail to specify expiration date, event or condition, this authorization will expire in six (6) months.

3. I understand that any disclosure of this information carries with it the potential for redisclosure and the information may not be protected by federal or state confidentiality regulations/rules.

4. I understand that my continued or future treatment by or payment to Holland Hospital is not conditioned upon my providing or signing this authorization unless this authorization is provided for the purpose of providing data in connection with medical or clinical trial research.

5. I understand that authorizing the disclosure of this health information is voluntary. I need not sign this form in order to assure continued or future treatment.

□ I have been provided a copy of this authorization for my records.

X ___________________________ Date: ___________________________
Signature of Patient or Person Authorized to Consent
Note: If signature is marked by X you must have two witnesses.

X ___________________________
Relationship, if not Patient, Legal guardian - attach documentation

X ___________________________ X ___________________________
Witness Witness

If you have any questions, please call Holland Hospital Medical Records Department at (616) 394-3154.

C63, Revised 04/05 #50053
Appendix C
Participant Recruitment Poster

Volunteers Requested
For a "Study on the Effect of Splinting on Pain during Pinch for Osteoarthritis of the First Carpometacarpal Joint"

A FREE experimental hand splint will be given to all study participants!
You may participate if you:
* Have been diagnosed with osteoarthritis of the joint at the base of your thumb (first carpometacarpal)
* Have no other conditions affecting the use of your hands
* Are willing to wear a hand splint for 1-4 weeks and report on how well the splint helps to relieve pain and improve function

***Please call Leana Tank, Occupational Therapy Student at 648-1057 if you are interested in participating. Thank you
Appendix D

Splinting Study

Date of initial splint application: _________  Clinician Initials: _______

History

Age: _______
Gender: M F

Affected hand:  Dominant  Nondominant
Right  Left

Level of severity of Osteoarthritis (if known): 1st degree  2nd deg.  3rd deg.  4th deg.

Duration of pain (circle one):  <6 months  6-12 months  >1 year

Primary occupation: ____________________________________________________

Current work status:  Full time  Part time  not working

Primary leisure activities: ________________________________________________

Any other conditions affecting the hand: _________________________________

Date of Initial Assessment: ______________

Current Pain medications

Initial Assessment

*** Please pinch the pinch gauge using a tip pinch as hard as you can until the point of pain, and mark your pain level on the Visual Analogue Scale. Please record the pinch gauge measurement for each pinch as well. Do this without the splint and then once again while wearing the splint. Then please complete the QuickDASH questionnaire.

1. Pain level while tip pinching without the splint

Visual Analogue Scale

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>No Pain</td>
</tr>
</tbody>
</table>
Force of tip pinch ______ lbs

2. Pain level while pinching and **wearing** the splint

Visual Analogue Scale

|-----------------------------------------------|---|---|
|No Pain                                      | Extreme Pain

5. Force of tip pinch ______ lbs

6. ***Please complete the QuickDASH regarding the pain in your HAND only***

****Please take the splint home with you and wear it at as much as possible during the day and night. Bring it with you to your next appointment. Thankyou!

Second Assessment

**Please follow the same procedure as the initial assessment**

Date of second assessment: ______ _

1. Any changes in your pain medications

________________________________________________________

2. Pain level while tip pinching **without** the splint

Visual Analogue Scale

|-----------------------------------------------|---|---|
|No Pain                                      | Extreme Pain

Force of tip pinch ______ lbs

3. Pain level while pinching and **wearing** the splint

Visual Analogue Scale

|-----------------------------------------------|---|---|
|No Pain                                      | Extreme Pain

Force of tip pinch ______ lbs
4. Please complete the QuickDASH regarding the pain in your HAND only

In a typical 7 day period, how many nights did you wear the splint? _______ nights

In a typical day, how many waking hours did you wear the splint? _______ hours

Please answer the following questions to the best of your ability:

Please describe your experience with this splint in the areas of:

Comfort? ________________________________________________________________

Convenience? __________________________________________________________

Effectiveness? __________________________________________________________

Suggestions? ____________________________________________________________

Thank you so much for your participation in this study! Please feel free to keep the splint as a token of our appreciation. We hope that it has been beneficial to you. Please call Leana Tank, at 616-648-1057 if you have any problems, concerns or questions about the splint. You may also contact Paul Retemeir, Chair of the Human Subjects Review Board for Grand Valley State University at 616-331-7105 if you have any concerns about your rights as a research study participant. Thank you once again!
Appendix E
QuickDASH

INSTRUCTIONS

This questionnaire asks about your symptoms as well as your ability to perform certain activities.

Please answer every question, based on your condition in the last week, by circling the appropriate number.

If you did not have the opportunity to perform an activity in the past week, please make your best estimate of which response would be the most accurate.

It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.
**QuickDASH**

Please rate your ability to do the following activities in the last week by circling the number below the appropriate response.

<table>
<thead>
<tr>
<th>Activity</th>
<th>NO DIFFICULTY</th>
<th>MILD DIFFICULTY</th>
<th>MODERATE DIFFICULTY</th>
<th>SEVERE DIFFICULTY</th>
<th>UNABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Open a tight or new jar.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. Do heavy household chores (e.g., wash walls, floors)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Carry a shopping bag or briefcase.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Wash your back.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Use a knife to cut food.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>NOT AT ALL</th>
<th>SLIGHTLY</th>
<th>MODERATELY</th>
<th>QUITE A BIT</th>
<th>EXTREMELY</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. During the past week, to what extent has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>NOT LIMITED AT ALL</th>
<th>SLIGHTLY LIMITED</th>
<th>MODERATELY LIMITED</th>
<th>VERY LIMITED</th>
<th>UNABLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**Please rate the severity of the following symptoms in the last week. (circle number)**

<table>
<thead>
<tr>
<th>Symptom</th>
<th>NONE</th>
<th>MILD</th>
<th>MODERATE</th>
<th>SEVERE</th>
<th>EXTREME</th>
</tr>
</thead>
<tbody>
<tr>
<td>9. Arm, shoulder or hand pain.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Tingling (pins and needles) in your arm, shoulder or hand.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>NO DIFFICULTY</th>
<th>MILD DIFFICULTY</th>
<th>MODERATE DIFFICULTY</th>
<th>SEVERE DIFFICULTY</th>
<th>SO MUCH DIFFICULTY THAT I CAN'T SLEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. During the past week, how much difficulty have you had sleeping because of the pain in your arm, shoulder or hand? (circle number)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

**QuickDASH DISABILITY/SYMPTOM SCORE** = \( \frac{\text{Sum of } n \text{ responses}}{n} \times 25 \), where \( n \) is equal to the number of completed responses.

A QuickDASH score may not be calculated if there is greater than 1 missing item.
Appendix F
Instructions of Independent Investigators

Instructions for A Study on the Effect of Splinting on Pain During Pinch for Osteoarthritis of the First CMC Joint

Thank you for assisting in this research. My name is Leana Tank and I am an OT student at Grand Valley State University. I can be reached at 616-648-1057, or by e mail, Leana_Tank@yahoo.com. I will be going over the instructions for this study in person, but here are the general guidelines for your reference.

1. Please ensure that the participant meets all of the study criteria, which includes:
   • They must be diagnosed with Osteoarthritis at the base of your thumb.
   • They may not have any other diagnoses affecting the hand.
   • They must be able to wear the splint over a period of weeks and accurately remember your experiences with the splint during that time.
   • They must be able to cognitively express pain levels using a Visual Analogue Scale and fill out a short questionnaire.

2. Select either a Right or Left handed splint for the participant, depending on the affected hand. If the participant has bilateral involvement, please refer to the randomized list to decide which hand to splint. Please record on the list when you have issued the splint.

3. Have the participant read and sign the Informed Consent document as well as Consent to use Medical Records, and file in the file marked “Informed Consent,” and “Medical Record Perm.” Please have it photocopied and give the participant a copy to take home with them if they wish.

4. Demonstrate to the participant how to properly apply the splint.

5. Have the participant pinch the pinch gauge using TIP PINCH without the splint and then while wearing the splint. Each time, they should mark their pain level on the Visual Analogue Scale on the form entitled “Splinting Study.”

6. Have the participant fill out the DASH questionnaire. You will be given more information as to how to fill out the DASH.

7. File the paperwork in the participants’ medical chart. Please ensure that you have filled out the date on the forms.

8. Show the participant again how to apply the splint and have them demonstrate to you that they can properly apply it themselves. Have them take the splint home and instruct them to wear it “as much as possible during the day and night, until their next appointment.” Instruct them to bring the splint back with them for their next appointment.

9. If this is their second visit with the splint, have them pinch the pinch gauge and complete the DASH again. Be sure that they answer the questions about how much they wore the splint and how well it worked for them.

10. If this is their second visit, file the paperwork in the “Completed Forms” File.
Appendix G

Participant Consent Form
A Study on the Effect of Splinting on Pain During Pinch for Osteoarthritis of the First CMC Joint

You are invited to participate in a research study entitled “A Study on the Effect of Splinting on Pain During Pinch for Osteoarthritis of the First CMC Joint.” The purpose of this study is to determine the effectiveness of a specialized CMC splint prototype for reducing pain at the base of the thumb joint while tip pinching for people with osteoarthritis. This study is being conducted by Grand Valley State University. Leana Tank, Occupational Therapy Student, is the principal investigator for this research. The splint is a prototype made by a company and is not yet available on the market.

In order to be included in this study:
* You must be diagnosed with Osteoarthritis at the base of your thumb.
* You may not have any other diagnoses affecting the hand.
* You must be able to wear the splint over a period of weeks and accurately remember your experiences with the splint during that time.
* You must be able to cognitively express pain levels using a Visual Analogue Scale and fill out a short questionnaire.

If both of your hands are affected by Osteoarthritis, you will be randomly assigned which hand will be used in the splinting study. At the end of the study, you may take home a splint for the alternate hand if you wish.

1. This study will last for the period of time between your first and second appointments, a period of 1 to 4 weeks.
2. On both clinic appointments, you will complete a visual analogue pain scale for the pain you experience at the base of your thumb while pinching a pinch gauge with and without the splint. You will also be asked to fill out a short 11 item questionnaire about your daily activities, as well as answer one open ended question about your experience with the splint.
3. The information you provide throughout the course of the study will remain confidential to the extent permitted by the law. Leana Tank and Jeanine Biese will be the only people allowed access to the data pertinent to the study. Your identity will not be disclosed without written consent in any publications resulting from this research project.
4. You may experience a decrease in pain at the base of your thumb during the course of this study.
5. Improper splint application may lead to discomfort and increased pain. If you experience significant discomfort with this splint you are instructed to remove it and discontinue use. Please notify the researcher, Ms. Tank, as soon as convenient. If you seek medical treatment for the discomfort, you are responsible for any costs associated with that treatment.
6. A small percentage of people are allergic to Neoprene fabric of which the splint is made. If you experience itching, swelling or rash on your hand during this study please discontinue the use of the splint and notify Ms. Tank as soon as is convenient.

Please also discontinue use of the splint if you have any increase in pain.

7. The splint to be used in this study is a confidential prototype and is not to be given to anyone not connected with the study.

8. At the end of the study, the splint is yours to keep at no cost.

9. If you choose not to participate in this study, your clinician will provide you with other options for the treatment of Osteoarthritis at the base of the thumb. These may include splinting, assistive devices, joint protection, as well as other options.

10. Splinting is a common practice in the treatment of Osteoarthritis at the base of the thumb.

11. Participation in this study is voluntary and you may withdraw at any time without penalty of any kind by contacting Leana Tank by phone at 616-648-1057 or Jeanine Biese, Research Advisor, at 616-331-3117.

12. You will be informed if significant new findings become available during this study that may affect your willingness to continue to participate in this study.

13. A copy of the signed consent form will be given to you.

I acknowledge that:

A researcher has personally gone over this consent form with me and given me the opportunity to ask questions about this research study. I feel that my questions have been answered to my satisfaction. If I have any questions about human subjects rights, I can phone Leana Tank at 1-616-648-1057 or Paul Reitemeier, Chair of Human Subjects Review Board at Grand Valley State University at 616-331-3417 or Jeanine Biese, chairperson for this study, at 616-331-3117.

I hereby authorize the researchers to release the information obtained in this study to scientific literature. I have been informed that my name will not be identified and that all information I have provided will remain confidential.

I acknowledge that I have read and understood the above information and I agree to participate in this study.

Participant’s signature Date

This research proposal 08-09-H has been approved by the Human Research Review Committee at GVSU. Expiration Date: October 23, 2008