A quick guide to the management of traumatic upper extremity injuries: for entry level occupational therapists

Marty Melland
University of North Dakota

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A QUICK GUIDE TO THE MANAGEMENT OF TRAUMATIC UPPER EXTREMITY INJURIES: FOR ENTRY LEVEL OCCUPATIONAL THERAPISTS

By

Marty Melland

Advisor: Anne Haskins MA, OTR/L

A Scholarly Project
Submitted to the Occupational Therapy Department
of the
University of North Dakota
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For the degree of
Master’s of Occupational Therapy

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This Scholarly Project Paper, submitted by Marty Melland in partial fulfillment of the requirement for the Degree of Master's of Occupational Therapy from the University of North Dakota, has been read by the Faculty Advisor under whom the work has been done and is hereby approved.

Faculty Advisor

5-6-2008
Date
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Title                           A Quick Guide to the Management of Traumatic Upper Extremity Injuries: For Entry Level Occupational Therapists

Department                     Occupational Therapy

Degree                         Master’s of Occupational Therapy

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ABSTRACT

According to Kasch, Greenberg, and Muenzen (2003), occupational therapists who are initiating their entry into hand therapy or upper extremity orthopaedic specialization do not have the knowledge and skills of an experienced therapist. This is especially true for occupational and physical therapists who enter the workforce with a general overview of many treatments but have not trained or worked in a specialized upper extremity orthopaedic practice. Upper extremity orthopaedics is a specialty area of the occupational therapy (OT) profession which requires not only a wide range of generalized knowledge and experience, but also an extended knowledge of specific diagnostic categories and treatment. Secondary to the need to prepare students for entry-level generalized practice, many OT programs are not designed to prepare students for areas of specialized practice, including upper extremity orthopaedic therapy. Despite the absence of specialty knowledge, many students obtain employment in OT hand therapy clinics or treat patients with upper extremity dysfunction in other practice settings. While comprehensive literature exists for treating patients with upper extremity injuries, there are limited resources designed to assist entry level therapists during their transition from an OT student to a clinician in a specialty area.

A literature review was conducted to obtain information on the process of specializing in OT hand therapy. Informal discussions with practicing OTs and faculty members specializing in orthopaedic upper extremity therapy were also conducted to obtain more information about hand therapy and the process of becoming a competent
therapist. The product portion of this project was created after gathering information about three common traumatic upper extremity injuries, distal radius fractures, traumatic tendon injuries, and traumatic nerve injuries, and the therapeutic approaches to treat these injuries. Information was gathered from materials produced by orthopedic surgeons, general physicians, hand therapists, occupational therapists, and other medical professionals specializing in the treatment of hand injuries.

The information collected culminated in the creation of a manual designed for use by entry-level occupational therapists and is presented in three sections that are congruent with the three aforementioned diagnoses. Each of the three sections of the manual provides an overview of the diagnosis being discussed as well as common problems associated with each diagnosis and treatment strategies that are commonly used in the hand therapy setting. Each section also includes pictures or diagrams representing the traumatic injury, explanations of common etiology of the injury and the general symptoms that may be present. The manual also includes a resources section which includes helpful literature, websites and associations for occupational therapists who are treating patients with upper extremity orthopaedic dysfunction.

I believe this product can be used by students who are interested in entering the hand therapy setting but do not feel they have the knowledge and experience to do so. Further, I believe this product will be useful for practicing therapists who work in rural settings or other settings in which patients with hand injuries are not the primary population being treated.
CHAPTER I
INTRODUCTION

Occupational therapy can be a difficult profession to master and can often require years of training, learning, and practice to become a competent therapist. It is often difficult for new therapists to transition into the field of occupational therapy, especially when entering a specialized area of occupational therapy such as hand therapy. Hand therapy is a specialty area of the occupational therapy (OT) profession which requires not only a wide range of knowledge and experience but also extended knowledge of specific diagnostic categories and treatment. Secondary to the need to prepare students for entry-level generalized practice, many OT programs are not designed to prepare students for areas of specialized practice, including hand therapy. Despite the absence of specialty knowledge, many students obtain employment in OT hand therapy clinics. While comprehensive literature exists for treating patients with upper extremity injuries, there are few resources designed to assist entry level therapists during their transition from an OT student to a clinician in a specialty area.

A literature review was conducted to obtain information on the process of specializing in OT hand therapy, the three most common traumatic upper extremity injuries and the therapeutic approaches to treat these three injuries. This literature review culminated in the creation of a handbook manual designed for use by entry-level occupational therapists which is intended to improve their transition from the role of
occupational therapy students to entry-level therapists practicing in the specialized area of hand therapy.

The cognitive learning theory was used as the basis for the intended product. The cognitive learning theory is based on the idea that the internal factors play a role in how each person learns and assumes that each individual learns differently depending on his or her thoughts and perceptions (Bastable, 2006). Following this theory, an entry-level hand therapy manual was written using simple hand therapy terms that new therapists are able to understand. According to the cognitive learning theory, as stated by Bastable, the learners’ goals and expectations should drive them to learn and continue working towards understanding the information. It is this idea that brought me to the conclusion that an entry-level therapist who desires to become competent and successful in the area of hand therapy will seek out and use resources, such as the manual that I have designed.

The constructivism theory was also used in creation of this manual to help the entry level therapists to build new information based on information that they currently have (Joyce, Weil & Calhoun, 2004). Constructivism implies that learning not only involves acquiring new information, but also includes allowing this information to adjust preexisting knowledge to form new ideas (Joyce, Weil & Calhoun, 2004). This theory was used to help design this product based on the idea that entry-level therapists may have previous knowledge in the area of hand therapy, but the information based in this product may help them to reconstruct their ideas and form new perceptions of hand therapy.

This chapter of the project serves the purpose of introducing the problem which is being addressed and the population that may benefit from the knowledge gained through
the entire process. Chapter II provides the literature review of information found in research articles and publications that was studied in order to design a product to address the problem stated in Chapter I. Chapter III provides a description of the process that was followed to obtain information that was used in the culmination of the product section of this project. Chapter IV contains the product section of this project. This product is separated into three main sections, each dealing with a specific type of upper extremity injury. It also includes a glossary of upper extremity terms and a resources section that provides upper extremity publications, research articles, and other resources. Chapter V provides a summary of the entire project and the key information.
CHAPTER II
REVIEW OF LITERATURE

Approximately 250,000 people in the United States (U.S.) experience various hand injuries each year (Sheppard, 2001). Hand injuries are one of the most common injuries sustained in the U.S. secondary to the high frequency with which people use their hands during occupational task performance. Hand injuries are often extremely serious in terms of loss of functional ability and treatment can be complicated due to the complexity of the hand's anatomy, kinesiology, and physiology. These complications from injury can have lasting effects on peoples’ lives which makes appropriately treating people with these injuries incredibly important. Treatment for hand injuries can include physical rehabilitation as well as psychological counseling to help people overcome the difficulty of functioning with a hand injury (Sheppard, 2001). The appropriate treatment of hand injuries can improve the function of the clients’ hands while also helping to improve their quality of life by allowing them to participate in their usual occupations.

Hand therapy and upper extremity rehabilitation are often used in conjunction with one another and or as synonyms. Upper rehabilitation is often referred to as a more holistic form of therapy because it consists of the entire upper extremity where as hand therapy can sound as thought it just consists of strictly the hand. Occupation is defined in many different ways depending on the source of the definition. According to Merriam-Webster’s online dictionary (2007, ¶1) the definition of occupation is “an activity in which one engages” or “the principle business of one’s life”.
Function has been defined by Merriam-Webster’s online dictionary (2007, ¶1) as “the action for which a person or thing is specially fitted or used or for which a thing exists” and “any of a group of related actions contributing to a larger action”. The American Occupational Therapy Association, AOTA (2002) defines occupation in the Occupational Therapy Practice Framework as “Activities of everyday life, named, organized, and given value and meaning by individuals and a culture. Occupation is everything people do to occupy themselves, including looking after themselves...enjoying life...and contributing to the social and economic fabric of their communities....” (p.610). Body function is defined by AOTA (2002) as “The physiological functions of body systems (including psychological functions)” (p.630). Hand injuries can have an effect on people’s occupations and body functioning by making simple tasks more complicated and time consuming or preventing people from engaging in their daily activities at work or at home entirely. The role of an occupational therapist who is treating patients with upper extremity injuries should always address the concepts of occupation and function. This can include performing functional assessments on patients with hand injuries to develop an understanding of the functional requirements of the patients’ limbs and hands during activities of daily living. Also, by performing a functional assessment the therapist is able to see which occupations have been affected by the loss of function in the patient’s hand (Kimmerle, Mainwaring & Borenstein, 2003). Improving a client’s participation in his or her meaningful occupations is one of the main goals of an occupational therapist (Crepeau, Cohn, Boyt & Schell, 2003). In the occupational/hand therapy setting this would include providing treatment to the upper extremity which will allow the client to
participate in his or her occupations with the greatest amount of independence and efficiency possible.

Hand therapists are often involved in treating hand injuries when a doctor, hand specialist, or hand surgeon refers the patient to obtain hand therapy services. Occupational and physical therapists can work in the area of hand therapy with their OT or PT degrees but since the area of hand therapy requires an advanced body of knowledge, special certification for hand therapy is offered by the Hand Therapy Certification Commission (HTCC). This certification helps to ensure that the therapists offering hand therapy services have the knowledge and experience required to offer proficient services. Acquiring this certification also indicates that those therapists are dedicated to providing quality hand therapy services and are furthering their education to improve their knowledge and skills in the area of upper extremity rehabilitation. This certification is offered to both OT’s and PT’s and requires further training beyond that of the respected degrees in both areas. The requirements are that the therapist has practiced in the fields of occupational or physical therapy for five years and has proof of licensure, certification, and registration (Hand therapy Certification Commission, 2007). Also, the therapist must have documentation of 4,000 hours of experience or training in the area of hand therapy completed within the five years, and this must be verified by the therapist’s employer (Hand therapy Certification Commission, 2007). Provided that the hours and experience are confirmed, each therapist must then take the hand therapy certification exam and obtain a passing score of 80% or better. (Hand therapy Certification Commission, 2007).
According to the HTCC (2007) “there are 4,776 certified hand therapists worldwide” (¶1). Approximately 95% of these certified hand therapists (CHTs) are registered in the United States (HTCC, 2007). Also, about 85% of those certified in hand therapy started as occupational therapists while 14% are physical therapists and about 1% had combined degrees of both occupational and physical therapy (Hand therapy Certification Commission, 2007). The HTCC (2001) conducted a study that provided them with information from approximately ¼ of the certified hand therapists. The HTCC study was particularly important as it assisted the commission in their 2002 revision of revise the definition of hand therapy:

“Hand therapy is the art and science of rehabilitation of the upper quarter of the human body. Hand therapy is a merging of occupational therapy and physical therapy theory and practice that combines comprehensive knowledge of the upper quarter, body function, and activity. Using specialized skills in assessment and treatment, hand therapist promote the goals of prevention of dysfunction, restoration of function, and/or reversal of the progression of pathology in order to enhance participation in life situations for individuals with upper quarter disease or injury” (HTCC, 2007, ¶3).

One reason for designing an entry level hand therapy manual is that I feel there is a lack of information provided on hand therapy and hand injuries in the graduate level occupational therapy curriculums. My own OT departmental curriculum provided a two-week course in hand therapy which covered a brief overview of a variety of potential hand injuries. Through personal communication with an entry level therapist and other occupational therapy students who attended a different program, I have discovered that others schools have approximately equal or even less training in the area of hand therapy. Kasch, Greenberg, and Muenzen, (2003) published an article stating the results of a practice analysis conducted by the HTCC in order to gain information about when therapists working in hand therapy learned the skills needed to be a competent hand
therapist. The competencies examined in this study were related to the knowledge and skills of therapists and the time frame in which they learn these competencies. Certified hand therapists were the participants of this study and considered experts as the authors acknowledged the advanced knowledge of therapists who had completed the certification process. Additionally, the authors illustrated the perception in practice that CHTs are often considered more competent than entry level therapists. This study revealed that most therapists felt that they learned the foundational skills of hand therapy during the first five years of practice with a majority of those skills being learned in the first year of practice. Skills which were learned before practicing in hand therapy were found to be basic knowledge of injuries, data collection, client interaction, basic theory knowledge, safety standards, and patient confidentiality. Students learn many of these areas in the occupational therapy educational programs and the skills are then developed more extensively in treatment setting.

The education that occupational therapy students receive on the topic of hand therapy is not the only education that could be increased and improved. A survey performed in Canada has shown that many therapists feel they are lacking continuing education opportunities in hand therapy and the opportunities that currently exist are too expensive and difficult to attend (Marcuzzi, Kelly, Chang, & Hannah, 1998). Victoria Frampton (1998), president of the International Federation of Societies for Hand Therapy, also promoted the evaluation and improvement of education standards for hand therapy. According to Frampton (1998), there should be an expert on an executive committee with the specific responsibility of following hand therapy education. She wrote that this person could develop a resource of the educational opportunities available
in all countries and also provide a means for hand therapists to discuss these educational opportunities with one another and make them more readily available (1998).

The amount of information occupational therapy students receive in the area of evaluation and treatment of upper extremity injuries is not consistent at all schools but from my personal experience, I believe this information is not extensive enough to meet the needs of an entry-level occupational therapist who wishes to practice in the specialty area of hand therapy. The broad overview I received during my education in hand therapy included a variety of patient injuries, disorders, and diagnoses including nerve injuries, cumulative trauma disorders, burns, and fractures. Each of these topics was mentioned and discussed briefly in my course work. This information helped to familiarize me with the topics but the details were not clear and I feel this prevented me from fully understanding each specific diagnosis. Evaluating upper extremity injuries was also discussed briefly with the main focus appearing to be on the evaluation of patients who have sustained nerve injuries. Manual muscle testing is covered during muscle function in my own OT program which is consistent with that of other programs I have researched. These tests allow the therapist to identify problems with a specific muscle or group of muscles but the tests are not specific to the type of injury or disorder. Information that would be helpful to students would be specific tests and evaluation methods that can be used during the evaluation of the upper extremity.

Entry level therapists are required to pass a national certification and state certification in most states in order to practice as occupational therapists. The only state that does not require state licensure from the research I have done is Colorado. This certification exam is designed to test competence in occupational therapy but many
people are asking questions regarding how competent an entry level therapist can be. According to Hinojosa & Blount (1998) competence is having the skills necessary to be effective and offer quality services in your area of practice. Competence is always changing and is measured in many ways by different people. In order to be a competent therapist, one must be committed to continuing their education and expanding their knowledge to keep up with the demands of the occupational therapy profession (Hinojosa, & Blount, 1998). Entry level therapists may have a plethora of knowledge which they have learned in the classroom and during fieldwork experiences, but they may lack the knowledge and practice that helps experienced therapists to be more competent. An entry level OT may be competent in one area of practice such as stroke rehabilitation or cardiac rehabilitation but they may be lacking competence in the area of hand therapy which would require them to pursue continuing education and clinical experiences.

Fieldwork education is required in order to become an occupational therapist and it is through this fieldwork that students continue learning and preparing to be a competent therapist (Crist, Brown, Fairman, Whelan & McClure, 2007). Although occupational therapy students have the option of completing additional fieldwork opportunities in the setting of their choice, many students choose to enter the realm of general occupational therapy practice instead of completing additional fieldwork opportunities. They may choose not to enter additional fieldwork settings due to a lack of knowledge they may have in that area and also lack of experience and comfort in that specific area. This could also be caused by a lack of financial resources due to the increasing cost of tuition, lack of opportunities in their geographic area, and other reasons. According to Crist et al. (2007) who discussed fieldwork education opportunities
and competence, “[a]s a profession, we can no longer make the dangerous assumption that fieldwork completion under our current model equates with preparation for entry-level practice competency. A greater accountability regarding the specific intervention preparation of our entry-level professionals is warranted” (p. 88). I believe these authors’ opinions illustrate the need for an additional fieldwork opportunity in hand therapy. This additional training and experience would allow the student to receive more knowledge and experience in the specialization arena of hand therapy that he or she would get during a regular physical disabilities fieldwork.

According to Bush, Powell, & Herzber, (1993), there are many components that are involved in self-efficacy in occupational therapists. These components can include how well one deals with situations involving treatment, how the therapist rates their capabilities, personal accomplishments, treatment success, current job position, and others. According to practicing therapists in informal discussions, some believed a minimum of six months may be required to make the transition from being an entry level therapist to being a competent therapist who is comfortable with his or her abilities. Self-efficacy is developed over a lifetime and it can be influenced by a student or therapist’s supervisors and colleagues including educational advisors or teachers, fieldwork supervisors, co-workers, and job supervisors (Bush et al., 1993). If a new therapist is confident in his or her abilities and has a high level of self-efficacy, he or she is more likely to provide quality treatment and services to his or her clients. Bush et al. (1993) wrote “the first year of employment is an important period in professional development. Employers and colleagues affect the initial transition positively by being sensitive to the needs of entry-level practitioners and structuring the transition process” (p. 932).
In designing the product for this project, I chose to follow the cognitive learning theory as the basis for my intended product: a hand therapy manual for entry-level therapists who have chosen not to complete an additional fieldwork in upper extremity orthopedics. The cognitive learning theory is based on the idea that the internal factors play a role in how each person learns and assumes that each individual learns differently depending on his or her thoughts and perceptions (Bastable, 2006). I chose this learning theory for the purpose of designing an entry-level hand therapy manual that will be written using simple hand therapy terms in order for new therapists to easily acquire greater understanding of the basic anatomical, physiological, legislative, practice specific, occupationally-based knowledge of evaluation and treatment that is required to begin treating upper extremity orthopedic patients who have sustained a traumatic injury. Further, this manual will include comprehensive resources of which an entry-level therapist intending to work with upper extremity orthopedic patients should be aware. According to the cognitive learning theory as stated by Bastable (2006), the learners’ goals and expectations should drive them to learn and continue working towards understanding. It is this idea that brought me to the conclusion that an entry-level therapist who desires to become competent and successful in the area of hand therapy will seek out and use resources such as the manual that I have designed.

The constructivism theory will also be used to help the entry level therapists to build new information based on information that is currently known by entry-level therapists (Joyce, Weil & Calhoun, 2004). Constructivism implies that learning not only involves acquiring in new information, but also includes allowing this information to adjust preexisting knowledge to form new ideas (Joyce et al., 2004). This theory will
assist me in designing my product based on the idea that entry-level therapists may have previous knowledge in the area of hand therapy, but the information based in this product may help them to reconstruct their ideas and form new perceptions of hand therapy.
CHAPTER III

METHODOLOGY

The product described in the next chapter is a manual designed to be used by students, entry level therapists making the transition from students to practicing therapists, and occupational therapists that may treat an occasional patient with an upper extremity injury. This manual is comprised of three separate sections of common traumatic upper extremity injuries including: distal radius fractures, tendon injuries, and nerve injuries. It is designed with each section focusing on the etiology of each injury followed by common surgical and medical interventions to treat the injury and subsequent therapy that may be involved to help patients reach their highest functional potential. The manual also includes a reference section that provides information on where therapists can find additional information about these injuries and the treatments that may be used throughout the therapy process.

The process of developing this manual began with a review of literature regarding common upper extremity injuries and the rehabilitation process involved with each injury. A number of data bases were used to review literature on the topic including: PubMed, OT Search, E-Medicine, American Journal of Hand therapy, Scopus, AJOT, and others. The initial literature search covered topics of hand injuries and treatments involved with each injury. The search was then expanded to include upper extremity injuries, surgical interventions, rehabilitation processes, occupational therapy student
competency, occupational therapy student requirements, hand therapy requirements, and
treatment efficacy.

The articles that were selected for use during this process were reviewed and
examined to establish: problems that need to be addressed in occupational therapy
programs, statistics regarding upper extremity injuries, treatments involved with upper
extremity injuries, and ways to relate information to students and therapists that are
interested in the area of upper extremity rehabilitation. The next part of the process
involved designing the three sections of the manual with important information that is
relevant to the treatment of upper extremity rehabilitation. Each section of this product
includes the information involved with each injury including pictures and diagrams
explaining both the anatomy of the injury and treatments that may be beneficial. The
finished product is included in Chapter IV of this material and it is based on the research
and literature review discussed in Chapter II.
CHAPTER IV

PRODUCT

The information gathered through the literature review was instrumental in the development of the entry level hand therapy manual for the treatment of traumatic upper extremity injuries. The manual includes three sections each based on a specific type of upper extremity injury. These injuries are distal radius fractures, tendon injuries, and nerve injuries. Each section includes information on the etiology of the injury, medical treatment of the injury, the rehabilitation process, and general anatomy of the upper extremity. Also included in this manual is a glossary of terms that are commonly used in upper extremity rehabilitation that some occupational therapists may not be familiar with. The manual also includes a reference section to provide students and therapists with resources that can be used to guide their treatment process. The information is presented in a spiral bound manual that is divided into sections based on the type of injury. The information provides students and therapists with a general overview of the injuries discussed along with treatment strategies that can be used during the rehabilitation process.

This manual was designed with the purpose of helping students and entry level therapists in the transition from the student role to the often difficult role of working in upper extremity rehabilitation. Upper extremity rehabilitation is an extremely specialized area of practice and is not covered in depth in most occupational therapy programs which can make the transition into this area difficult. This manual is also designed to provide
information regarding resources that can be used when working with upper extremity
injuries. It is the author’s intention to provide this manual for students and therapists
interested in upper extremity rehab that do not have the resources and experience needed
to be competent in this area. This manual could be beneficial in all occupational therapy
education settings as well as clinics that are not specialized in treating upper extremity
injuries, but do occasionally treat these patients.
A QUICKGUIDE TO MANAGEMENT OF TRAUMATIC UPPER EXTREMITY ORTHOPAEDIC INJURIES: FOR ENTRY-LEVEL THERAPISTS

Authors: Marty Melland, MOTS
Anne Haskins, MA, OTR/L
DISTAL RADIUS FRACTURES

Prevalence

Fractures of the distal radius are the most common type of fracture in the adult population (Greene, 2001).

According to Orbay, (2003) there are approximately 800,000 injuries to the wrist or distal radius in the United States each year. Orbay (2003) also reports that these injuries continue to rise based on the increase in age of the general population. As people age their bones begin to degenerate and become more fragile. This degeneration of bone tissue increases the chance of breaking of injury bones. Older individuals may also begin to have difficulty with their balance as they age and this could lead to an increase in falls and accidents that result in broken bones especially distal radius fractures because the hands are often the first to touch the ground. Also, approximately 17% of emergency room visits each year in the United States are a result of wrist injuries (Wood, 1992; Hanel, 2002 as cited by Richards, Diego de Dios, & Craig, 2006).

The high number of wrist injuries is a result of the function of the hands. The hands serve a great importance in the daily lives of many people and as a result of how often people use their hands, they are the most common site of injury. Also, when people fall or try to prevent a sudden impact, the first thing they usually do is put out their hands to protect themselves. This results in a majority of force being applied to the hands which increases the likelihood of injury. A majority of distal radius fractures occur in elderly women with an approximate ratio of 4:1 women to men. These injuries occur more often in elderly women due to the rate of bone degeneration after menopause. Women's bone density degenerates at a faster rate...
than that of men which increases the chance of suffering a bone related injury. The incidence rate in children is also high due to their high levels of activity and active nature in sports and other activities. (Richards, Diego de Dios, & Craig, 2006)

**Fracture Definitions**

While "distal radius fracture" is often used to denote any fracture to the terminal aspect of the radius, there are specific fractures that occur to this bone. Therapists should be aware of the mechanism of the injury to appropriately treat their patients. There are five main types of distal radius fractures described by Greene (2001) which are: Colles fractures, Smith fractures, Barton fractures, Chauffeur's fractures, and Die-punch fractures.

<table>
<thead>
<tr>
<th>Fracture Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colles</td>
<td>This most common type of distal radius fracture. Usually occurs with a fall on an outstretched dorsiflexed hand. The radius is fractured and displaced in an upward or dorsal direction. A fracture of the ulnar styloid often occurs with a Colles fracture.</td>
</tr>
<tr>
<td>Fracture Type</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
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</tr>
<tr>
<td>Smith</td>
<td>The opposite of a Colles fracture. Can occur from an impact to the dorsal aspect of the hand or from hyperflexion of the hand. The fracture is displaced downward or in a volar direction.</td>
</tr>
<tr>
<td>Barton</td>
<td>Occurs in a similar way as the Smith fracture but usually with more force. Can be caused by falling on a pronated and extended hand which results in a subluxation of the wrist.</td>
</tr>
<tr>
<td>Fracture Type</td>
<td>Description</td>
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<tr>
<td>-----------------------</td>
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</tr>
<tr>
<td>Chauffeur's</td>
<td>This fracture occurs when the radial styloid is fractured in an oblique fashion. Ligament damage is often seen in this type of fracture.</td>
</tr>
<tr>
<td>Die-punch (Lunate)</td>
<td>This is a fracture that often is the results of a forceful compression of the lunate bone into the radius. This can occur with a closed fist punch or other high force compression.</td>
</tr>
</tbody>
</table>

Source: Richards, Diego de Dios, & Craig, (2006); Greene (2001)
SYMPTOMOLOGY

Many patients who obtain a distal radius fracture will have acute or chronic pain, swelling or edema, tenderness or sensitivity to touch, possible deformity, loss of circulation, bruising, discoloration, and a possible loss of sensation (Greene, 2001).

Each of these symptoms should be carefully considered throughout the course of occupational therapy treatment.

EVALUATION METHODS

Medical doctors perform evaluation to determine if a fracture is present and also to determine the extent of the fracture. This evaluation is completed by performing a physical examination which includes looking for discoloration, deformity, and swelling. It also can include checking for sensation, tenderness, and blood supply to the hand. X-rays are also used to view images of the wrist to obtain information about the location of the fracture (Greene, 2001). Computer tomography scans (CT scans) and magnetic resonance imaging (MRI) may also be used to view detailed images of the fracture site and injuries that may be present to ligaments and other bones in the wrist and hand (Wolfe, 2007). Physicians will then determine the need for surgical or conservative treatment which is based on the stability of the fracture as well as alignment of the fracture.

Stable fractures can be treated by realignment and casting to prevent movement and encourage bone growth. Unstable injuries may require surgery as well as casting to fix the fracture and stabilize after fixation. If surgery is required there is usually a two week period when surgery is possible. If surgery is not performed within this time frame, the bone may be healing improperly and it could be difficult to properly fix the fracture. Internal fixation is also an option that can be used if required for further stability. Internal fixation can include pins holding the fracture together as well as plates and screws to help mobilize the fractured area. External fixation devices are also used in some occasions and are located on the injured area.
external to the body. They consist of screws of pins connected to a fixation device that stabilizes the fractured area until fully healed at which time the device and connecting pins and screws are removed. (Wolfe, 2007)

Upper extremity orthopaedic occupational therapy evaluations that can be performed include, but are not limited to, an initial objective evaluation and clinical observation to gain information about what types of activities the person performed pre-injury and to gain an understanding of which activities represent the patient’s functional goals.

Potential Precautions/Complications:

**** THE THERAPIST MUST KNOW THE STATUS OF THE PATIENT’S FRACTURE PRIOR TO INITIATING ANY EVALUATION OR TREATMENT****

1. Stiffness in the wrist, digits of the hand, forearm, elbow, and shoulder.
2. Nerve compression of the radial, ulnar, and median nerves.
3. Loss of mobility in the digits, elbow, or shoulder.
4. Loss of sensation and grasp in the hand.
5. Formation of arthritis in the upper extremity, especially the hand.
6. Chronic pain caused by injury or RSD (Reflexive Sympathetic Dystrophy)
7. Tendonitis occurring as a result of improper body mechanics post injury.
8. Tendon Rupture as a result of impingement of the fracture or hardware on the tendon.

A Few Evaluation Specifics:

• RANGE OF MOTION
  - Can be evaluated using a goniometer and comparing results to those whose ages and gender are congruent with the patients’ demographics. Precautions should be noted and during acute fracture stages only active range of motion (AROM) and passive range of motion (PROM) of the non-involved joints should be evaluated. AROM and PROM of the joints that are proximal to the fracture should only be evaluated upon request of the physician.

• EDEMA
  - Edema can be evaluated simply by observing the injured limb, comparing the affected limb with the contralateral limb, completing circumferential measurements, or by using a volumeter for specific

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measurements. Edema can have a positive effect on injured areas by bringing nutrients and encouraging tissue growth but can also have a negative effect on the wrist by limiting mobility and causing pain.

- According to Hunter, Mackin, & Callahan, (2002), edema can be present in all three stages of wound healing. It is normal in the first stage which lasts from 3 to 5 days. It is in this stage that edema can be helpful to bring nutrients and cells and help heal an injured area. The edema can also be too excessive and can be controlled by edema management techniques.

- In the second stage from 2 to 6 weeks edema can become more of a problem. In this stage the fluid causing edema becomes thicker due to an increase in proteins needed to rebuild tissue and repair the injured area. This thickened fluid can cause tissues to become thick and cause damage to ligaments and tendons. It is important to control and reduce edema during this stage.

- In the last stage of healing which lasts from 6 months to 2 years, edema is especially dangerous because the fluid can become very thick and prevent proper wound healing and cause problems with blood flow and circulation.

• PAIN

- Pain should be evaluated on a consistent basis and is unique to the individual. Despite this the individual’s experience of pain, occupational therapists should familiarize themselves with the pain quality (burning, aching, etc.) that is associated with neurological and physiological disturbances that often accompany the presence of a distal radius fracture which can alert the therapist to ancillary problems that the patient may be experiencing.

- Pain can be evaluated by patient description, a visual scale, and by using pain scales or ratings. (J. Armstrong, personal communication, March 15, 2007)

• INCISION/WOUND

- Following surgery or open fractures, the patient’s wound should be monitored for appropriate healing and signs and symptoms of infection. There is a large body of literature that exists to guide the practitioner in evaluating incision and wound healing. Please refer to the references section of this manual for a list of resources.
• VASCULARITY

  o Vascularity can be evaluated using Allen's test which is performed by blocking the flow of the radial and ulnar arteries of the wrist and having the client open their hand and then the therapist releases an artery and observes in the hand regains color. (J. Armstrong, personal communication, March 15, 2007)

• SENSATION

  o Sensation can also be tested a number of ways including temperature discrimination, monofilament testing, sharp/dull discrimination, 2-point discrimination, and by patient description. (J. Armstrong, personal communication, March 15, 2007)

• DEXTERITY

  o Dexterity can be tested using standardized tests such as the Purdue Pegboard, the Jebson-Taylor, the Minnesota Rate of Manipulations Test, and others (J. Armstrong, personal communication, March 15, 2007). Dexterity may be further evaluated during functional task evaluations as the patient completes fine motor tasks that are specific to that patient's function. Dexterity of the fingers should be a focus of treatment even when the patient is utilizing a cast or splint to maximize return to function once precautions are discontinued.

• FUNCTION

  o Activities of daily living can be evaluated by client survey and demonstrations. Work and performance capacity is tested using evaluations specific for the area being observed (J. Armstrong, personal communication, March 15, 2007). Note that functional evaluation is subject to the precautions that are determined by the physician. A patient may be initially evaluated to determine his or her capacity for one-handed technique independence. Once the fracture is stabilized via casting or splinting the patient may engage in light functional tasks.
STRENGTH

- Strength is evaluated by performing manual muscle testing, using a dynamometer to test grasp, and a pinch gauge for pinch strength. (J. Armstrong, personal communication, March 15, 2007) Strength may be evaluated further through the use of clinical observation of the patient during functional tasks. **NOTE: This should not be initiated until later phases of treatment.**

TREATMENT METHODS

Occupational therapists must be aware of their patients’ precautions and potential complications that may arise during the course of treatment. A list of potential areas of concern are provided below. Please note that this list is not all-inclusive and therapists are encouraged to review precautions with the referring physician.

**Potential Precautions/Complications:**

**** THE THERAPIST MUST KNOW THE STATUS OF THE PATIENT'S FRACTURE PRIOR TO INITIATING ANY EVALUATION OR TREATMENT****

1. Stiffness in the wrist, digits of the hand, forearm, elbow, and shoulder.
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6. Chronic pain caused by injury or RSD (Reflexive Sympathetic Dystrophy)
7. Tendonitis occurring as a result of improper body mechanics post injury.
8. Tendon Rupture as a result of impingement of the fracture or hardware on the tendon.
Rehabilitation of distal radius fractures consists of much more than just the wrist itself. The **shoulder, elbow, hand, and fingers are all included in treatment** of this type of injury.

Therapy should be provided by a certified hand therapist or an occupational or physical therapist who is knowledgeable in the area of hand therapy. Therapists who are novices in this area should refer to the references that are offered in the resource section of this handout as a starting point and are encouraged to contact therapists’ and physicians who have experience in the treatment of patients with upper extremity orthopaedic injuries.

**General Overview of Treatment Techniques**

Therapy can include many different exercises such as tendon gliding exercise, active and passive range of motion to the affected limb including all joints of the wrist and hand where movement is allowed, the elbow, and the shoulder.

- **Range of Motion:** Range of motion exercise is essential in the rehabilitation of an upper extremity injury. Range of motion exercises should involve all joints that are not immobilized in a cast and can include the motions of extension, flexion, abduction, adduction, and rotation. These exercises help to increase joint mobility while preventing tendon adherence and reducing edema. Range of motion exercises consist of passive and active range of motion. To reach the full effect of these exercises, they should be performed in sets of 5-10 repetitions for approximately 10 seconds per repetition. The exercises should also be performed multiple times throughout each day.
With a distal radius fracture these exercises should be performed at the fingers, joints of the hand, wrist, elbow, and shoulder to encourage movement in the entire upper extremity. If pain and swelling result from performing the exercises, the therapist should instruct the patient on how to modify the exercises to prevent these complications. The exercises may feel uncomfortable at time but should not be painful. Regaining complete range of motion would be the ideal goal for therapy but a more realistic goal is to regain functional range of motion that allows the patient to participate in their daily activities (Hunter, Mackin, Callahan, 2002).

Normal wrist range of motion is 140 degrees flexion/extension and 150 degrees pronation/supination.

Other treatments can include coordination exercises, gross and fine motor movement exercises, strengthening exercises, and specific activity training exercises. After casting devices, internal and external fixations devices, and splints are able to be removed the therapy program will continue to encourage increases in range of motion and will also focus on regaining lost sensation, reducing scars from surgery and fixation devices, edema management or reducing the amount of swelling.

Please refer to the pain, edema, scar management and strengthening sections of this handbook for further detail on specific treatment interventions.

There are many exercises that therapists working in upper extremity rehabilitation can use to treat distal radius fractures. These exercises can include any activity that involves coordination of the injured extremity such as grasping objects and moving them from one area of a table to another by moving only the upper extremity. This would also work on using fine motor movements in the fingers and hand and gross motor movements in the upper arm.
Physical agent modalities may also be used in conjunction with many of these treatments to promote healing and produce a better outcome. Please refer to the physical agent modalities section of this handbook for further details.

Splinting: Hand therapists may also be required to develop and modify certain splints to help prevent loss of motion and encourage the proper healing process.

- Splinting the wrist in slight extension can increase wrist support and improve healing when the mobilization device such as a cast or fixation device is removed. Therapists can choose you use prefabricated splints or they may choose to make customized splints from thermoplastic splinting material (Hunter, Mackin, Callahan, 2002).

- Customized splints are often more comfortable and provide the support patients need. Many types of customized splints can be designed depending the on the needs and desires of the patient and his or her doctor (Hunter, Mackin, Callahan, 2002).

These procedures are to be performed with the goal of helping the client return back to their daily activities including work, leisure, and self cares. After treatment in the clinic is completed clients can be fitted with a home program to meet their rehabilitation needs (Murray, Trigg, 2002).

e. Efficacy of treatments:
In the studies I have reviewed regarding the effectiveness of distal radius fracture treatments and rehabilitation, the results are inconclusive. Many studies show that control groups as well as groups receiving therapy make progressive gains in regards to hand function. In my personal experience treating patients with distal radius fractures, I have found that patients who receive upper extremity rehab services earlier in their injury process make better gains than those who wait. Although not all patient make a complete and full recovery, all patients that I have treated made functional gains that were noticeable when compared to their post injury status.
Traumatic Tendon Injuries

Flexor Tendon Injuries:

a. Overview:

Lacerations of the flexor tendons are the most common type of flexor tendon injury. Ruptured flexor tendons are also very common especially when dealing with sports related injuries. If these injuries are undiagnosed or not treated in a timely manner they can lead to serious disabilities and loss of function (Daniels, Zook, & Lynch, 2004). These injuries can present as either open or closed injuries that can often result in difficulty with grasp, pain, swelling, tenderness, difficulty flexing, and stiffness. They are also often seen in conjunction with neurovascular injuries which makes the treatment of these injuries even more complicated (Jones & Laing, 2006). There are 5 zones to consider when working with flexor tendon injuries. These zones are important when considering how to repair and treat the injury.

<table>
<thead>
<tr>
<th>Flexor Tendon Zones</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Includes the flexor digitorum profundus tendon from its insertion to the insertion of the flexor digitorum superficialis tendon.</td>
</tr>
<tr>
<td>2</td>
<td>Includes the area from insertion of the flexor digitorum superficilis to the proximal edge of the A1 pulley.</td>
</tr>
<tr>
<td>3</td>
<td>Includes the palm of the hand from the proximal edge of the A1 pulley to the distal edge of the carpal tunnel and also includes the insertion of the lumbrical muscles of the hand.</td>
</tr>
<tr>
<td>4</td>
<td>Includes the carpal tunnel</td>
</tr>
<tr>
<td>5</td>
<td>Includes the area from the forearm to the carpal tunnel.</td>
</tr>
</tbody>
</table>

(Hunter, Mackin, & Callahan, 2002) (Jones & Laing, 2006)
Extensor Tendon Injuries:

a. Overview:

Most extensor tendon injuries are caused by direct force to the dorsal aspect of the hand. Other sources of injury to the extensor tendons can be caused by injury of the muscles from which the tendons originate and also to the nerves attached to the tendons (American Association for Hand Surgery, 2007). These injuries can occur as open or closed injuries just as flexor tendon injuries can. Injuries that include punctures and incisions are also common and can be the cause of complete disruption of the tendons (Jones, Laing, 2006). According to Hunter, Mackin, and Callahan (2002), extensor tendon injuries are often thought of as less important than flexor tendon injuries. The therapy and treatment are often looked upon as less time consuming and less intense that the treatment for flexor tendon injuries. They also go on to say that from their personal experience, these injuries often prove to be just as difficult to treat and can often cause many complications. The extensor tendons are more fragile and more easily injured than the flexor tendons and injuries to the extensor tendons often cause functional deficits (Hunter, Mackin, and Callahan 2002). There are 8 zones to consider when treating and evaluation.
extensor tendon injuries opposed to 5 zones for the flexor tendon injuries. The first three zones are located on top of joints which makes them particularly susceptible to intra-articular joint injuries (Jones, Laing, 2006).

<table>
<thead>
<tr>
<th>Extensor Tendon Zone</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DIP joints</td>
</tr>
<tr>
<td>2</td>
<td>Middle phalanges</td>
</tr>
<tr>
<td>3</td>
<td>PIP joints</td>
</tr>
<tr>
<td>4</td>
<td>Proximal phalanges</td>
</tr>
<tr>
<td>5</td>
<td>MCP joints</td>
</tr>
<tr>
<td>6</td>
<td>Wrist metacarpals</td>
</tr>
<tr>
<td>7</td>
<td>Wrist carpals</td>
</tr>
<tr>
<td>8</td>
<td>Proximal to the wrist</td>
</tr>
</tbody>
</table>

(Hunter, Mackin, & Callahan, 2002) (Rosh & Kwon, 2007)

**Extensor Zones**
b. Symptoms:

There can be many symptoms that a person with a tendon injury may exhibit. One of the most common symptoms is pain that is present with movements of the involved tendons. Loss of function can also be a prominent symptom that is noted when a tendon injury is present. Deformation at the site of injury is also common with some tendon injuries and includes specific deformities such as mallet finger, boutonnières deformity, and swan neck deformity. The site of injury may also be swollen or have a significant amount of edema in the general area of injury. Each specific tendon injury can have its own symptoms usually noted by loss of function. The specific loss of function can be an indication of which tendons have sustained the injury (Rockwell, Butler, & Byrne, 2000).

c. Prevalence:

Both flexor and extensor tendon injuries are relatively common and are often associated with other injuries such as fractures and neurovascular injuries (Jones, Laing, 2006). The most common type of flexor tendon injury is an open injury that often involves a neurovascular injury as well. Closed injuries are commonly caused by forced extension of the fingers (Jones & Laing, 2006). Extensor tendon injuries occur more often due to their position on the dorsal aspect of the hand where they are relatively unprotected (Rockwell, Butler, & Byrne, 2000).

d. Evaluation Methods:

Flexor Tendons:

Initial evaluation is performed by emergency room doctors and orthopedic specialists. The clinical examination includes observing the hand in the resting position to observe the level of tendon injury. If the fingers lie in complete extension the result of the injury is complete division of the flexor tendons. If the DIP joint is the only joint in extension the result of the injury is a lacerated flexor digitorum profundus tendon. If the client presents with pain when making a fist, a partial tendon injury could be present. The injury is often located directly below the site of a laceration unless the client’s hand was in a flexed position at the time of injury. In the flexed position, the injury may have occurred distal to the laceration site (Jones & Laing, 2006).

Extensor Tendons:

The initial evaluation of extensor tendon injuries is similar to flexor tendons and is performed by emergency room doctors and orthopedic specialists. If a client is unable to extend their fingers and open their hand it is possible that they have suffered an extensor tendon injury. These injuries often cause a loss of function in the area that is distal to the actual site of injury. The site of injury itself is often painful but the area where function is lost usually is not painful. These injuries
require surgical repair which is performed by trained hand surgeons (American Association for Hand Surgery, 2006).

Rehab evaluations for both flexor and extensor tendon injuries begin by obtaining general medical information including age, hand dominance, occupations, previous injuries to the injured extremity, mechanism of injury, time of injury, and position of hand during injury. This information is helpful to the therapist when designing a rehab program to fit the client’s needs. Observation can be used to identify visible signs of edema, color change, posture, positioning, and scarring. Range of motion can be evaluated using a goniometer for exact measurements. Edema can be evaluated using circumferential measurements or by using a volumeter. Strength is tested using manual muscles tests, dynamometers, pinch strength gauges, and weight testing. Pain is evaluated on pain scales and by client description. Sensitivity to touch and feeling can be tested using monofilaments and discrimination testing. Vascularity is checked by touching the skin and watching for a return of blood flow to the area being tested. Dexterity can be tested using standardized tests such as the Perdue Pegboard test. ADL’s are also observed using standardized tests as well as surveys and observations. Other specific tests can be performed to evaluate a client’s capacity to participate in daily activities such as work and leisure activities. (J. Armstrong, personal communication, March 15, 2007)

e. Treatment Methods:
Specific treatment protocols have been developed by doctors and therapists together to provide common treatments that can be followed by upper extremity rehabilitation professionals. Protocols are available from (Hunter, Mackin, Callahan, 2002) and Indiana hand therapy protocol. These resources have been listed in the resources section of this product.

Phases of Tendon Healing

Inflammatory Phase
0-5 days

Fibroblastic Phase
5 days – 3 weeks

Remodeling Phase
6 weeks - 12 months

(Hunter, Mackin, & Callahan 2002)
Flexor Tendons:

<table>
<thead>
<tr>
<th>Zone</th>
<th>Treatment</th>
</tr>
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<tbody>
<tr>
<td>For all extensor zones involved with the injury it is important to have the patient perform tendon gliding exercises and range of motion exercises, when cleared by the Doctor, to prevent tendon adherence and loss of range of motion. Modalities can also be used in conjunction with other treatment strategies to promote and increase healing time.</td>
<td></td>
</tr>
</tbody>
</table>

1 Zone 1 injuries involve injury to the FDP tendon. These injuries are repaired surgically by reinserting the FDP into the distal phalanx. The patient is then fitted with a splint to protect the surgical sight and tendon repair. Early mobilization with AROM is indicated to prevent contractures. The splint is normally discontinued for day use at the 6 week point. PROM can be used when approved by a Doctor and full use of the hand normally occurs after 12 weeks of rehab. |

2 Injuries to this zone require surgical repair using stitching and reattachment of the tendon. After surgical repair, splinting is used to prevent further injury and allow healing with the wrist in 30 degrees of flexion and the MCP joints in 45 degrees of flexion. The splint is normally used for approximately 3 weeks at which time AROM is started. At 4-6 weeks, PROM and tendon gliding exercises can be initiated to increase range of motion and prevent tendon adherence. |

3 Injuries in zones 3-5 require repair which is similar to the repairs made in zone 2 injuries. They require surgical suturing and reattaching the tendons. The area of injury is often extended in order to allow the surgeon to recover the tendon and reattach it to the correct area. After surgical treatment is completed, splinting is again used to prevent further injury and allow for tendon healing. The splint is designed to keep the wrist in 30 degrees of flexion with the MCP joints flexed to approximately 45 degrees. The splint is used for 3-6 weeks depending on the Doctors orders at which time AROM is initiated. After a period of AROM exercises for approximately 2-3 weeks or until cleared by the doctor, PROM and tendon gliding exercises are initiated to prevent contractures and increase motion of the wrist and fingers. |

(Hunter, Mackin, & Callahan, 2002) (Jones & Laing, 2006)
**Extensor Tendons:**

<table>
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<td></td>
</tr>
</tbody>
</table>

1. Splinting may be the only treatment needed for injuries in this extensor zone. Splinting is usually used for 6 weeks continuously then at night for a period determined by the Doctor and therapist. If surgical fixation is required splinting will begin when determined by the Doctor. Occupational therapists will also begin the patient on specific exercises based on each individual’s current needs. |

2. Injuries to this zone are normally treated by caring for the injury site and wound if present followed by a short period of splinting usually lasting about 1 week to allow for healing. After the splint is removed the therapist will design an exercise program including active and passive range of motion exercises for the patient to complete. If surgical intervention is needed, splinting is indicated for up to 6 weeks. |

3. Injuries to this extensor zone can be treated by splinting as well as surgical fixation depending on severity of the injury. Splinting is used for a period ranging from 4-6 weeks depending on recovery of each patient. This period of splinting is followed by implementation of a range of motion program designed by the occupational therapist. |

4. Repair for injuries occurring in this zone is not common but when needed treatment consists of splinting for periods ranging from 3-6 weeks. Early mobilization and range of motion activities are important to prevent contractures and loss of motion. |

5. Injuries to zone 5 often require surgical fixation followed by periods of splinting. Splinting occurs with the wrist in extension of approximately 40 degrees with MCP flexion of 20-30 degrees. Dynamic splinting is commonly used to increase range of motion with injuries to this zone. |

6. Injuries to this zone can be treated by splinting the hand with the wrist and fingers in extension. If the EDC tendon is involved, all fingers must be splinted. If the EDC is not involved only the finger with the involved tendon injury needs to be splinted. The normal length of splinting ranges from 4-6 weeks and dynamic splinting can be used to increase motion after this time. |

7. Surgical fixation may be required to repair injuries of this zone followed by a period of dynamic splitting to prevent contractures and increase range of motion. |

8. Injuries in this zone will be repaired surgically followed by splinting of the wrist and MCP joints in extension of 45 degrees and 20 degrees respectively for periods ranging from 4-6 weeks. After the injury is healed,
dynamic splinting should be used to regain motion that may have been lost during static splinting.

(Hunter, Mackin, Callahan, 2002) (Rockwell, Butler, & Byrne, 2000)

Treatment Precautions/Complications:

1. Stiffness in the wrist, digits, forearm, elbow, and shoulder.
2. Loss of mobility in the digits, wrist, elbow, and shoulder.
4. Chronic pain caused by injury or RSD (Reflexive Sympathetic Dystrophy)
5. Tendonitis occurring as a result of improper body mechanics post injury.
6. Tendon ruptures from overuse or misuse of the extremity.

Pain Management: See pain management section

Edema Management: See edema management section

Physical Agent Modalities: See physical agent modalities section

Scar Management: See Scar management section

Strengthening: See strengthening section

Range of Motion: See Range of Motion Section

Splinting: Discussed in the treatment sections listed above

- Static splinting is used to allow tendons to heal after being injured and can be used as an individual treatment or in conjunction with surgical repair.

- Dynamic Splinting is used after the tendons have been repaired and given time to heal. This type of splinting allows for an increase in movement to improve range of motion and prevent contractures.
f. Efficacy of Treatment:

Although a near full recovery can be expected in many cases of tendon injury, there are many factors that can increase or decrease the efficacy of treatments. A patient’s physical and mental health can increase the likelihood that their therapy program will be beneficial in their healing. Also, motivation levels can help with therapy because if a patient is motivated to get better they are more likely to participate in therapy and follow the recommended precautions.

When tendon lacerations are repaired within two weeks of initial injury and the client participates in the appropriate therapy program, complete or near complete recovery can be expected. The client should re-gain the functional abilities they possessed before obtaining the injury. Any other injuries associated with lacerations can decrease the expected gains in functional ability. These associated injuries can include tissue damage, broken bones, nerve damage, open wounds, and infections (American Association for Hand Surgery, 2007). The literature regarding the efficacy of treatments for tendon injuries is currently lacking support and is needed in high demand. There are few studies published that prove certain treatments and treatment protocols within the upper extremity rehab realm are beneficial. According to Jones and Laing, (2006), if treated by an experienced hand surgeon approximately 75% of injured patients are expected to regain function and achieve gains in their active range of motion. According to Steinberg, (1992), approximately 70-90% of patients will have good results after flexor tendon repair. The results of treatment and repairs to the flexor and extensor tendons will continue to improve as technology advances and healthcare practitioners continue to improve treatments and rehabilitation protocols.
Nerve Injuries:

b. Overview:

Nerve injuries are a very common injury to the upper extremity and can have a variety of causes including blunt trauma, crush injuries, compression, nerve stretching, electrical injuries, fractures, lacerations, and other causes. These injuries can often be difficult to treat and many nerve injuries only heal with time and there are limited ways to treat them surgically. Only traumatic nerve injuries are able to be treated surgically and the recovery for each injury is dependent on the extent of damage and the individual's rate of recovery (Hunter, Mackin & Callahan 2002). Traumatic nerve injuries can have long lasting negative effects on an individual's fine and gross motor function. Sensory problems have also been noted when dealing with nerve injuries. Many factors influence the progression and recovery of nerve injuries including: rate of nerve regeneration, patient age, physical conditioning, type of injury, level of nerve injury, and compliance to rehabilitation and treatment regime (Lundborg & Rosen, 2007). The nerves that will be focused on in this section will include the 3 major nerves of the upper extremity; the radial, median, and ulnar nerves.

<table>
<thead>
<tr>
<th>Nerves</th>
<th>Muscles Innervated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial</td>
<td>• Triceps brachii (long, medial, &amp; lateral heads)</td>
</tr>
<tr>
<td></td>
<td>• Brachioradialis</td>
</tr>
<tr>
<td></td>
<td>• Extensor carpi radialis longus</td>
</tr>
<tr>
<td></td>
<td>• Extensor carpi radialis brevis</td>
</tr>
<tr>
<td></td>
<td>• Anconeus</td>
</tr>
<tr>
<td></td>
<td>• Supinator</td>
</tr>
<tr>
<td></td>
<td>• Extensor digitorum</td>
</tr>
<tr>
<td></td>
<td>• Extensor digiti minimi</td>
</tr>
<tr>
<td></td>
<td>• Extensor carpi ulnaris</td>
</tr>
<tr>
<td></td>
<td>• Abductor pollicis longus</td>
</tr>
</tbody>
</table>

40
<table>
<thead>
<tr>
<th>Nerve</th>
<th>Muscles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median</td>
<td>• Pronator teres</td>
</tr>
<tr>
<td></td>
<td>• Flexor carpi radialis</td>
</tr>
<tr>
<td></td>
<td>• Palmaris longus</td>
</tr>
<tr>
<td></td>
<td>• Flexor digitorum profundus</td>
</tr>
<tr>
<td></td>
<td>• Flexor pollicis longus</td>
</tr>
<tr>
<td></td>
<td>• Pronator quadratus</td>
</tr>
<tr>
<td></td>
<td>• Abductor pollicis brevis</td>
</tr>
<tr>
<td></td>
<td>• Opponens pollicis</td>
</tr>
<tr>
<td></td>
<td>• Flexor pollicis brevis</td>
</tr>
<tr>
<td></td>
<td>• Lumbricals 1(^{st}) &amp; 2(^{nd})</td>
</tr>
<tr>
<td>Ulnar</td>
<td>• Flexor carpi ulnaris</td>
</tr>
<tr>
<td></td>
<td>• Flexor digitorum profundus</td>
</tr>
<tr>
<td></td>
<td>• Adductor pollicis</td>
</tr>
<tr>
<td></td>
<td>• Flexor pollicis brevis</td>
</tr>
<tr>
<td></td>
<td>• Palmer interossei</td>
</tr>
<tr>
<td></td>
<td>• Abductor digitii minimi</td>
</tr>
<tr>
<td></td>
<td>• Opponens digitii minimi</td>
</tr>
<tr>
<td></td>
<td>• Flexor digitii minimi</td>
</tr>
<tr>
<td></td>
<td>• Dorsal interossei</td>
</tr>
<tr>
<td></td>
<td>• Lumbricals 3(^{rd}) &amp; 4(^{th})</td>
</tr>
</tbody>
</table>


The following pictures depict the radial, median, and ulnar nerves.
Radial Nerve Posterior View
Median Nerve Anterior View
b. Symptoms:

<table>
<thead>
<tr>
<th>Nerve</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial</td>
<td>Motor &amp; sensory loss of the muscles innervated by the radial nerve. Functional losses are MP joint extension of the digits, extension and abduction of the thumb, and radial and ulnar wrist deviation. Sensation may be compromised or absent over the dorsal area of the thumb, second, third, and, partially, the fourth digits. Grip strength is also often compromised with radial nerve injuries. A common symptom of radial nerve injuries is drop wrist deformity due to the loss of innervation to the wrist extensors.</td>
</tr>
<tr>
<td>Median</td>
<td>Motor &amp; sensory loss of the muscles innervated by the median nerve. Functional deficits involved with median nerve injuries can include; loss of thumb opposition, weakened wrist pronation and flexion, and joint flexion of the IP joints of the thumb and index fingers. Sensory loss can include: the volar and dorsal aspects of the thumb, index, long, and ring fingers. A common symptom that accompanies median nerve injuries is</td>
</tr>
</tbody>
</table>
called ape hand. This is caused from disruption of nerve innervation to the thenar muscles that are involved in thumb opposition.

<table>
<thead>
<tr>
<th>Nerve Injury Deformities:</th>
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<tbody>
<tr>
<td>- Radial Nerve</td>
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<tr>
<td>o Drop Wrist</td>
</tr>
<tr>
<td>- Median Nerve</td>
</tr>
<tr>
<td>o Ape Hand</td>
</tr>
<tr>
<td>- Ulnar Nerve</td>
</tr>
<tr>
<td>o Claw Hand</td>
</tr>
</tbody>
</table>

**c. Prevalence:**

Traumatic upper extremity injuries are rather common and can often occur secondary to or as a result of another injury. These injuries can also occur as the sole injury to the upper extremity. In a study performed by Noble, Munro, & Prasad, (1998), it was found that approximately 75% of the patients who obtained peripheral nerve injuries had nerve injuries to the upper extremity. This number of patients which was 121, came out of a sample of almost 6,000 patients over a 10 year period. These injuries involved injury to the radial, median, and ulnar nerves. The radial nerve was the most commonly injured nerve of the upper extremity with almost half of the injuries occurring to the radial nerve. Ulnar nerve injuries were the next most common with approximately 30% of the total injuries, followed by median nerve injuries with approximately 20% of the upper extremity injuries (Noble, Munro, & Prasad, 1998).
d. Evaluation Methods:

Rehab evaluations for both traumatic nerve injuries begin by obtaining general medical information including age, hand dominance, occupations, previous injuries to the injured extremity, mechanism of injury, time of injury, and position of hand during injury. This information is helpful to the therapist when designing a rehab program to fit the client’s needs. Manual muscle testing is also an important tool in the evaluation of nerve injuries. Manual muscle testing allows the Doctor and therapist to gain a better understanding of the muscles that have been affected by the injury. By knowing which muscles have been affected, the physician and therapist are able to perform the correct repairs if needed and design a specific treatment plan for each patient. Range of motion is also used along with manual muscle testing to see the extent of muscle functioning and to find out if there are motion limitations caused by the initial injury. Sensation testing is used in almost all cases of nerve injuries to determine the level of sensation the patient currently has. This measurement is a good baseline to keep track of progress that is being made as well as a guideline for patient safety if they have a loss of protective sensation. With nerve injuries, the evaluation process is ongoing at all times. Changes in the evaluation results are used to monitor patient progress or declines and to determine the effectiveness of the treatment regime (Hunter, Mackin, & Callahan 2002). Specific evaluation methods can be found in the resources listed at the end of this manual.

e. Treatment Methods:

The treatment of traumatic nerve injuries is normally separated into three phases. These phases are the acute phase which is the time for healing and protection, the recovery phase which is the time of nerve re-innervation and regaining function, and the chronic phase which is the period of time where the patient has reached their potential for recovery. Specific splinting strategies for each injury are discussed in the splinting section (Hunter, Mackin, & Callahan 2002).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Treatment</th>
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</thead>
<tbody>
<tr>
<td>Acute</td>
<td>This phase focuses on preventing further injury and contractures as well as allowing the injured or repaired nerve time to heal. Immobilization is used to reduce movement around the injury site, protect the injured nerve, and prevent contractures and range of motion losses. After immobilization is complete, the goal of the therapist is to increase range of motion in the injured extremity. This can be achieved by designing active and passive range of motion programs for the patient to complete. Patient education is also important to help the patient to understand what is expected of them during treatment and also what they can expect concerning outcomes and results of treatment. Education also includes letting the patient know the risks and precautions of their injury. Another treatment strategy is to design home programs for patients to perform when outside of the treatment setting. These</td>
</tr>
</tbody>
</table>
programs consist of range of motion exercises and other strategies that are used to increase functional use of the injured extremity.

**Recovery**
The recovery phase begins when reinnervation starts to appear with clinical testing. Retraining and reeducating the muscles are the goals of this phase. Desensitization is also common during this phase when sensation is regained in the injured extremity. Retraining muscles is important during this phase because after a nerve injury the connection between the muscles and nerves is disrupted. Retraining these muscles can be performed using various activities such as place and hold exercises and by electrical stimulation or bio feedback. The specific exercises are dependent on the nerve and muscles affected by the injury. Desensitization is used to regain normal sensation for both protective and functional purposes. Desensitization occurs when the patient is exposed to different stimuli that are tolerable but irritating and increasing tolerance until the sensations are suitable for the patient. Sensory reeducation is also used to retrain the patient’s brain to perceive objects in a way similar to how it did before the injury. This involves identifying different objects and textures during a variety of activities. This can include picking out small objects from a bucket of sand with the injured extremity and other activities with similar concepts.

**Chronic**
The chronic phase begins when the patient stops making progress. When this phase begins the patient may have limitations that were not present before the injury. During this phase the therapist focuses on compensation techniques rather than regaining function. Compensation can come in the form of adaptive equipment, activity modification, and surgical alternative. The therapist focuses mainly on the use of adaptive equipment and activity modifications with the idea of making each activity possible for the patient to perform independently or with as much independence as possible. Surgical options are discussed between the patient and their Doctor and can include tendon transfers to improve motor function.

(Hunter, Mackin, & Callahan 2002)

**Treatment Precautions/Complications:**

1. Limitations of the wrist, hand, elbow and shoulder due to prolonged positioning.
2. Loss of mobility in the digits, wrist, elbow, and shoulder.
3. Re-injury of the involved nerve.
4. Chronic pain caused by injury or RSD (Reflexive Sympathetic Dystrophy)
5. Loss of protective sensation in areas innervated by the involved nerve.
6. Paralysis or motor loss of the muscles innervated by the involved nerve.
Pain Management: See pain management section

Edema Management: See edema management section

Physical Agent Modalities: See physical agent modalities section

Scar Management: See Scar management section

Strengthening: See strengthening section

Range of Motion: See Range of Motion Section

<table>
<thead>
<tr>
<th>Injured Nerve</th>
<th>Splinting</th>
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<tbody>
<tr>
<td>Radial</td>
<td>Splinting for radial nerve injuries can be used for extended periods of time while the nerve innervation continues to improve. Both static and dynamic splints are helpful. Dynamic splints may be more functional due to the ability of the patient having more movement while wearing this type of splint. Static splints are used for protection to prevent further injury and promote healing. The wrist is splinted in extension to prevent the drop wrist deformity which often accompanies radial nerve injuries.</td>
</tr>
<tr>
<td>Median</td>
<td>Splinting for median nerve injuries is not always necessary but is often used to prevent the Ape hand deformity caused by the nerve injury. These splints are made to promote thumb abduction, MP flexion, and IP extension. This positioning allows for functional use of the hand and prevents contractures that often result in a loss of active range of motion.</td>
</tr>
<tr>
<td>Ulnar</td>
<td>Splinting for ulnar nerve injuries is common and is often used to prevent further stretching of the ring and small finger intrinsic muscles. These splints are usually made to prevent MP extension and keep the digits in slight MP flexion and also allows for complete IP range of motion. This positioning also helps to prevent losing active range of motion at the MP joint level by preventing contractures.</td>
</tr>
</tbody>
</table>

(Hunter, Mackin, & Callahan 2002) (Trombly, & Radomski, 2002)

f. Efficacy of Treatment:

Although the prognosis of nerve injury recovery is often unclear, there are studies that have shown early repair and treatment of nerve injuries can result in increased function of the involved upper extremity. The results may be seen early in the rehabilitation process, or they may take months to years to achieve good results. Also, it should be noted that some patients may never reach levels of
previous function depending on the severity of their injuries. In a study presented by (Guerra, Baldauf, & Schroeder, 2007), satisfactory functional outcomes were observed in approximately 80% of patients that were involved in surgical treatment of upper extremity traumatic nerve injuries. It was also found that the recovery process was dependent on the age of the patient, the severity of injury, and the length of time between injury and repair. The authors of this study recommended that treatment should be performed within 3 months of the initial injury for the best functional results.

My personal experience working with patients who have suffered nerve injuries has allowed me to see the results of both surgical repair and the rehabilitation process. In my 12 weeks working in upper extremity rehabilitation, I was able to see many traumatic nerve injuries including lacerations, burns, electrical injuries, and compression injuries. I have seen that upper extremity rehabilitation has had a positive effect on 100% of the patients I have been in contact with. These patients may not have been rehabbed to 100% of their previous function, but they all had made significant gains in both motor and sensory function. Even for the patients who made slow progress and were not immediately able to see large gains, the treatments were effective because they were able to feel more sensation and use their extremity for more activities than before treatment.
Treatment Strategies Section:

Pain Management:

Pain management is a crucial component in the rehabilitation of upper extremity injuries. Pain often prevents use of the injured limb and can prevent patients from participating in their treatment regimes. The first area of pain management is medications that help to control pain, which doctors can prescribe and give to the patient based on their needs. Pain management can also include resting the injured limb to prevent swelling, overuse, and pain caused from movement. Another area of pain management is reducing swelling or edema. Edema is positive to some degree but too much edema or edema that lasts too long can cause tissue damage which is painful and can also prevent healing. Icing can be used to help reduce swelling and inflammation and also reduce pain by slowing the nerves ability to transfer the pain signals to one another. Icing can be performed 3-5 times per day for approximately 10 minutes each time. Compression dressings can be used to reduce swelling but it is important to make sure the dressing is not restricting blood flow or causing neurovascular damage. These dressings should be removed and checked approximately every 2-3 hours and reapplied if needed. Elevation is also useful in pain management due to its role in reducing and preventing swelling which can be painful because swelling may cause injured tissues to stretch and suffer further damage. Elevation is performed by elevating the injured extremity above heart level assuming the patient does not have a heart condition or other circumstance that is a contraindication for moving fluid towards the heart (Cunneen & Gately, 2007).
Edema can have a positive effect on injured areas by bringing nutrients and encouraging tissue growth but can also have a negative effect on the wrist by limiting mobility and causing pain. According to Hunter, Mackin, and Callahan, (2002), edema can be present in all three stages of wound healing. It is normal in the first stage which lasts from 3 to 5 days. It is in this stage that edema can be helpful to bring nutrients and cells and help heal an injured area. The edema can also be too excessive and can be controlled by edema management techniques. In the second stage from 2 to 6 weeks edema can become more of a problem. In this stage the fluid causing edema becomes thicker due to an increase in proteins needed to rebuild tissue and repair the injured area. This thickened fluid can cause tissues to become thick and cause damage to ligaments and tendons. It is important to control and reduce edema during this stage. In the last stage of healing which lasts from 6 months to 2 years, edema is especially dangerous because the fluid can become very thick and prevent proper wound healing and cause problems with blood flow and circulation.

Elevation is one strategy that can be used to help reduce edema. Elevation above the heart level helps to draw the edema fluid down the injured extremity towards the heart. If the arterial systems are blocked or not allowing fluid movement properly, elevation should be avoided. In a replanted extremity elevation should be avoided to prevent arterial system complications (Hunter, Macki & Callahan, 2002).

Active and passive range of motion can also reduce edema by drawing the fluid away from the injured extremity. These motions prevent stiffness and encourage movement of the joints. Range of motion also helps to prevent tendons from becoming attached to one another which can prohibit movement (Hunter, Mackin, & Callahan, 2002).

Massage is another technique that is often used to reduce edema. When performing massage, the therapist is moving the fluid from the site of injury into the
lymphatic system for removal from the body. The message stimulates the lymphatic system which can increase the rate of fluid movement and result in reducing edema (Hunter, Mackin & Callahan, 2002).

Bandaging and wrapping are also often used to reduce edema. They reduce edema by reducing the amount of space open for fluid to accumulate. When using bandaging and wrapping, the therapist should be careful to check for adequate circulation and movement in order to prevent neurovascular damage and pain (Hunter, Mackin & Callahan, 2002).

Physical agent modalities are used in conjunction with other treatment methods to reduce edema but can also be used alone. Icing helps to reduce edema by reducing inflammation and swelling in the injured area. Electrical modalities can also be used to push fluid molecules away from the injured site by encouraging muscle contractions (Hunter, Mackin & Callahan, 2002).

Physical Agent Modalities:

Physical agent modalities are described as modalities that produce a physiological response through the use of light, water, sound, temperature, electricity, and mechanical devices (L. Norman, personal communication, September 15, 2007). Many modalities can be used when treating upper extremity injuries. The table below lists and briefly describes some of the more common modalities used in upper extremity rehabilitation.

<table>
<thead>
<tr>
<th>Modality</th>
<th>Description</th>
<th>Physiological effects</th>
<th>Indications</th>
<th>Contraindications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cryotherapy (Cold Therapy)</td>
<td>Consists of using cold packs, ice baths, ice massage, cool whirlpool, ice towels, cold compression, and vapocoolant sprays.</td>
<td>Constricting blood vessels, decreased cell metabolism, increased nerve latency, and decreases pain.</td>
<td>Acute injury, Edema, Pain, muscle spasticity.</td>
<td>Healing wounds, grafts of flaps, open wounds, cold hyper/hyposensitivity</td>
</tr>
<tr>
<td>Superficial Heat Agents</td>
<td>Whirlpool/hydrotherapy/fluidotherapy, hot packs, contrast bath, warm water soak, paraffin bath.</td>
<td>Increases tissue elasticity, pain relief, vasodilation, decreases nerve latency, promote vascularization</td>
<td>Pain, limited range of motion, tissue adhesions, nerve involvement, arthritis, cumulative</td>
<td>Decreased circulation, peripheral vascular disease, hypo/hyposensitivity, acute injuries, open</td>
</tr>
<tr>
<td>Treatment</td>
<td>Effect</td>
<td>Contraindications</td>
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<tr>
<td><strong>Ultrasound</strong></td>
<td>Increases tissue elasticity, increases blood flow, breaks up scar tissue, decreases nerve latency, increases new tissue growth and collagen flexibility.</td>
<td>Muscle pain, decreased range of motion, inflammation, scar tissue.</td>
<td>Never used over eyes or heart, avoid malignant tissue, decreased circulation, growth plates and healing bones, arteriosclerosis, pacemakers.</td>
<td></td>
</tr>
<tr>
<td><strong>Transcutaneous Electrical Nerve Stimulation (TENS)</strong></td>
<td>Used for pain management, blocks pain signals, increases endorphin production.</td>
<td>Musculoskeletal disorders, arthritis, soft tissue inflammation, postoperative pain.</td>
<td>Pacemakers, cardiac disease, epilepsy, over the eyes, mucosal surfaces, nervous system disorders, stroke patients, children.</td>
<td></td>
</tr>
<tr>
<td><strong>Iontophoresis</strong></td>
<td>Delivery of ionized topical medications by electrical current.</td>
<td>Localized inflammation, localized anesthesia, hypertrophic scarring.</td>
<td>Allergy anti-inflammatory medications, pregnancy, open wounds.</td>
<td></td>
</tr>
<tr>
<td><strong>Electrotherapy (E-Stim)</strong></td>
<td>Charged particles are moved from one area to other areas forcing muscle contractions, increases metabolic rate, increases circulation.</td>
<td>Loss of range of motion, muscle spasticity, muscle strengthening, muscle endurance, muscle re-education, control edema.</td>
<td>Pacemakers, thoracic region, carotid sinus/anterior neck, loss of nerve sensation, acute infection, pregnancy, nerve synapse involvement.</td>
<td></td>
</tr>
</tbody>
</table>

*(Bracciano, 2000; L. Norman, personal communication, September 15, 2007)*
Strengthening:
Exercises and everyday activities can be used to strengthen injured upper extremity muscles. The difficult part of strengthening is deciding when to begin and how much strengthening is needed. The therapist should consult with the patient’s physician regarding when to begin strengthening. The therapist must then use their own judgment on how much weight and what types of strengthening they will use. Using too much weight or starting strengthening too soon can result in injury, inflammation, and pain which will have a negative effect on the healing process. Exercise frequency and intensity should be increased as patient makes progress. Exercises that can be use include but are not limited to therapy putty, weights, hand grip devices, Baltimore Therapeutic Equipment machines, and everyday activities. Therapy putty is available in many grades and it is recommended to start with a lower grade and work towards the more difficult grades. The same recommendation is made for weight strengthening to start lower and work up to heavier weights. Hand grippers can also be adjusted from little resistance to greater resistance depending on patient progress. BTE machines simulate many different activities and can also be used for exercises and resistance training. (J. Armstrong, personal communication, March 15, 2007)

Scar Management:
Scars can occur from the injury itself or from the method of treatment such as and external fixation device. Whatever the reason for the scar, proper management can help to reduce the sensation and size of the scar. Pressure on scar tissue has been shown to be effective in reducing the size of a scar. The reasoning behind this technique is debated whether the pressure reduces the formation of scar tissue or if the pressure causes the scar tissue growth to dehydrate and die. Either way the process reduces scar formation and is beneficial to patients. The purpose of pressure is form a smooth, flat scar that does not rise above the level of the skin. To apply pressure for scar management, pressure garments and bandaging are often used. These can be commercially designed products or constructed individually by the therapist for each patient’s needs. Areas of concern with pressure garments are the breakdown of skin tissue, pressure on nerves, and decreased circulation due to the pressure (Hunter, Mackin, Callahan, 2002).

Scar Massage is also often used to reduce the formation of scars. This procedure is performed in three directions which are circular motions, parallel motions, and alternating transverse motions across the scar. The purpose of massage is to break up the scar tissue and prevent the scar formation.
Modalities are used in conjunction with other scar management techniques but can also be used unaccompanied. These modalities include paraffin wax, ultrasound, and silicone gel. Paraffin wax is used with massage or stretching to increase movement in the scar tissue and help break of the collagen. Ultrasound can also be used to increase range of motion and help loosen scar tissue. Silicone gel sheets also loosen up scar tissue and help to flatten raised scars (Hunter, Mackin & Callahan, 2002).
Glossary

AROM- active range of motion

Contralateral- part on the opposite side of the body.

DIP- distal interphalangeal joint- distal joint of the digits.

Dorsal aspect of hand- the area opposite of the palm of the hand.

Dynamic Splinting- the splint moves allowing normal motions in certain directions.

Dynamometer- device used to test strength in the upper extremities.

Edema- a swelling or accumulation of fluids that often accompanies an injury.

Goniometer- device used to measure range of motion angles.

MP or MCP- metacarpalphalangeal joint- joint between metacarpals and digits.

Physical agent modalities- modalities used to cause physiological response.

PIP- Proximal interphalangeal joint- proximal joint of the digits.

PROM- passive range of motion

Pronation- rotation of the hand and arm so the palm faces down or back.

Static Splinting- the splint is molded in one shape and does not allow movement.

Subluxation- a dislocation or interruption in a joint where two bones come together.

Supination- rotation of the hand and arm so the palm faces forward or up.

Volar aspect of hand- the palmer side of the hand.

Volumeter- device used to measure edema.
# Resources for Upper Extremity Rehabilitation:

<table>
<thead>
<tr>
<th>Textbook Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rehabilitation of the Hand and Upper Extremity</td>
<td>Hunter, Mackin, &amp; Callahan</td>
</tr>
<tr>
<td>Physical Agent Modalities: Theory and Application for the Occupational Therapist</td>
<td>Bracciano</td>
</tr>
<tr>
<td>Essentials of Musculoskeletal Care</td>
<td>Greene</td>
</tr>
<tr>
<td>The Hand: Fundamentals of therapy</td>
<td>Morrin &amp; Conolly</td>
</tr>
<tr>
<td>Fundamentals of Hand Therapy : Clinical Reasoning and Treatment Guidelines for Common Diagnoses of the Upper Extremity</td>
<td>Cooper</td>
</tr>
<tr>
<td>Splinting The Hand And Upper Extremity</td>
<td>Jacobs &amp; Austin</td>
</tr>
<tr>
<td>Hand and Upper Extremity Rehabilitation: A Practical Guide</td>
<td>Burke</td>
</tr>
<tr>
<td>Diagnosis and treatment manual for physicians and therapists - Upper extremity rehabilitation</td>
<td>Cannon</td>
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## Research Articles & Studies

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<tr>
<td>Extensor tendon rehabilitation a prospective trial comparing three rehabilitation regimes</td>
<td>Bulstrode, Burr, Pratt &amp; Grobbelaar</td>
</tr>
<tr>
<td>Outcomes in hand rehabilitation using occupational therapy Services</td>
<td>Case-Smith</td>
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<tr>
<td>Adaptation to hand injury: An evolving experience</td>
<td>Chan &amp; Spencer</td>
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<tr>
<td>A qualitative study of coping in the early stage of acute traumatic hand injury</td>
<td>Gustafsson, Persson, &amp; Amilon</td>
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<tr>
<td>Educational techniques used in occupational therapy treatment of cumulative trauma</td>
<td>Lawler, James, &amp; Tomlin</td>
</tr>
<tr>
<td>Websites/Journals/Associations</td>
<td>Link</td>
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<tr>
<td>Hand Therapy Certification Commission</td>
<td><a href="http://www.htcc.org">http://www.htcc.org</a></td>
</tr>
<tr>
<td>American Society of Hand Therapists</td>
<td><a href="http://www.asht.org">http://www.asht.org</a></td>
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<td>Journal of Hand Therapy</td>
<td><a href="http://www.jhandtherapy.org">http://www.jhandtherapy.org</a></td>
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<tr>
<td>British Journal of Hand Therapy</td>
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</tr>
<tr>
<td>European Federation of Societies for Hand Therapy</td>
<td><a href="http://www.eurohandtherapy.org">http://www.eurohandtherapy.org</a></td>
</tr>
<tr>
<td>American Occupational therapy Association</td>
<td><a href="http://www.aota.org">http://www.aota.org</a></td>
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</table>
REFERENCES


CHAPTER V
SUMMARY

Making the transition from being an occupational therapy student to working as an occupational therapist in the clinical setting of upper extremity rehabilitation can be difficult for many individuals. This project was designed to help reduce the difficulty when making this transition and better prepare students who plan on working in upper extremity rehab. While researching literature on this topic, it was also found many entry level therapists feel they are not competent when they first enter practice and experienced therapists may not feel competent when faced with diagnoses they are not familiar with. The product designed from this research will also help therapists who are experienced in areas other than upper extremity rehab to have an understanding of how to treat a few of the common traumatic upper extremity injuries. The product also provides a list of resources where therapists of all levels and abilities can look for more in-depth information regarding the upper extremity injuries and the occupational therapy treatment for these injuries.

The main limitation of this project is that the product portion of the project is not all inclusive. The product contains information regarding three of the most common traumatic injuries, but there are numerous injuries that are not discussed in this product. Also, the product does not contain any information on the topic of cumulative injuries or other disorders that can affect the upper extremities. Another limitation is that each therapist uses their own clinical reasoning and judgment when treating patients who have
upper extremity injuries which I believe has limited the amount of similar information published on upper extremity treatment. There have been multiple publications regarding treatment for upper extremity injuries, however many of these publications focus on different types of treatments and more research is needed to confirm the best types of treatment for each specific injury.

I feel the product portion of this project can be used by both students and therapists who wish to have a better understanding of upper extremity rehabilitation. These students and therapists may plan on working in the area of upper extremity rehab or they may just want to be prepared in the event that they are required to treat a patient with an upper extremity injury. I also see it being used by fieldwork educators and educational programs to help students feel more comfortable when working with patients who have upper extremity injuries. For anyone using this product, it is important to remember it is not intended to be a complete treatment protocol for the injuries discussed. It is a basic guideline with some ideas and information that may help to guide a therapist’s treatment and provide resources on where to find more information. Therapists wishing to find complete treatment protocols should contact practitioners that refer their patients or check out the resources section of the product.

Recommendations for the future include performing more research on upper extremity rehabilitation techniques to see which techniques are use most often, and which are most effective. Also, I hope to add to this manual in the future as I learn more about upper extremity rehabilitation and gain more experience as an occupational therapist. I would like to continue developing this manual to include many more upper extremity diagnoses and conditions which are not covered by this manual. I would also like to
develop a treatment protocol based on my clinical experience, knowledge, and experience in the future.
REFERENCES


