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Interdisciplinary Amputee Care from Injury to Independence: Medical, Occupational Therapy, and Prosthetic Intervention

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OT 7202- Capstone Experience & Project

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April 16, 2023
Interdisciplinary Amputee Care from Injury to Independence: Medical, Occupational Therapy, and Prosthetic Intervention

Abstract

During my doctoral capstone experience, I focused on advanced clinical practice of hand therapy and treatment of upper extremity amputees. I had the opportunity to observe and collaborate with surgeons and prosthetists to gain an improved understanding of my patients’ multi-disciplinary care. I assisted in teaching three upper extremity courses for WMU’s OTD program. I also evaluated and treated my site’s entire amputee caseload in addition to my site mentor’s more complex cases. Utilizing what I learned, I created educational resources and HEPs specifically geared toward amputees. Theses resources were supplied throughout the patient’s POC as needed and at my site’s bi-monthly amputee clinic. This filled a need at both my site and in the scope of upper extremity amputee treatment, as this information was not readily available through other resources. I also created a case study ready to be published discussing the fabrication of a novel prosthosis for an amputee awaiting a permanent prosthetic device. This outline can be utilized by other therapists to aid their patients in reaching function faster.

Introduction to Capstone Project

My capstone project encompassed three ACOTE concentration areas: advanced clinical practice skills, program development, and education. The populations served by my project were people of all ages with hand and upper extremity injuries, with a specific focus on upper extremity amputees. Most of my patients were from Muskegon, MI and the surrounding area. My site was an outpatient hand center, where nearly all of my patients were post-operative from an injury or elective procedure. One day per-week, I worked with a prosthetist who specialized
in upper extremity prosthetics. This site served amputees from around west Michigan. Services included molding and plaster casting for new prosthetic device, prosthesis consultation, initial prosthesis fitting, and prosthesis adjustments.

My site consisted of a board-certified hand surgeon, board-certified plastic and reconstructive surgeon, physician’s assistant and two certified hand therapists (CHTs), who are both occupational therapists (OTs). Over the past three years, my mentor and the plastic surgeon have been collaborating on expanding outreach to amputees across west Michigan. They have attended multiple national conferences on best practices for upper extremity amputees. From this additional education, the plastic surgeon learned novel surgical procedures for amputee pain management and prosthesis preparation. Because of this, he is the only practitioner in west Michigan that performs Targeted Muscle Reintegration for the upper extremity. This procedure allows higher level amputees better control with a myoelectric prosthesis. He, along with the hand surgeon, collaborate on traumatic and elective amputations at various levels.

My mentor provides occupational therapy services for the entire amputee caseload and has completed multiple continued education courses on best practices for treatment of a patient with an amputation. My mentor and the plastic surgeon collaborate alongside prosthetists and a social worker to create an interdisciplinary amputee clinic that meets every other month to provide support to amputees at various stages of recovery. This group has collaborated to provide a holistic and unique resource for upper extremity amputees to seek answers and find new ways to increase their independence.

**Advanced Clinical Practice**
Advanced clinical practice skills were addressed by working intimately with my mentor, a CHT with a background in OT. I treated approximately 80% of her total caseload. This consisted of a higher complexity of patients and more independence with treatment than my level II experiences. I learned new, progressive treatment protocols from my site mentor. Many of these protocols stem from emerging surgical interventions and treatment methods performed by the surgeons at my site. I had the opportunity to treat patients with diagnoses and surgical interventions I had not seen in prior learning environments. Additionally, I performed wound care, suture removal, and staple removal, which were all areas that I had very little experience in prior to my DCE.

I treated the entire amputee caseload. Prior to this, my site mentor guided me to scholarly resources to expand my knowledge in treatment of amputees. Treatments consisted of wound care, extensive patient and caregiver education, suture removal, mirror box therapy, graded motor imagery, coban wrapping for digit shaping and edema management, scar massage, occupational adaptation, adaptive equipment, support groups, return to work, grief management, HEPs, AROM/PROM/AAROM, comfort measures, soft tissue mobilization, strengthening, decongestive massage, prosthetic education, and prosthetic training. Treating upper extremity amputees is a specialty area within hand therapy that takes additional knowledge and a holistic approach that goes beyond a standard hand therapy treatment session.

I had a unique opportunity to observe and collaborate with an upper extremity prosthethist. Upper extremity prosthetics require a high level of nuance, knowledge, and consideration of the patient’s activity participation. I gained an increased understanding of the variety of prosthetic devices available and the processes that go into molding, fitting, fabrication, and adjustment. I observed molding of a thumb amputee, a congenital trans-radial limb difference, and a trans-
radial amputee using BodyDouble silicone and traditional casting material. I observed fitting for
digital amputations and multiple trans-radial amputations. Multiple patients required fixes to
electrical control system, socket fit adjustments, and fixes to their terminal device. I observed the
prosthetist adjust and troubleshoot prostheses in his lab. I learned about proper care of
prostheses, precautions when wearing a prosthesis, barriers, preferred adaptive equipment, what
they liked and disliked about OT services, and activity modifications. This additional exposure
further enriched my doctoral capstone experience, improved the quality of the handouts I
created, and aided in my ability to complete prosthetic training during my DCE.

Collaborating with a prosthetist is an important part of a hand therapists’ job when
treating an amputee. Working with a prosthetist has provided me with an intimate knowledge of
their scope of practice. As an OT, I will be seeing my patients more often than nearly any
provider. It will be up to me to guide my patient to seek assistance from their prosthetist if they
have issues with fit, use, or mechanical issues. After this experience, I have a better clinical eye
for prosthetic issues. Early identification of these issues will improve patients’ pain, participation
in ADL, frustration with the device. All this in turn should improve prosthetic wear compliance.

I also had the opportunity to observe medical interventions. I shadowed both surgeons at
my site. I observed an office day, where the surgeon diagnosed patients, discussed surgical
intervention, administered pain-relief injections for arthritis, percutaneous pin removal, and
multiple in-office surgical procedures. I observed the plastic surgeon perform multiple hand
procedures at the surgery center. I observed a revision surgery with a skin flap and web space
deepening procedure for one of my amputee patients who I treated before and after surgery. I
observed a trapeziometacarpal arthritis procedure that included excision of the trapezium and
suspension-plasty between the 1st and 2nd metacarpal. I treated this patient post-operatively
through her entire OT plan of care. Finally, I observed a patient with a complex crush injury with excessive scar tissue and joint contractures. The surgeon removed hardware, completed PIP capsulotomies with manipulation, and tenolysis. I treated this patient before and after this surgery as well. During each procedure, the surgeon explained his rational and what he was doing, pointed out anatomical structures, and answered questions.

Two interdisciplinary amputee clinic days occurred during my DCE. During those days, I served as the treating OT, problem-solving occupational barriers and limitations with amputees that had previously discharged from therapy. I also observed the surgeon’s sessions, prosthetists’ sessions and the social worker’s sessions. This provided me a great interdisciplinary approach to the patient’s care. I also aided in the meet up- of two amputees during the most recent amputee clinic day. Both men were right thumb amputees at similar levels. One was approximately 3 months from his initial injury while the other was about 8 months out. The men discussed occupational adaptions, difficulties surrounding thumb loss, healing progression, and prosthetic options. Seeing two people who have gone through such a life altering experience trade advice with one another was one of the most rewarding opportunities I had during my capstone experience.

During my DCE, I completed a case study following one of my amputee patients. He sustained a traumatic amputation of his thumb at work and indicated interest in a prosthetic early on. However, due to slow healing he required additional surgical intervention that delayed the prosthetic process. Because of this, I had the opportunity to fabricate a unique thermoplastic and Orficast orthosis with a built-up thumb called a “prosthosis.” My case study focused on the feasibility of creating a removeable thermoplastic digit to gain functional opposition for prehension. The case study also investigated the usefulness of the prosthosis to the patient in
chosen occupations while awaiting a full-time prosthesis. My goal is to publish this case study to help fill the gap in prosthesis literature. I hope to publish this information to therapists that specialize in hand therapy and the treatment of amputees. Please see appendix for a copy of this case study.

Working with upper extremity amputees not only provided me with better clinical reasoning skills in an area of advanced clinical practice, but it also allowed me to focus care holistically. Commonly in a traditional orthopedic medical model, OTs focus on physical limitations with little emphasis on other areas. This leads to a lack in understanding of the occupations, contexts, performance patterns and client factors that impact the patient. If the OT does not address this, it is unlikely another health care provider will, and things may slip through the cracks.

This experience also allowed me the unique opportunity to follow multiple patients throughout their interdisciplinary plan of care. In conjunction to treating these patients, I was also able to observe their medical interventions and prosthetic appointments. This not only allowed me to have a better understanding of OT’s role in the patient’s bigger picture but prepared me better than my Level II experiences could for treatment of amputees and other post-operative patients.

**Program Development**

Pulling from my literature review, on-site research, experience treating patients, and shadowing experiences, I created 16 unique handouts for my amputee caseload. I noticed early on in my DCE that while my site mentor had quality home exercise programs (HEPs), there were none specifically created for her high volume of amputees. She also had a large binder full of
psychosocial resources. I took this information and compiled it into digestible and patient-friendly resources.

After the observational period with my site mentor, it became clear therapy can be very overwhelming to an amputee, especially the first few sessions. Commonly, the first time the patient sees and moves their affected hand or arm is at their OT evaluation. This can be frightening and overwhelming for the patient, as one can imagine. The first few appointments can be physically painful, emotionally taxing, and stressful for the patient. However, it is important the OT provides early education to for optimal outcomes. By creating and providing step-by-step HEPs and educational handouts, the patient can more deeply understand this important information at a time that is best for them. When they are home, and not in a clinic, the patient may have a better ability to absorb new information.

I was unable to find any shoulder strengthening handouts with photos or drawings of an amputee. I took this into my own hands by creating handouts with photos of trans-radial amputees performing shoulder strengthening and isometric exercises. Many resources I created were unique to the needs of an amputee, but some were beneficial to all post-operative patients. These handouts include: “Desensitization”, “Graded Motor Imagery”, “Mirror Therapy”, and “Scar Massage”. These are beneficial for patients that are far enough into their healing progression that sutures have been removed and wounds are completely healed. Education and resources for new amputees include “Post-Amputation Support”, “Getting Back to Daily Activity”, “Edema Management” and” Limb Shaping” (individual digit and higher-level handouts), “Amputation Tips and Tricks”, “Job and Employment Resources”, “Amputee Shoulder Exercises” and “Amputee Isometric Exercises.” These can all be initiated at the initial evaluation, or when deemed appropriate. Another group of handouts was created for those who
opted for a prosthetic: “Trans-humeral” and “Trans-radial Prosthesis Training Activity Checklist,” “Digit and Partial Hand Prosthesis Training Activity Checklist,” “Taking Care of your Prosthesis,” and Prosthesis Wear Schedule.” These handouts are appropriate for the patient returning to therapy after receiving a prosthesis. Originally, these handouts were going to be provided based on timeline after surgical intervention. Upon further reflection, these handouts were provided based on individual clients’ needs, treatment, and healing progression. This provides unique, patient centered care.

Please see appendix for copies of each handout. These handouts will be available for my mentor to utilize for future patients. Additionally, these resources have been shared with an occupational therapist that provides resources and education to OTs and PTs treating amputees across the eastern US. Not only will my resources and HEPs benefit amputees in west Michigan, but around the country.

**Education**

I assisted my mentor in teaching three modules for Western Michigan University’s entry level Doctor of Occupational Therapy program. We taught first year students upper extremity topics for adults and older adults. I led topics including exercise interventions, activity analysis and a case study including documentation. I assisted my mentor in instruction of orthosis fabrication including resting hand, long opponens, wrist cock-up, and digital trough. I aided students during creation of a resting hand orthosis template, when completing case studies, and when completing orthosis identification assignment. I provided hands-on assistance during shoulder module which included PROM/ AROM with goniometrics, joint mobilizations, palpation, and strengthening exercise.
I independently conducted a make-up shoulder intervention class for two students. I utilized hands-on demonstration, education, and observation to teach PROM/AROM with and without goniometrics to the shoulder and forearm, glenohumeral and scapular joint mobilizations, palpation of shoulder and scapula, and pendulums. We also reviewed and discussed common AAROM, AROM, and strengthening exercises for the shoulder and forearm. I utilized information from didactic courses, Level II clinical experiences, the doctoral capstone experience, and past work experience to inform this class session.

**Literature Review of Capstone**

**General background**

People with upper extremity amputations (UE) or congenital limb difference make up only 10% of the amputee population (Arm Dynamics, 2023). The number of UE amputations performed each year in Michigan are on the rise, increasing by over 30% between 2001 and 2014 (The Amputee Coalition, 2019). Over this thirteen-year period, 4,421 amputation procedures were performed in Michigan, with 337 of these occurring in 2014 alone (The Amputee Coalition, 2019). The overwhelming majority (92.8%) of UE loss is due to trauma, followed by dysvascular disease (Ziegler-Graham et al., 2008). Most amputations are performed on males, between the ages of 45-64, followed by those aged 65-84 (The Amputee Coalition, 2019).

An article by J.H.Davidson et al. (2010) states 94% of UE amputees experience persistent limb pain after amputation (Davidson et al., 2010). 64% of UE amputees surveyed reported moderate-severe chronic pain and are 2.8 times as likely to experience constant pain than lower extremity amputees (Davidson et al., 2010). About 1 in 4 UE amputees have painful neuroma formation at some point in their lifetime (Pierrie et al., 2018). UE amputees report worse mental
health than members of a chronic pain clinic (Davidson et al., 2010). UE amputees also report similar levels of general health and social functioning (Davidson et al., 2010). Compared to the general population, amputees also report a lower quality of life (QOL) (Davidson et al., 2010).

**Prostheses**

There are a variety of available prostheses available to amputees today. These include MCP, PIP and thumb drivers; ratcheting digits; 3-D printed stationary digits; silicone digits or hands for aesthetics; body powered hooks; and myoelectric prosthetics. Myoelectric prostheses are prosthetic devices that move a terminal device, such as a hand or hook, when muscle contractions are elicited. These electrical contractions are picked up by sensors embedded into the prosthetic. These other options may be more appropriate for different patients and occupations (*Partial Hands & Fingers*). A study conducted by Resnik et al. (2020) concluded “that those who did not use a prosthesis reported more difficulty in activities, greater disability, and lower [quality of life reports] as compared with those who used any type of active prosthesis.”

While UE prosthetics have made many advancements, there is still a large functional gap between the human hand and prosthetic options, regardless of type (Pierrie et al., 2018). The timeline between molding, fabrication and fitting can take up to 6 weeks. This process includes insurance approval, scanning and casting the hand, creating a mock-up, and a final fitting of the finished product. “May be months until the final prosthetic is delivered” (Johnson, 2014). Research has shown amputees fit with a prosthetic 30 days or less after amputation showed a 93% rehabilitation success rate and 100% return to work rate (Smurr et al., 2008). Those who
were fitted with a prosthetic more than 30 days after their amputation had only a 42% and 15% success rate, respectively (Smurr et al., 2008.)

**Prosthesis Fabrication**

Upon review of the literature, there are only a few examples of temporary prosthetic fabrications made from thermoplastic material. The vast majority of results bring up temporary prosthetic devises fabricated by prosthetists, which still take weeks to be delivered to the patient. From this review, a gap in the literature was found. Sudhagar and Le Blanc (2009) outlined a thermoplastic prosthosis for a thumb amputee. They created a template utilizing two pieces of thermoplastic heated together. This was a good starting point of reference, but the final product did not appear stable enough for stronger opposition and prehensile grasps. Dewey, et al. (2009) also outlined a template for a thermoplastic prosthosis utilizing a thicker thermoplastic packed to the thumb base with thermoplastic. Almond (2011) documented a simple to fabricate, hollow prosthosis for digital amputation. Almond’s template was also used as a reference for fabricaton of my prosthosis. Finally, Warthman & Martinez (2021) utilized a similar technique as Dewey, et al. (2009), but utilized a thumb-spica template as the base of the prosthosis.

**Occupational Therapy Intervention**

Occupational Therapy (OT) services are utilized by roughly 90% of amputees (Burger et al., 2007). Amputation, even minor, results in decreased grip and pinch strength, difficulty with writing, and many other ADL and IADL (Burger et al., 2007). Less than 1/3 of amputees wear their prosthesis at work regularly, so it is important to properly train clients in completing work and other occupations both with and without their prosthesis donned (Burger et al., 2007).
Early post-operative OT care consists of “wound healing, pain management, limb shaping, hand-dominance re-training, myocyte training, one-handed ADL training, and education on adaptive equipment” (Cancio et al., 2019). As the client masters skills and acquires their prosthesis, intervention will shift focus to prosthetic training of ADL, work, and leisure activities (Cancio et al., 2019). A study conducted with the Department of Veteran Affairs demonstrated the most used OT interventions were active therapy, manual therapy, and therapeutic modalities. The most-used CPT codes were prosthetic training, therapeutic activity, cryotherapy, therapeutic exercise, and soft-tissue mobilization (Cancio et al., 2019). Studies also recommends a focus on maximizing independence in ADL, strength and ROM of the residual limb, and mastery of the prosthetic device through preferred occupations (Cancio et al., 2019).

Pain management is controlled with the use of e-stim, hot/ cold packs, massage, desensitization, and functional tasks that encourage proper motor patterns (Smurr et al., 2008). Figure of eight wrapping is completed over the residual limb to control edema, manage shape of the stump, and to promote healing, which many clients have the goal to independently don and doff the wrapping (Smurr et al., 2008) Visual feedback is given to promote proper body positioning and symmetry after amputation (Smurr et al., 2008). Finally, the client is trained to incorporate their prosthesis efficiently and to use correct motor patterns (Smurr et al., 2008).

A large aspect of the rehabilitation processes is psychological support, which should be provided by the care team as a whole (Smurr et al., 2008). Some of the most common psychological issues seen in amputees are “fear of the unknown; loss of self-esteem; loss of self-confidence; fear of rejection; and loss of occupational roles” (Smurr et al., 2008). These clients can be supported by education on the rehab process, reassuring the client that their response to
their amputation is normal, utilizing empathy when speaking to the patient and their loved ones, utilize a trained amputee peer visitor, engage in therapeutic outings, and aid the client in gaining life skills to reach a state of normalcy (Smurr et al., 2008). Additionally, the OT and other mental-health practitioners can teach the client appropriate coping skills such as relaxation training, exercise, diet, support from others, acceptance, identifying negative self-talk, and pacing during occupations (Belon & Vigoda, 2014).

**Interdisciplinary Clinics**

Research has shown amputees fit with a prosthetic 30 days or less after amputation showed a 93% rehabilitation success rate and 100% return to work rate (Smurr et al., 2008). Those who were fitted with a prosthetic more than 30 days after their amputation had only a 42% and 15% success rate, respectively (Smurr et al., 2008). This underlies the importance of quick interdisciplinary care. OT, Physical Therapy, (PT) prosthetics/orthotics, and behavioral health have been cited as the most-used services after amputation (Cancio et al., 2019). It is imperative this team of professionals and the surgeon meet with the client as soon as possible post-amputation to ensure the client receives the best prosthetic for their lifestyle and proper training. This will allow for increased compliance and an easier transition back to work and leisure. Additionally, it is important the patients receive appropriate psychosocial support from the interdisciplinary care team.

Interdisciplinary care is becoming a best practice when treating amputees. An example of this is Walter Redd Medical Center, which is cited as an “ideal” medical center as it has both prosthetists and OTs on staff to aid amputees (Cancio et al., 2019). The Interdisciplinary Care for Amputees Network (ICAN) at Massachusetts General Hospital (MGH) in Boston consists of
PM&R physicians, PT, OT, pain management specialists, infectious disease specialists, and psychiatrists (Sobti et al., 2021). ICAN utilizes three core areas: “combined pre-operative patient evaluation, orthoplastic surgical intervention, and multi-specialty postoperative functional and psychosocial rehabilitation” (Sobti et al., 2021). ICAN’s surgeons and prosthetists collaborate to ensure proper timing of the surgery and additional procedures as needed (Sobti et al., 2021).

ICAN’s approach allows the team decrease functional limitation and lower the mental health burden after amputation (Sobti et al., 2021). ICAN cites their interdisciplinary team as one that improves workflow, enhances the patient experience, provides more comprehensive amputation support and improves long-term outcomes (Sobti et al., 2021). Longitudinal follow-up compared to the standard limited follow-up allows the client to have better long-term outcomes and allows the therapists and surgeons to monitor their progress and provide additional needed follow-up care (Sobti et al., 2021).

**Gaps in the Literature**

There is limited research available outlining fabrication of a thermoplastic prosthetic or prosthesis. The articles that are available, with the exception of Warthman & Martinez, 2021 are over 10 years old, and outdated for the current material available. There is a need in the literature for a simple, replicable prosthesis that can be fabricated quickly for an amputee who is awaiting a permanent prosthetic.

A search of current available HEP templates including those at HEP2go, Hanger Clinic, Amputee Coalition, Arm Dynamics, and review of available resources at my capstone site showed no UE exercise handouts specifically for UE amputees or featuring photos of amputees.
In addition to exercise-based handouts, I wished to create psychosocial handouts, handouts for various therapeutic interventions, and prosthetic training handouts. While there was more information on these topics readily available, much of it was written for the therapist and not the patient. This meant the verbiage and explanations used were written for healthcare professionals and not for the patient. To provide this information to the patient, it needed to be condensed down and re-worded in layman’s terms.

There is little research on the use of an interdisciplinary team, as this is still a novel idea in a very siloed, multidisciplinary health care system. This appears to still be a novel idea and has not been implemented in many care teams. While the VA and MGH have created well-rounded and successful multi-disciplinary care teams, there are no articles citing successes of multidisciplinary care teams within a small clinic setting, rather than a large hospital system. These articles touch on the practices of the care team, there is no evidence of client outcomes in the multidisciplinary care team compared to standard practice of care. However, this may be due to the ethical issue of withholding care to clients. Additionally, there is a lack of evidence showing the use of self/home care and other ADL during prosthetic training (Cancio et al., 2019).

**Needs Assessment**

Based on my review of the literature and interviews stakeholders, I found two main areas of need. The biggest area of need was a lack of educational and HEP resources available to amputees. There is a large amount of education that should be provided to an amputee regarding physical, occupational, mental, and psychosocial areas. However, this information can be easily lost on a patient who is still experiencing shock and pain from their amputation. Not only that, but the OT can also forget to provide information to the patient if it is only provided verbally.
The handouts I created fill the need for physical resources and education for the high amputee caseload my site mentor has.

Another area of need included the gap of time between amputation and receiving a prosthetic device. Part of this process depends on how quickly the patient heals. Once open wounds have sufficiently healed, the process of prosthesis fabrication can begin. Patients are told to expect a 6 week wait from molding to first fitting (Johnson & Mansfield, 2014). My site mentor outlined the need for an inexpensive, easy to replicate thermoplastic prosthesis. She reported prior fabrication but was unsatisfied with the outcome. She also reported difficulty procuring articles for prosthoses she believed would be durable, simple to make, and repeatable.

By outlining and fabricating a novel prosthesis device for a thumb amputee, I increased the functional use of the patient’s hand as he continued to heal and awaited his permanent prosthesis. In addition, my site mentor now has a tried-and-true method of prosthesis fabrication that is easily replicable, modifiable, and durable to repetitive use. This case study will be disseminated to other therapist who can also benefit from the use of this prosthosis.

**Objectives Achieved during Capstone**

1) “By the end of 14 weeks, the student will gain increased knowledge of and proficiency in delivering evidenced based interventions to increase occupational participation and promote appropriate healing for amputees, and those with other upper extremity ailments.”

I Spent first 2-3 weeks shadowing my site mentor’s amputee and general patient caseload. I took extensive notes on evaluation processes, intervention types and education style. I then compared treatment styles and protocols of site mentor, previous Level II educator and past volunteer experiences with hand therapists. Additionally, I read peer-reviewed scholarly articles, blog posts and videos from CHTs for ideas and suggestions for treatments. I began evaluating,
treatment planning, and treating all amputee patients and 80% of my site mentor’s remaining caseload. She provided direct supervision for most patients. This allowed my site mentor to educate me throughout sessions as I needed it. She was available for advising when I had questions before, during and after treatments.

I collaborated with my site mentor to conceptualize, fabricate, and fit a custom thermoplastic and Orficast prosthosis for an amputee I was treating. Read multiple scholarly articles outlining various methods for prosthosis fabrication. My site mentor and I discussed various fabrication and material options. Once the prosthosis was fit for my patient, he completed ADL training with prosthosis donned. I adjusted his prosthosis as needed for functional use and comfort of fit.

I assisted my site in preparation and teaching of three, 4-hour long class sessions for first-year students of Western Michigan University’s Doctor of Occupational Therapy program. I provided hands-on assistance in fabrication of forearm, hand and digital-based thermoplastic prosthetics, answered questions and guided students in completion of in-class assignments, independently taught lecture portions of classes, and independently instructed a make-up class for students.

In addition, I observed multiple surgical procedures both in-office and in the surgery center. Observing these procedures provided a better perspective of the surgical procedures performed for common diagnoses seen by a CHT. The surgeons discussed their clinical reasoning and pointed out anatomical structures. This experience allowed for better understanding and insight into the procedures performed on my patients. This was especially beneficial for the patients I treated in therapy before and after their procedures.
2) “By the end of 14 weeks, the student will gain an increased knowledge and skill set in related surgical procedures and prosthetics for those with an amputation.”

I spoke at length with one of the surgeons discussing potential options for amputation revision surgery on a patient I had been treating in therapy. This patient was a complex case and required additional surgical interventions to promote healing and to prepare for a prosthetic. I had the opportunity to observe my patient’s amputation revision surgery. I now have an increased breadth of understanding of the surgical procedure performed and the anatomy involved. Because I was present during the procedure, I was able to give my patient an in-depth understanding of his procedure and had a better understanding of his healing process than I would have otherwise. I gained a better grasp on the timeline, considerations and surgical interventions that can be required to prepare a traumatic amputee for a prosthetic.

Approximately one time per week, I collaborated with an upper extremity prosthetist. Through this experience, I met a variety of people with amputations and limb differences. I gained a greater knowledge of how prosthetics work, how to conduct prosthetic training and when a referral to prosthetics is needed. I got a better sense and understanding of the different prosthetics currently available, and how they are used.

I assisted the prosthetist and patient in functional use of the prosthetic as appropriate. I observed the prosthetist in the laboratory adjusting and problem solving to allow a better fit and increased functional use for the patient. I also observed and assisted in the molding process of partial hand amputees and the casting of forearm congenital limb differences and amputees. I also gained insight into the insurance processes and considerations when billing for a prosthesis.
3) “By the end of 14 weeks, the student will gain knowledge in creating and researching materials for protocol for amputees at the Hand Center.”

Completed self-directed research of peer-reviewed articles and resources for evidence-based interventions and recommended exercise prescriptions. Compared resources that provided differing information to conclude an optimal exercise and therapeutic activity prescription for HEPs. Reviewed current HEPs offered at capstone site and created additional resources as needed. Reviewed mental health resources for amputees currently available at site and compiled these into a more concise and deliverable resource. Reviewed blogs from amputees and their therapeutic journey. Self-reflection of handouts from level II experiences that would be useful to the amputee population. Email communication with hand therapist at nationally recognized prosthetics group who provided additional ideas for HEPs. Collected ideas through shadowing and later treating amputees for additional resources. Compiled information based on reports and interviews with amputees. Created 16 handouts, reviewed by CHT for accuracy and need. Utilized research collected to complete accurate prescriptions and best practices for handouts. Took photos of amputees, other therapists, and myself to create these novel handouts.

**Implications of Capstone**

The creation of handouts and educational resources for amputees allowed my capstone site to provide better resources to the patient. This in turn should increase the patient’s outcomes. Being skilled in treating amputees is uncommon. My site mentor is in a unique position in west Michigan as she is the foremost expert in treating amputees. The addition of my handouts further reinforces her plan of care with this unique caseload after I am gone.

Prosthetic training is another even more niche area of hand therapy. It requires in-depth knowledge of upper extremity anatomy and physiology, ADL participation, and the specific
settings and type of prosthetic the patient has. I have created handouts for prosthetic training at different levels of amputation for the patient to work on at home. Prosthetic training is completed almost completely in the patient’s free time. I saw quite a few patients that were excited to receive their prosthesis but did not follow through on prosthetic training. With the implementation of a check list, the patient is provided with step-by-step activities to complete. These activities should be a just right challenge for the patient if done correctly. Additionally, this handout holds the patient accountable to prosthetic training and allows the OT to track their progression.

I also completed handouts focused on job boards and resources for returning to work as an amputee and a compiled list of support groups in west Michigan. I created these resources because they encompass the holistic nature of OT. At my site, OT is the only provider that would touch on return to work and social supports. I felt that it was important to compile this information into easy to digest handouts for the patient that wishes to engage in a support group or return to work. My handouts are printed and available to the shared drive at my site as the OT needs them.

My case study, which I hope to publish to a journal, will provide OTs and CHTs with an easy to replicate, comfortable and resilient novel prosthesis template. Once published, the article will hopefully encourage therapists who treat amputees to consider fabricating their own prostheses. It is my hope that this case study will lead to more amputees regaining functional use from their hand faster than ever. At my site specifically, the OT now has a tried-and-true template for creating future prostheses that are comfortable, supportive, and can withstand a strong oppositional grip.

Conclusion
During my capstone experience, I gained a focused knowledge of OT, surgical, and prosthetic intervention for amputees. I had the unique opportunity to follow an amputee from surgery, to treatment, to prosthosis fabrication, to molding and fitting for a permanent prosthetic. This experience gave me a broad interdisciplinary view of amputees throughout their plan of care that I would not have been afforded in a level II experience. It allowed me to explore health care intervention outside of OT treatment. I utilized this great knowledge to guide my educational handouts, case study, and enrich my treatment sessions.

I learned just how important it is to collaborate and communicate with other members of the patient’s care team. Learning from other perspectives and frames of reference allowed me to grow as an OT. I wish I had more time to continue to gain information for my case study, both by having another patient to create a prosthosis on and to gather continued data on my case study’s compliance and use of the prosthosis. I think this would be a good future direction to go with a future student or for my mentor.

In the appendices below, I have attached the educational resources and HEPs I created for amputees and the general patient caseload at my site. I have also attached a copy of the prosthosis case report that I hope to publish to a journal. Finally, I have compiled an excel spreadsheet of the amputee patients I treated and observed during my capstone. The spreadsheet gives a synopsis of their diagnosis, what we focused on in therapy, and if they received a prosthetic.
References


## Appendix

### Excel spreadsheet of amputee caseload

**Resources and HEPs**

**Prosthosis case study**

### Amputee Caseload

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Diagnosis</th>
<th>OT Eval Date</th>
<th>IT Discharge Date</th>
<th>Treatments</th>
<th>Amp Clinic?</th>
<th>Injury</th>
<th>Mechanical Injuries</th>
<th>Surgeon Performed</th>
<th>Surgeon</th>
<th>Prosthesis</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB</td>
<td>24</td>
<td>R Rhumb amputation</td>
<td>9/9/2022</td>
<td>2/7/2023</td>
<td>Diabetic, STM, Pinch grasp, AROM, PROM, desensitization, functional use, mirror box therapy, ultrasound, strengthening, prosthesis training, pre-prosthetic training</td>
<td>Y - March 2023</td>
<td>Work crush injury</td>
<td>11/23/22 Revision amputation of right thumb with local flap coverage, Digital neurotomy. 2/8/23 Excision of PREPARATION OF FIT THUMB WOUND, 2 CM's EXCISION OF FLAP NEUROVASCULAR ISLAND PEDICLE FLAPFULL - THICKNESS SKIN GRAFT TO THE DORSAL RIGHT INDEX FINDER, 2.5 x 15 CM, PLANTAR SPACE DEEPING WITH FOUR- LAY FLAP PLASTY. ADJACENT TISSUE TRANSFER, 1.5 x 15 CM</td>
<td>Tar Louis</td>
<td>Prosthetics</td>
<td>Fabricated prosthesis for patient. Molded for prosthesis. Mid-march for 3-4 months. Printed temporary prosthesis. Likely require additional extracorporeal prosthesis. Before swelling subsides, procedure in may/june before permanent prosthesis can be fitted.</td>
<td></td>
</tr>
<tr>
<td>AP</td>
<td>62</td>
<td>R Transradial amputation</td>
<td>9/9/2022</td>
<td>1/3/2023</td>
<td>Exercise wound care, patient and caregiver education, assistance with housing and work programs, edema management, decongestion, mirror therapy, pre-prosthetic training, prosthesis training, hand dominance training</td>
<td>Yes - January-March 2023</td>
<td>Head/neck, shoulder, elbow 25 min</td>
<td>7/12/22 Cuff and ulnar, tendon repair and vein placement 7/12/22 Pedal artery repair 7/29/12 Amputation and repair placement after getting 4/23/23 Excision of right ulnar neuraxis, repaired muscle reinsertion, (pedicle nerve transfer)</td>
<td>Olaic</td>
<td>Yes-o</td>
<td>Yes-o</td>
<td>Struggled with abuse and domestic violence after amputation. Now lives with his brother and is back into own housing. Works on a farm again.</td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>Diagnosis &amp; Procedure</td>
<td>Date(s)</td>
<td>Cause</td>
<td>Procedures/Notes</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GC</td>
<td>63</td>
<td>Left F and R F: SF</td>
<td>2/7/2023</td>
<td>Unknown</td>
<td>Yes - myoelectric arm and fingers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: KJ needs a myoelectric prosthesis.*

**Continued to require prosthetic adjustments due to weight loss.**

- Hanger Clinic peer support person.
- Social worker: Volunteer for MDA amputee clinic.
<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Date of Injury/Amputation</th>
<th>Active Status</th>
<th>ARCOM, PRON, and PROM:</th>
<th>决策</th>
<th>Additional Treatment</th>
<th>Decision/Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>RV</td>
<td>63</td>
<td>3/18/2023</td>
<td>Active Patient</td>
<td>AROM, PROM, debulking, patient education, manual therapy, edema management and shaping of digits</td>
<td>Yes, March 2023</td>
<td>Revision amputation of the middle finger at the IP joint with digital neurotomy.</td>
<td>Ter Lour, Not currently interested at this time</td>
</tr>
<tr>
<td>NH</td>
<td>70</td>
<td>10/19/2022, 6/19/2023</td>
<td>Active Patient</td>
<td>AROM, PROM, debulking, patient education, manual therapy, edema management and shaping of digits</td>
<td>No, Failed graft and failed first digit</td>
<td>Revision amputation and RLF Finger release.</td>
<td>Ter Lour, Not currently interested at this time.</td>
</tr>
<tr>
<td>AS</td>
<td>63</td>
<td>3/25/2023</td>
<td>Active Patient</td>
<td>AROM, PROM, debulking, patient education, manual therapy, edema management and shaping of digits</td>
<td>No, Failed graft and failed first digit</td>
<td>Revision amputation of the left middle finger at the IP joint with digital neurotomy.</td>
<td>Ter Lour, Not currently interested at this time.</td>
</tr>
<tr>
<td>JC</td>
<td>45</td>
<td>3/19/2023</td>
<td>Active Patient</td>
<td>AROM, PROM, debulking, patient education, manual therapy, edema management and shaping of digits</td>
<td>No, Failed graft and failed first digit</td>
<td>Revision amputation and RLF Finger release.</td>
<td>Ter Lour, Not currently interested at this time.</td>
</tr>
<tr>
<td>ME</td>
<td>47</td>
<td>4/4/2023</td>
<td>Active Patient</td>
<td>AROM, PROM, debulking, patient education, manual therapy, edema management and shaping of digits</td>
<td>No, Failed graft and failed first digit</td>
<td>Revision amputation of the left middle finger at the IP joint with digital neurotomy.</td>
<td>Ter Lour, Not currently interested at this time.</td>
</tr>
</tbody>
</table>
2) Resources and HEPs

Post-Amputation Tips and Tricks

- **Posture:** be mindful of your shoulder, elbow, and wrist position regardless of level of amputation; this can lead to sore muscles and issues such as tendonitis (inflammation of tendons), rotator cuff injuries, and epicondylitis.

- **Joint Protection:**
  - Use your entire hand, palm, and arm as possible to lift items.
  - Use two hands to carry/lift.
  - Avoid heavy gripping for prolonged periods of time.
  - Slide or roll items when possible instead of carrying them.
  - Utilize built-up handles for items such as pots/pans, kitchen tools, toothbrush, and writing utensils to protect finger joints.
    - Use tape, foam, or a cloth to build-up handles.
  - Pick up cups and glasses with entire palm, use two hands if necessary.
  - Avoid holding items for long periods of time, such as when reading a book.
  - Use Dycem or a silicone jar opener when opening twist off containers.

- **Energy Conservation:**
  - Be prepared to tire quickly during activities during your recovery.
  - Plan your daily tasks ahead of time. Start with the most physically taxing activity, followed by less difficult tasks. Take breaks as needed.
  - Gather all items to your workstation before beginning a task.
  - Use electric tools in the kitchen and when competing housework as able.

- **Skin Checks:** it is important to check your residual limb daily to ensure no skin wounds or infections are present. Many times, sensation is limited in a residual limb after amputation, and you may not feel a cut or infection. Use a mirror if the site is not easily visible.

- **Phantom Sensation:** 60-80% of amputees suffer from phantom sensation. This can include feeling an itch, hang nail, discomfort, etc. on the fingers or arm that no longer exists. This can be treated with “graded motor imagery.”

- **Skin tightness:** After amputation, skin may be sutured tightly over remaining bone. If you feel tightness at the tip of your amputation, push skin towards the tip of your finger with long, gentle strokes. Complete 2-3 times per day until the tightness subsides.
• **Swelling**: edema of the residual limb and surrounding tissues is normal during the healing process. It is important to remove the excess fluid out of the residual limb to allow for appropriate healing and motion. This can be combated by compression garments such as compression gloves, compression sleeves (Tubigrip), digit caps, Coban wrapping, elevation above heart level, Kinesiotape, ice, pumping fingers (if applicable).

• **Residual limb changes**: over the first year, your limb/ fingers will continue to change shape and size. This is normal, but may mean adjustments need to be made to your prosthesis (if applicable). Years 2-3, your body will begin to stabilize in shape and size.

• **Sensation Changes**: whether your amputation was traumatic or surgical, it is common to have had cut or inflamed nerves. Because of this, you may be hypersensitive to temperature, pressure and various textures.
  - Be mindful of your residual limb when placing it under hot water – test temperature with your other hand first
  - Ensure your hand is properly covered in cold weather- you may not feel frostbite coming on
  - Hypersensitivity is normal- alert your therapist if you feel overly sensitive to touch, temperature, textures, etc.

• **Complications**: While uncommon, complications can occur after an amputation. Things to be aware of include:
  - Necrotic tissue: Hard, thick tissue black in color
  - De-hissed tissue: opening along the suture line due improper closure, edema, or other factors
  - Blisters: blisters can form from pressure points from laying in bed to a prosthetic that does not properly fit
  - Improper blood circulation: limb looks ashy and gray in color, cold to the touch
  - Infection: redness, excessive warmth, fluid or pus discard
  - Neuroma: highly sensitive nerve tissue

If you notice any of these symptoms, contact your doctor immediately.
Returning to Daily Activity

Sites such as YouTube, Arm Dynamics, Amputee Coalition, and Hanger Clinic are all great resources for videos and more information of specific activity modifications for your prosthetic. Suggestions listed may or may not work for you, depending on the type of amputation and prosthesis you have and your specific wants or needs. Feel free to trial what does and does not work for your lifestyle.

Hand dominance:
- If your dominant hand is affected, you may find switching to utilizing your non-dominant for fine motor activity and strength easier.
- Even if you choose to use a prosthesis, it will not have the fine control or strength of your natural hand. Many amputees use their prosthetic as a support and stabilizer rather than as their dominant hand.

Training your non-dominant hand:
- The more you practice, the easier it is to utilize your non-dominant hand. It is normal to feel uncoordinated during this time. Give yourself extra time to make meals, get dressed, etc.
- Watch yourself in a mirror or have someone record you when possible, to allow for you to self-correct any abnormal body movements or postures.
- Think through how you would do actions with your dominant side. Sometimes miming the action or copying someone else’s movement can help you remember how to complete an action.

Driving:
- Discuss return to driving with your doctor, therapist or prosthetist
- You need to report your injury to the Secretary of State’s Office. They will instruct you on the steps needed to continue to drive legally.

Travel:
- On the day of travel, allow yourself extra time to get through TSA.
- Inform TSA you have a prosthetic device.
- All prostheses are allowed on airplanes and through TSA. The agent may need to see or touch your prosthetic but should never ask you to remove it.
- When you go thought the security line you may keep your prosthesis on. If you wish, you can voluntarily remove your prosthesis for X-ray screening. TSA will likely need to swab your prosthesis to collect an explosive trace sample. This can be done in a private room per request or in the open.

Getting Dressed:
- Try placing a plastic bag over your prosthesis before putting your shirt on if it is difficult to get sleeves over your prosthesis
- Adapt your lace-up shoes with elastic laces to avoid having to tie your shoes.
- Adaptive clothes can be purchased from sites such as Tommy Hilfiger, Land’s End, and JC Penny.
• Talk to your local tailor. They may be able to adapt your current clothes with Velcro and magnets instead of buttons, add elastic loops to pants to help slide them up, open arm holes to aid in donning your prosthetic, and other creative options to make dressing easier.

In the kitchen:
• For difficult to open jars, try wedging the edge of a spoon between the jar and lid and push down on the spoon handle. This should break the initial seal and become easier to remove.
• Purchase pre-cut food when able. Restaurants are happy to cut food in the kitchen before serving you.
• Wear an oven mitt over your prosthesis/ residual limb when using it to hold onto warm objects to avoid burning.
• Try using a pizza cutter as an alternative to using a standard knife.
• Re-organize your kitchen if you have difficulty reaching frequently used items due to their weight or height.
• Use a spatula to gather chopped items.
• Dycem is a sticky surface that aids in gripping jars, cups, and utensils. It also can be used to stabilize mixing bowls:
  o Have various options, including placemats for stabilizing plates, bowls, etc. as well as bottle openers, and rolls that can be cut to size for various uses.
• Adaptive items:
  o Electric salt and pepper grinders, Electric can openers, Pump soap bottles
  o OXO “POP” good grips containers- only require one limb to open
  o OXO brand has many options for those who need items with larger handles and good grip
  o One-handed rolling pins
  o “Etac Delux one-handed paring board”
• Wear an oven mitt over your prosthetic when using it to hold onto warm objects to avoid burning/ damaging the prosthesis.
• Try using a pizza cutter as an alternative to using a standard knife.

In the Bathroom:
• Use pump bottles rather than squeeze bottles for soap, shampoo, etc.
• Try liquid soap or “soap on a rope” rather than slippery bar soap.
• Use a wash mitt to aid in washing your body.

Electronic Use:
• Use a stylus for touch screens. Place in a universal cuff if needed.
• Universal hand clip to go around arm to hold cell phone.
• “Kensington expert trackball” mouse.
Post Amputation Job Resources

Resources for Re-Entering the Work Force:

- **Michigan Rehabilitation Services:**
  - Services for students (14-26), young adults, and adults with disabilities. Aid people in finding and holding a job as well as assisting those employ people with disabilities.
  - Michigan Career & Technical Institute: “an educational center for adults with disabilities offering career assessment and exploration and 13 trade training options”
    - https://www.michigan.gov/leo/bureaus-agencies/mrs

- **Career One-Stop:** resources for gaining skills, searching for a job, how to interview, when to disclose your disability, job accommodations, and vocational rehabilitation
  - careeronestop.org/resourcesfor/workerswithdisabilities/workers-with-disabilities.aspx

- **Job accommodation Network:** “The leading source of free, expert, and confidential guidance on workplace accommodations and disability employment issues”
  - askjan.org

- **National AgrAbility Project:** “The vision of Agrability is to enhance quality of life for farmers, ranchers, and other agricultural workers with disabilities”
  - agrability.org

Job boards:

- **AbilityJOBS:** “Largest job site for people with disabilities”
  - Abilityjobs.com

- **Chronically capable:** “leading the flexible work revolution for job seekers with chronic illnesses and disabilities”
  - Wearecapable.org

- **Disability Solutions:** “Changing minds and changing lives through disability & Inclusion”
  - Jobs.disabilitytalent.org

- **Galt:** “non-profit employment company that matches great organizations with motivated employees”
  - Galtfoundation.org
Post-Amputation Support

The Grieving Process:
- Grief is a normal reaction to the loss of a limb or finger(s). Some people feel grief immediately and some may feel grief later.

There are 5 stages of Grief:
- Denial - “This isn’t happening to me”
- Anger - “Why is this happening to me?”
- Bargaining - “If only I hadn’t gone to work that day, I would be normal.”
- Depression - “I’ll never be okay again.”
- Acceptance - “In some ways, my life is now better.”

- Some stages last longer than others, but it is important not to get “stuck” in one stage
- These stages can occur in any order, some at the same time, and can re-occur at a later date

Important things to remember:
- Exercise: regular physical activity can aid in physiological healing. People are more likely to have positive self-image when they are active.
- Sleep: maintaining regular sleep is important. Without it, your circadian rhythm will be impacted which leads to the sense of withdrawal and depression

Support Groups:
- National Amputee Support Groups:
  - AMPOWER - peer support, education and community events empoweringamputees.org
  - Amputee Coalition - group and 1-on-1 peer support amputee-coalition.org
  - Naked Prosthetics Finger and Digit Support Group Facebook: fingerandpartialhandamputees

- Local Amputee Support Groups:
  - Corewell (formerly Spectrum Health)/ Hanger Clinic limb loss meet-up - Grand Rapids Contact Corewell Inpatient Rehabilitation center at 616-774-8170
  - Great Lakes Amputee Network - Grand Rapids Contact Stephanie Rose at 616-591-8980, stephanie.rose@maryfreebed.com
  - U-CAN: University of Michigan Community Amputee Network: Meets virtually and in-person Contact Brittany Shupe-Sawyer/ Carla Vollmer at 734-975-7432, cyollmer@med.umich.edu

- Rehabilitation Psychology: Therapists who work with clients who have a disability from illness or injury. Discuss with your OT or surgeon if you would like to receive a referral for psychological treatment
  - Mary Free Bed
  - Trinity Health Life Counseling

Edema management & Shaping- Finger(s)

The goal of edema (swelling) management and limb shaping is to prepare the area for the prosthesis and normal range of motion.

- Compression is worn as tolerated, up to 24 hours/day and removed for massage and hygiene.
- Compressive garments should be long enough to extend down entire finger to avoid trapped fluids.
- Elevate entire arm above heart level whenever possible and apply ice.

External Compression/ limb shaping:

- “Silipose digit caps”- Amazon. Help to form a rounded, more natural looking tip
- “Roylan compression gloves”- Amazon. For swelling over entire hand
- Apply external compression such as coban wrap, compression gloves or digit caps to help decrease swelling.

Coban Wrapping: always apply a constant 20% stretch during wrapping. Avoid inconsistent layers and variable amount of stretch

1. Begin with a tail on the back of your remaining finger. Wrap coban diagonally across the top of the finger.

2. Loop coban around to connect to the tail end.

3. Complete ½ wrap around finger, then cross diagonally the other direction across the top of the finger.

4. End by wrapping coban with ½ overlap down length of finger to secure.


**Edema management & Limb Shaping-Arm**

The goal of edema (swelling) management and limb shaping is to prepare the area for a prosthesis.

- Compression is worn up to **24 hours/day** and removed for hygiene, massage, and exercise.
- Compression should be long enough to extend 2/3 down arm to avoid fluid pockets.
- Elevate entire arm above heart level whenever possible and apply ice.
  - Retrograde massage – only complete upward movements, towards shoulder
  - Apply a light layer of lotion to hand/arm and if able, position arm above heart level
  - Complete entire cycle, **1-2 times per day. Complete ten of each movement:**

<table>
<thead>
<tr>
<th>1. Make half circles into armpit on affected side</th>
<th>2. Make half circles into crease of elbow on affected side</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
</tr>
<tr>
<td>3. (If applicable) Lace fingertips of both hands together and push down towards palm</td>
<td>4. Using moderate pressure, stroke swollen fingertips with unaffected hand down towards the palm</td>
</tr>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
</tr>
</tbody>
</table>
___ Compression

- Apply compression sleeves such as Tubigrip, a shrinker, or Compressogrip (usually provided by therapist or prosthetist)
- Putting on compression sleeves:
  - Apply sleeve so half the length is on arm
  - Twist sleeve one complete rotation so it better fits the stump
  - Flip sleeve inside out and slide up arm
  - Double layer of material is worn with the top layer ending 2 inches below bottom layer
  - **Forearm stump:** Sleeve should end 3+ inches above the elbow
  - **Above elbow stump:** sleeve extends as high as possible on the arm and strapped across the chest to secure it

- Compression sleeves should be as smooth and flat as possible to avoid pooling of fluids
- Once wound is fully closed, a silicone liner provided by a prosthetist is used for compression and to minimize scar.
- Goal: to be independent in taking on and off compressive garments
Isometric Exercises - Post Amputation

Repeat 10 times per set. Hold for 10 seconds. Do 1 set per session. Do 1-2 sessions per day.

For each exercise, place a folded towel between your arm and a corner wall.

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shoulder Extension</strong></td>
<td>Gently press your elbow back against the wall/towel. Hold, relax and repeat.</td>
</tr>
<tr>
<td><strong>Shoulder Flexion</strong></td>
<td>Turn shoulders to face towards wall. Gently push your arm straight forward with your elbow straight. Hold, relax and repeat.</td>
</tr>
<tr>
<td><strong>Internal Rotation</strong></td>
<td>Gently press the palm side of your arm towards a wall. Maintain a bent elbow the entire time. Hold, relax and repeat.</td>
</tr>
<tr>
<td><strong>External Rotation</strong></td>
<td>Gently press your hand into a wall using the back side of your arm. Maintain a bent elbow the entire time. Hold, relax and repeat.</td>
</tr>
<tr>
<td><strong>Shoulder Abduction</strong></td>
<td>Face shoulders straight ahead with the wall to your side. Gently push your arm out to the side into the towel/wall. Hold, relax and repeat.</td>
</tr>
</tbody>
</table>
## Amputee Shoulder Strengthening

Repeat 10 times per set. Do 1 set per session. Do 1-2 sessions per day

### Rotator Cuff Exercises

Perform the following movements while maintaining the shoulder blade back and slightly down. Hold for 3 seconds:

<table>
<thead>
<tr>
<th>Arms straight down at side (I position)</th>
<th>Arms straight out (T position)</th>
<th>Arms overhead (Y position)</th>
<th>Arms bent at elbow (W position)</th>
</tr>
</thead>
</table>

### Shoulder Flexion

Laying on your side, start with hand at your hip. Keeping your arm parallel to the ground, bring hand up past your head, then slowly bring back down.

### Scapular Depression/Elevation

While sitting up straight with good posture, push your shoulders down and hold 5 seconds. Relax and repeat. Bring shoulders up towards ear and hold 5 seconds. Relax and repeat.

<table>
<thead>
<tr>
<th>Start</th>
<th>End</th>
</tr>
</thead>
</table>

---
**Elbow Flexion/ extension**

Sit up straight with good posture. Bring shoulder up to 90 degrees. Next, bend elbow towards trunk and hold for **2-3 seconds**. Straighten elbow and hold for **2-3 seconds**. Repeat.

**Shoulder External Rotation**

Lie on unaffected side. Place small towel rolled up under elbow. Next, move your forearm and hand from the ground towards the ceiling as shown. Lower back down and repeat.

**Pectoralis Stretch**

While standing in a doorway, place your arms up on the door frame and lean in until a stretch is felt along the front of your chest and/or shoulders. Your upper arms should be placed upward along the door frame. NOTE: Your legs control how much you stretch by bending or straightening your knee through the doorway.
Taking Care of Your Prosthesis

At the end of each day:

- Clean device to the best of your ability following the instructions from your prosthetist and below
- Position the hand/ terminal device in an open position with the batteries removed and charging, or the device plugged in.

Cleaning:

Socket:

- Clean daily with soap and water. Use a scrub brush or compressed air to remove dust/debris.
- Wipe out with clean, damp cloth to remove soapy residue and dry thoroughly. **DO NOT** pour water into socket.
- Rub or spray with alcohol daily to avoid bacterial build-up.

Myoelectric Devices:

- Avoid submerging/ leaving the device in water. Getting moisture in and around the charging port or battery could destroy the device

Glove:

- Clean the cosmetic glove daily or when soiled with a damp cloth. Avoid immersing in water.
- Inspect the cosmetic glove daily for worn or frayed areas, loose components, cable issue or other problems with your prosthesis. If there is an issue, contact your prosthetist as soon as you can.
  - If you do have a cut in your glove, be careful around water, other liquids, sand, dirt, and other debris

Harness:

- Clean harness in soapy water and rinse in water daily. Air dry.

Precautions and Reminders:

- Do not submerge your prosthetic underwater as it can damage the battery and electrical components. Remove the prosthetic for activities such as swimming, bathing, fishing etc.
  - The glove can come in contact with water, such as when washing dishes.
- Avoid excessive vibration activity, sand and dirt, and prolonged exposure to hot and cold (below 32F and above 80F)- Don’t leave in car
- Discuss with your prosthetist further precautions for your device such as weight restrictions, durability, etc.
- Regular maintenance is crucial- your prosthetic is like a car. It needs maintenance to ensure it works properly for years to come.
- Keep the prosthetic away from pets and young children who could destroy your prosthesis or injure themselves.
- Don’t try to modify your prosthetic yourself. If you need adjustments to be made, contact your prosthetist.
Prosthesis Wear Schedule

Daily Skin Management:

- It is important to complete throughout skin checks every time your device is removed to avoid skin breakdown, infection, and sores
  - If redness persists for more than **20 minutes** after device removal, contact your prosthetist
  - Report bruising, scabbing, and blisters to your prosthetist
- It is important to monitor skin during the first month of prosthesis wear.
- Apply lotion before bed to keep skin from drying out. Avoid Vaseline and other petroleum-based moisturizers as they can damage the devices’ liner
  - It is best to have no products on your skin before donning your prosthetic to ensure proper fit
- Make sure your arm/ hand is completely dry before donning prosthetic to decrease bacteria build-up
- Donning your prosthetic should come with some resistance. If it is too hard or too easy to put on, the fit may not be right
  - Wet fit: apply liberal amount of hand sanitizer to help slide the skin into the prosthetic
  - Dry fit: apply baby powder to help slide the skin into the prosthetic

Wear schedule:

- If no redness or skin breakdown is present, progress as tolerated following this outline:

  - **Day 1:** 3x/day 30 min or 1.5 hours/ day
  - **Day 2:** 3x/ day 45 min or 2.25 hours/day
  - **Day 3:** 3x/day 60 min or 3 hours/ day
  - **Day 4:** 3x/ day 90 min or 4.5 hours/day
  - **Day 5:** 3x/day 2 hours or 6 hours/day
  - **Day 6:** 3x/day 2.5 hours or 7.5 hours/day
  - **Day 7+:** 8 or more hours/ day


Digit/Partial Hand Prosthesis Training - Activity checklist

- Maintain good, upright posture with back straight throughout exercise
- Practice the motion with your unaffected side first. Try to copy it with your prosthesis.
- Try using your prosthesis in the mirror. Watch for shoulder hiking, and unnatural arm positions
- Try using your prosthesis as the dominant hand and as the supporting hand to find what works best for you for activities that use both hands.
- Adjust the position of the prosthesis before you adjust your body when completing activities
- it is important to practice using the prosthesis daily. Control will improve over time with practice. It is normal to feel frustrated and tire quickly. Take frequent rest breaks.
- Only move to the next phase when you are successful in each activity 50% of the time of better

Phase 1

☐ Take off and put on prosthesis

☐ Make a fist and open hand

☐ Perform each pinch pattern (tip, three-point, key pinch) – 10x

☐ Switch between pinch patterns and hook & full fist (if applicable)

Phase 2:

☐ Pick up soft item and practice different amount of squeeze (Styrofoam cup / yellow sponge/ pom poms)

☐ Transfer item from one hand to the other

☐ Stack wooden blocks

☐ Ball pick up-bouncy ball/ golf ball size

☐ Marble pick up

☐ Full jar/ container pick up

☐ Clothespin pinch

☐ Move items from tabletop height to overhead and lower level shelves

☐ Pick up book and place vertically on shelf

Phase 3:

☐ Cut food with fork and knife

☐ Tie shoelaces

☐ Zip jacket

☐ Stir food in bowl

☐ Fold towels
☐ Open and close different size and style containers
☐ Put pillow in pillowcase
☐ Shuffle cards

☐ Scoop beans into plastic bags

☐ Screw with screwdriver

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**Phase 4:**

☐ Meal preparation

☐ Washing/drying dishes

☐ Leisure goal:

☐ Work goal:

☐ self-care goal:

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Below/Above Elbow Prosthesis Training- Activity Checklist

- Maintain good, upright posture with back straight throughout exercise
- Practice the motion with your unaffected side first. Try to copy it with your prosthesis
- Try using your prosthesis in the mirror. Watch for shoulder hiking, and unnatural arm positions
- Adjust the position of the prosthesis before you adjust your body
- It is important to practice using the prosthesis daily. Control will improve over time with practice. It is normal to feel frustrated and tire quickly. Take frequent rest breaks.
- Only move to the next phase when you are successful in each activity 50% of the time of better
- “Pre-positioning is placing each prosthetic joint in the most optimal position before initiating grasp and release”
  - This helps minimize the potential for overuse injuries, compensatory motions, and wear and tear at the shoulder and trunk

### Phase 1

**Device:**

- ☐ Put on and take off prosthesis

**Terminal Device:**

- ☐ Remove and replace terminal device from socket
- ☐ Power on and off the terminal device, if applicable
- ☐ Open and close the terminal device

***Wrist:***

- ☐ Complete wrist ROM- flexion/ extension, rotation
- ☐ Power on and off the terminal device, if applicable
- ☐ Open and close the terminal device
- ☐ Mimic arm positioning at various heights (tabletop while seated, tabletop while standing, standing from the floor, overhead standing)

***Elbow:***

- ☐ Turn elbow on and off
- ☐ Lock and unlock elbow
- ☐ Raise and lower elbow
- ☐ Adjust forearm lift assistance/automatic forearm
**Shoulder:**

☐ Lock the shoulder

☐ Unlock the shoulder for free swing motion

☐ Unlock the shoulder, move into desired position and lock.

**Composite:**

☐ Mime the shape of 5 letters of the alphabet with the shoulder, lock elbow, open terminal device, unlock elbow, repeat

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**Phase 2:**

☐ Prepositions shoulder/elbow/wrist/terminal device

☐ Ball pick up-bouncy ball/ golf ball size

☐ Pick up soft item and grasp (Styrofoam cup / yellow sponge/ pom pons)

☐ Marble pick up

☐ Transfer item from one hand to the other

☐ Full jar/ container pick up

☐ Stack wooden blocks

☐ Clothespin pinch

☐ Move items from tabletop height to overhead and lower level shelves

☐ Pick up book and place vertically on shelf

---

**Phase 3:**

☐ Cut food with fork and knife

☐ Tie shoelaces

☐ Zip jacket

☐ Stir food in bowl

☐ Fold towels

☐ Open and close different size and style containers

☐ Put pillow in pillowcase

☐ Shuffle cards

☐ Scoop beans into bags

☐ Screw with screwdriver
Phase 4:

☐ Meal preparation
☐ Washing and drying dishes
☐ Leisure goal:
☐ Work goal:


Home Desensitization Program

After a surgery or traumatic amputation, you may have areas of the skin that feel too sensitive. Desensitization programs help to decrease this overly sensitive area, and help it feel normal again. Overtime, this program will become more tolerable and the pain responses decrease. If considering a prosthesis, this process will allow for a more comfortable fit. It is normal for this process to be uncomfortable. The more consistently you complete this program, the less painful it should become.

___Massage:

- Complete 2-5 minutes of massage on the affected area with consistent direction, speed and pressure until numbness occurs
- Complete at least 3 times per day – the more the better
- Begin with a texture that is irritating, but tolerable
- After 1-3 weeks or as tolerated, progress to a rougher texture
- Continue to progress textures until area is no longer sensitive, which can take around 6 weeks

Texture Progression:

- **Soft**: silk, cotton linen, cashmere, cotton balls, makeup brush
- **Medium**: wool, course towel, jeans, self-massage with lotion, paint brush
- **Rough**: Velcro, zippers, canvas, corduroy, hairbrush/ comb, dry sponge

___Particle Bins:

- Add particles to a container that is large enough to cover the sensitive area
- Complete 2-5 minutes of submersion of the affected area, moving it around until numbness occurs
- Complete at least 3 times per day – the more the better
- Begin with items that are irritating, but tolerable
- After 1-3 weeks or as tolerated, progress to a rougher texture
- Continue to progress textures until area is no longer sensitive, which can take around 6 weeks

Particle Progression:

- Cotton balls/ pom poms, wax beans, buckwheat/Quinoa, uncooked rice, dry beans, plastic beads

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Graded Motor Imagery

Left/right discrimination, graded motor imagery, and mirror therapy are used together to help decrease phantom limb sensations.

___Stage 1: Left/ Right Discrimination Training: People in pain take more time to tell left and right body parts from one another. Practicing this has been linked to decreased pain levels.

Complete at least 2x per day for around 10 minutes

- **Tools:**
  - Orientate App for phone/tablet
  - Recognize App for phone/ tablet or Recognize flash cards
  - Photos of left and right arms/ hands in different positions from online data bases or magazines

- **Goals:**
  - Accuracy of 80% or higher
  - 2 second or less reaction time
  - Consistent results for at least one week

___Stage 2: Explicit Motor Imagery: 25% of our brain consists of “mirror neurons.” By simply imagining yourself completing an activity pain-free, it turns on the same areas in your brain that work when you move your painful body part.

Complete at least 2x per day for around 10 minutes – this activity can trigger pain or fear, do what you can, and take a break if it is too difficult or emotional

- Find a comfortable, quiet place to complete this task. Close your eyes, or keep them open
- Think of yourself (not someone else) completing tasks you enjoy, with no pain, and your hand/ fingers fully intact. **Do not move your body, just imagine moving.**
- Try imagining activities that use both hands, and those that just use your affected side
Mirror Therapy

Using a mirror in front of your painful hand while only moving your healthy hand makes it look like you have two healthy hands moving without pain. This tricks your brain into thinking you have two healthy hands, which helps decrease pain and phantom sensations. The visual of two intact extremities may be difficult to accept. Take your time and go slow.

- Remove jewelry (bracelets/ rings), and try to cover tattoos or scars
- Try to set up in a low-traffic area with minimal people
- Position both hands in the same way (if residual limb feels like it is in a fist, make a fist)
- End session if hand behind mirror hurts or is sweaty

Tools:
- “Travel folding mirror” or “mirror box” on Amazon or Google for finger or partial hand amputees – any mirror that can cover your affected side
- Full length mirror for forearm or higher-level amputees

Exercises: Complete 15 min/day, 5 days/week for 4-8 weeks – 12 sessions to see change

**Finger amputation:**
1) Begin with watching your hand rest in the mirror, allowing your brain to take in the image
2) Slowly bend and straighten fingers of the healthy hand only
3) Make a fist and straighten fingers of both hands
4) Bend and straighten fingers at their different knuckles one finger at a time on both hands
5) Complete “tendon glides” with both hands
6) Touch thumbs to fingertips on both hand
Partial hand amputation:
   1) Follow “finger amputation exercises”
   2) Bend wrists forward and back and side to side

Forearm amputation
   1) Follow “finger amputation exercises”
   2) Bend wrists forward and back and side to side
   3) Flip palms up and down on both hands

Above elbow amputation:
   1) Follow “finger amputation exercises”
   2) Bend wrists forward and back and side to side
   3) Flip palms up and down on both hands
   4) Bend and straighten elbow
   5) Trace alphabet with arm to move shoulder
It is important to begin scar massage after your scar has closed, scabs have healed, and is not at risk of opening. As your scar heals, it grows like a root system. These roots can attach to important structures such as tendons and nerves, which can lead to complications. Scar massage helps break up these roots before they attach to structures below, as well as decrease pain and form a flat, less noticeable scar. It is normal to have some discomfort when completing scar massage, which should go away over time.

- Be gentle over skin grafts, flaps, slow-healing areas and with tight scar over bone
- Apply sunscreen over scar line of SPF 30+ for at least the first summer after surgery. The skin is fragile and can burn easily, leading to more scarring
- Using a can, rolling pin, massage ball or golf ball can aid in breaking up tough scar tissue
- Dycem can be used to help better grip the scar

**Scar Massage:**

- **Complete 2-5 minutes 5 times per day as tolerated**
- Compare the scar and tissue around it to the same body part of the unaffected arm. How does the skin feel different?
- Utilize a small amount of lubricant (lotion, coconut oil, scar cream- vitamin E oil not recommended) to avoid discomfort from rubbing, but not so much that you are unable to “grip” the scar.
- Apply firm pressure with the pad of your fingers to secure the scar tissue under your grip
- Glide the top layer of skin (or, if you can feel it, the scar tissue) **slowly** in circles (A), up and down (B), and left and right (C)
- Once the scar is mobile enough, gently pinching up the tissue helps to further break the bonds of the scar

![Diagram of scar massage](image)


Thumb CMC Joint Strengthening

*Complete at 40-50% of Maximum pain-free effort*

Complete 10-15 repetitions of each exercise, holding for 5 Seconds. 1 time per day

Hold tennis ball in hand with gentle grasp, focusing it on touching all parts of the hand. Note thumb positioning. The goal is to have the thumb in a natural arc position. This helps support joint properly for the next two exercises.

<table>
<thead>
<tr>
<th>Collapsing Joint</th>
<th>Properly supported Joint</th>
</tr>
</thead>
<tbody>
<tr>
<td>After years of overuse, arthritis causes the joints to collapse, called a “Z formation”</td>
<td>Holding a tennis ball gives the joint proper support</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thumb Roll</th>
<th>Finger Lift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keep supported grasp on ball. Lift index and middle finger off ball into “bunny ear” position. Keeping pad of thumb on ball, roll thumb left and right as if trying to touch the outside edges of the nail.</td>
<td>Keep supported grasp on ball. Lift index finger off of ball, so it is pointing straight out. Without dropping finger, bring it to the side towards the thumb and back</td>
</tr>
</tbody>
</table>
4) *Prosthesis case study*

**Temporary Prosthesis for a Thumb Amputee Awaiting a Prosthetic Device: A Case Study**

Amanda Fox, Doctor of Occupational Therapy Student

Department of Occupational Therapy, Western Michigan University

April 2023
Abstract

Study Design: Case Study

Introduction: Hand therapists have the expertise to treat upper extremity amputations and possess a unique skillset making them well equipped to promote participation in ADL. This includes knowledge in orthosis fabrication, post-surgical healing timelines, activity modification and adaptation.

Purpose: The purpose of this case study is to assess the feasibility and replicability of fabricating a thermoplastic prosthosis for a thumb amputee as an interim while awaiting a permanent prosthesis.

Methods: Observation and self-report from patient of his ability to participate in ADL with and without the prosthosis donned.

Results: A simple, replicable, and effective prosthetic template and guide was created utilizing supplies commonly found in a hand clinic. The patient demonstrated increased ability to functionally use of his right hand and thumb for opposition and prehension. He reports increased ability to utilize hand for picking up items, preparing food, and completing household chores such as sweeping, mopping, and dusting.

Discussion: A prosthosis is beneficial for partial hand amputees with a variety of needs. A prosthosis can be fabricated as a quick and inexpensive trial prosthesis for the patient deciding if a permanent prosthesis is right for them. A prosthosis can be utilized by the patient that is not healed enough for prosthetic molding or casting but wishes to increase functional use of their hand. A prosthosis can also be beneficial for the amputee waiting for their prosthetic to be fabricated.

Conclusion: A thermoplastic functional prosthosis is a convenient, fast, and affordable option for both the patient and the therapist after an amputation. It allows the patient immediate improvement in ADL participation while they await a permanent prosthetic.

Introduction:

Research has shown amputees fit with a prosthetic 30 days or less after amputation showed a 93% rehabilitation success rate and 100% return to work rate (Smurr et al., 2008). Those who were fitted with a prosthetic more than 30 days after their amputation had only a 42% and 15% success rate, respectively (Smurr et al., 2008.) This underlies the importance of quick, interdisciplinary care for the patient. However, depending on the patient’s healing progression, compliance with therapy, and prosthesis fabrication timelines, it can be a challenge to fit a new amputee with a prosthesis in 30 days. Some patients receive a temporary prosthetic 2-3 weeks after surgery. However, many patients must wait longer. In fact, permanent prosthetic fittings generally begin two to six months after initial amputation surgery (Prosthetic FAQs for the New Amputee - Amputee Coalition, 2015.)
A study conducted by Resnik et al. concluded “that those who did not use a prosthesis reported more difficulty in activities, greater disability, and lower [quality of life reports] as compared with those who used any type of active prosthesis.” To increase a patient’s quality of life and rehabilitation outcomes, it is important to fit patients with a prosthesis, and fast. How then, can a hand therapist overcome this gap between the recommended prosthetic fitting timeline and reality?

This author proposes the utilization of a novel prosthosis, which is defined as a temporary, removable prosthetic made of thermoplastic material. A prosthosis allows for quick, inexpensive fabrication for a healing amputee that is waiting to be fitted for a permanent prosthesis. The supplies and tools used are commonly found in a hand clinic. This case study specifically focuses on the fabrication of a thumb- based prosthosis for a recent traumatic thumb amputation, just below the IP joint. It is intended to act as a thumb prehension post to allow for functional opposition.

A systematic review of the literature produces limited results for temporary prosthoses, thus presenting a gap in the literature. Sudhagar and Le Blanc, 2009, outlined a thermoplastic prosthosis for a thumb amputee. They created a template utilizing two pieces of thermoplastic heated together. This was a good starting point for reference, but the final product did not appear to be stable enough for stronger opposition and prehensive grasps. Dewey, et al., 2009 also outlined a template for a thermoplastic prosthosis for a thumb amputee utilizing a heavier thermoplastic packed to the thumb base with thermoplastic. Almond, 2011 documented a simple to fabricate, hollow prosthosis for digital amputation. Finally, Warthman and Martinez, 2021 utilized a similar technique as Dewey, et al., 2009 but utilized a thumb-spica template as the base of the prosthosis. There is no evidence of prosthosis fabrication utilizing an Orficast base overtop a modified thermoplastic orthosis template, which is what this case will outline.

**Participant Background:**

This study participant (S.B.) was a 24-year-old right-hand dominant foundry worker with a right thumb amputation at the level of the proximal phalanx. His mechanism of injury was a traumatic crush with avulsion from a press while completing maintenance on the machine. His occupational duties and interests include maintenance duties at the foundry, home care, yardwork, and art including paper mache and origami. Extensive soft tissue and bony damage was present at presentation to ED. Due to near complete avulsion through the proximal phalanx just below the interphalangeal joint, his distal thumb was not salvageable. Extensor Pollicis Longus, Extensor Pollicis Brevis, and Flexor Pollicis Longus, digital arteries, and nerves were all avulsed. He had normal alignment of 1st metacarpal and thumb metacarpal phalangeal (MCP) and carpometacarpal (CMC) joints. Other remaining bony structures were intact. The on-call plastics surgeon performed a revision amputation of the right thumb with local skin flap
coverage. Digital neurectomies were also performed. Patient was instructed to remain off work and complete one-handed ADL until occupational therapy was initiated.

Figures 1-3

Oc[...]adults. S.B.’s initial deficits include decreased thumb and digit range of motion, neural tension at rest, and 8/10 pain levels. Therapist and patient discussed prosthetic options. He reported the following ADL limitations: difficulty with housework, work tasks, lifting, reaching, carrying, and yardwork. He reported his main goal for treatment was to “gain use of my thumb.” He was utilizing his left hand to complete most tasks and his right for assistance with bilateral tasks. He was utilizing a compensatory scissor pinch pattern with his index and long fingers on his right hand. His Quick Dash score was 70.5/100.

After two months of occupational therapy treatment, the patient’s Quick Dash score remained high at 68.2/100. The distal end of the participant’s residual thumb remained unhealed. Thick eschar and necrotic tissue were present around the tip of his residual thumb. The initial skin graft did not take, and because of this, the distal tip of his residual phalanx was exposed. His

Chart 1

<table>
<thead>
<tr>
<th>Date</th>
<th>Quick DASH Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.8.2022</td>
<td>70.5/100</td>
</tr>
<tr>
<td>1.11.2023</td>
<td>68.2/100</td>
</tr>
<tr>
<td>2.16.2023</td>
<td>56.8/100</td>
</tr>
</tbody>
</table>
slow wound healing was likely due to his heavy smoking habit. An additional complication includes hypersensitivity throughout the entire length of the thumb down to the CMC joint. Due to these complicating factors, S.B.’s surgeon decided to complete another surgery, this time utilizing a vascularized skin flap to increase the likelihood that the soft tissue would adhere.

After the decision to perform a revision surgery was made, the discussion to fabricate a prosthosis was initiated between the patient and the therapist. This would occur after revision surgery and suture removal. With the patient’s history of slow healing and the average timeline of prosthetic acquisition taking between 2-6 months, it was likely he would benefit from a prosthosis to increase his participation in ADL (Prosthetic FAQs for the New Amputee - Amputee Coalition, 2015). If the patient can tolerate pressure during prehension and strong opposition, and sutures have been removed, the patient can be fitted for a prosthosis.

A second amputation revision surgery was completed 10 weeks after initial injury and subsequent revision surgery. This procedure aimed to cover exposed bone via a vascularized skin flap. His surgeon first performed debridement of eschar and exposed bone to prepare a healthy, vitalized base for the skin flap. He then harvested a first dorsal metacarpal artery flap from the patient’s index finger in hopes of achieving better soft tissue adherence. He then redirected the tissue under the dorsal web space and overtop the exposed tip. To add length to thumb in preparation for prosthetic use, the surgeon then completed a z-plasty web deepening.

Figures 4 & 5

At S.B.’s progress appointment one week after his second revision surgery, his Quick Dash score was 56.8/100. He continued to report hypersensitivity throughout his remaining thumb, as well as limitations in ADL and IADL. His sutures were fully removed at the three-week mark. 15% eschar began to form over skin flap, with remaining 85% maintaining healthy granulated tissue. At 13 weeks after initial injury, and 3 weeks after revision surgery, S.B. had incurred appropriate healing for fabrication and fitting of a prosthosis.

**Purpose:**

The purpose of this case study is to assess the viability and reproducibility of fabricating a novel prosthesis from combination low-temperature thermoplastic and Orficast materials. The prosthesis is meant to add length to allow for increased functionality in grip and a stable base to oppose to digits to when pinching. Use of Orfit Orficast allows a snugger fit at the base of the
residual thumb while leaving the tip free for continued healing. This has the added benefit of decreased pain and rubbing. The combination thermoplastic and Orficast prosthesis can be re-shaped as needed during the patient’s healing journey. The prosthesis can then be worn as needed until the patient receives their final prosthesis.

Methods:

A single patient case study was utilized to demonstrate the viability and reproducibility of fabricating a thermoplastic prosthesis for an amputee waiting to be fitted with a permanent prosthesis. A combination of thermoplastic and Orficast was utilized to balance support and durability. Orficast was chosen as the base due to its ability to contour to and secure the prosthesis to the base of the residual thumb. It is also a relatively thin material. Roylan TailorSplint 1/8in was utilized due to its durability and ability to be cleaned. The patient works a dirty, physical-labor intensive position, as well as assists in housework and yardwork at home. In contrast, he also enjoys paper Mache crafts, and origami in his free time. Because of this, a rigid and washable material that still allowed for fine movement was ideal for the patient.

Figures 6 & 7

A base for added stability overtop the residual digit was made from 3 cm Orfit Orficast on the right thumb of a model prior to the fitting appointment. Fabrication of the Orficast layer on a model allowed normal right thumb rotation and positioning of the inner Orficast layer. The base of the model’s thumb was built-up with a double layer of 3M Coban wrap to emulate the size of the patient’s thumb, which was measured at 9.8 cm. The Orficast was heated in hot water, then wrapped with 75% stretch on the material. The material was wrapped distal to proximal with 50% overlap. This ensured stability with opposition while keeping the prosthesis from becoming too bulky. The Orficast was molded with the thumb in opposition to the index and middle finger, with the IP joint in approximately 10 degrees of flexion.

Prior to fabrication, S.B.’s thumb was wrapped with his usual 2-inch 3M Coban wrap for tip protection. Next, the end of the prefabricated Orficast thumb was heated and re-molded to fit snug to the base of the patient’s residual thumb. An Additional Orficast double-layer was added to the base of the Orficast utilizing the same fabrication process as the thumb. This allowed for increased stability with prehension. Attention was paid to web space during this
process to avoid unnecessary layers restricting ROM. A modified gauntlet short opponens pattern was utilized for the outer thermoplastic component of the prosthesis. An additional 1.5-inch length was added to the thumb portion of the pattern to encompass the entire length of the Orficast thumb. Thermoplastic covered the entire Orficast thumb so the patient could utilize force when opposing. The Orficast alone did not allow for strong opposition during trials. A small air hole was left at the tip of the thumb to increase breathability of healing tissue. This was due to concern of tissue maceration.

Strapping was placed across the dorsum of the hand and at the base of the CMC joint around his wrist for increased stabilization when opposing with force. Due to the intimate fit of the Orficast, the patient opted out of backfilling the open space with cushioning material such as gauze or cotton. The prosthesis maintained strong stabilization during functional use test.

**Figures 8-15**

From left to right:
A) Patient opposing to Orficast thumb after additional support at base was added.
B) Inside view of completed prosthesis with orficast within thermoplastic outer layer.
C) Radial view of thumb in radial abduction
D) Dorsal view of prosthesis

From left to right:
A) Volar view of shortened prosthesis
B) Radial view of shortened prosthesis with opposition
C) Image of patient writing his name with prosthesis donned.
D) Demonstration of resistance activity with prosthesis donned

S.B. trialed the prosthesis at home until his next session. After home use, he reported discomfort around sensitive web space. He also felt the built-up thumb was too long for his
preference. However, he did report success with incorporation of the prosthesis into ADL activity and endorsed an easier time completing tasks that require grasping. Adjustments were made to length of thumb and at web space to allow for a more forceful and pain-free opposition. With a shorter thumb length, the patient demonstrated an improve ability to oppose to his index finger for small item pick-up during a prosthesis training session. Later in the session, S.B. demonstrated the ability to utilize small crafting scissors, pick up bottles, write his name, and successfully trialed a resistive Velcro board to demonstrate forceful opposition. It is worth noting he was unable to complete these activities without the prosthesis donned. He verbalized excitement to incorporate the prosthesis in daily activity. He further demonstrated use outgoing by utilizing the prosthesis to collect his items outgoing.

Two weeks after fabrication of the temporary prosthosis, his prosthetist deemed him appropriate for prosthetic molding. At a bi-monthly interdisciplinary limb restoration clinic, S.B was molded for a temporary prosthetic made from 3-D printed silicone. 15 weeks after initial injury and 5 weeks after his second revision surgery. He tolerated BodyDouble molding process well. Following a standard timeline, the patient should receive his temporary prosthetic around 18 weeks after injury. After he receives his 3-D printed temporary prosthetic, it should take 4-6 weeks to receive his permanent prosthetic.

S.B.’s surgeon proposed an additional procedure to lengthen his thumb phalanx to allow for fitting of a Naked Thumb Driver or a Point Digit prosthetic. Without the additional length, these prosthetics will not fit. This procedure would occur 6-8 weeks after the revision surgery to allow for adequate soft tissue healing. After this procedure, His prosthosis could be easily modified with minimal time and effort to accommodate the change in shape of his residual limb. This will allow him to continue to practice functional use of his hand while his body heals and his full-time prosthetic is fabricated.

After molding of his prosthetic device, S.B. self-discharged from occupational therapy services. Because of this, the author was unable to obtain additional Quick DASH scores. This would have provided additional insight to the functional benefit of the prosthetic device, as well as insights to continued use and adherence. Continued check-ins would have also provided the opportunity to adjust the prosthetic as needed to allow for ideal fit.

**Results:**

This case report demonstrated the occupational need for and feasibility of a prosthosis for an upper extremity amputee. The supplies for this prosthosis can be found in most hand clinics, and fabrication does not require a greater time commitment than a traditional orthosis. Utilizing an elongated gauntlet orthosis template makes this an easily replicable and modifiable prosthosis. The patient demonstrated the usefulness of the prosthosis and its ability to enhance the functional use of his hand. If the patient has another surgery or edema reductions lead to a change in shape, the Orficast and thermoplastic allow for modifications and adjustments.

**Discussion:**
Prostheses have many benefits for the patient. First, the device affords the patient increased functional use of the amputated digit(s) during the lengthy process of prosthesis fabrication. Secondly, the prosthesis can be fabricated and worn throughout the healing process. A permanent prosthetic cannot be fabricated or worn until sufficient wound healing and edema reduction has taken place and healing has stabilized. This is due to the suction related to the fabrication process and need for a consistent digit shape for proper final fit. Low-temperature thermoplastic allows for re-molding and adjustments to the prosthesis as physical changes and patient preference dictate. Dressings, Coban wrapping, and edema coverings can all be worn beneath the prosthesis as necessary. Additional benefits include low out of pocket costs for the patient and room for patient input on fit and form, which improves buy-in.

**Conclusion:**

Future studies could explore the implications of utilizing a prosthesis before being fit with their permanent prosthesis. Other studies could examine if there is a relationship between prosthesis use and long-term prosthesis use and adherence. Finally, studies could examine further options for prosthesis fabrication on other digits or multiple digits. Fabrication and fitting of a combination Orficast and thermoplastic prosthesis is a feasible endeavor for the hand therapist to undertake. It utilizes common materials and methods for fabrication that a hand therapist would be acquainted with. The prosthesis offers increased participation in ADL when the patient is not ready for a permanent prosthetic.

**References:**


