# PROSTHETICS

# Case Study: David Ware

Age:	62 y/o male
Cause:	Traumatic injury
Date of Injury	March 2019
Vocation:	Construction
Interventions:	GripLock Finger, ⊓ThumbDriver™
	by Naked Prosthetics
Previous	
Prosthetic	
Intervention:	JAWS Voluntary Opening
	Terminal Device by TRS Prosthetics





#### Purpose

To understand both the functional and psychological impact of intervention with both positionable and body-driven mechanical devices from Naked Prosthetics (Olympia, WA) on a patient with traumatic partial amputations of his right hand.

### **Patient History**

David is a 62-year-old male with a traumatic partial hand amputation of his right, dominant hand, sustained in 2019. He presents with amputations of digits two through five at the metacarpal level while the thumb is amputated distal to the metacarpophalangeal (MCP) joint. The accident was sustained in his home workshop when his right hand was drawn into a wood planer. After the accident, David worked with an occupational therapist to learn how to live with his new physical limitations, given the injury. He was able to return to work part-time as a carpenter in a limited role. Additionally, he was diagnosed with ALS in 2006 but is not showing many physical symptoms at this time.

## Patient Objectives

David makes home between Tennessee and Florida, traveling between both several times per year. Before his accident, we worked full time in construction. He is currently on disability but has returned to work in a part-time capacity. He still enjoys working in his home workshop. He is right-hand dominant, but since his accident has learned to compensate with his left hand as well as right palm and remaining thumb. These compensatory actions cause pain and fatigue in the right thumb and wrist and will likely lead to overuse injuries on his left side. David has a difficult time dressing and feeding himself independently. He is an active man; he enjoys outdoor activities such as fishing, kayaking, camping, grilling, and gardening. Each of these activities are no longer easily accessible to him after his injury. David would like to be able to return to bimanual activities such as stabilizing the oar of his kayak for rowing, casting a line when fishing, and independently buttoning his shirt. He would also like the ability to return to work in a full-time capacity.

### **Prosthetic Intervention**

After his accident, David sought out a prosthetic intervention. He considered a passive silicone prosthesis but feared the cost was too high for its lack of function and articulation. A passive device would not help him reach his functional goals in either work or recreational activities. David met with a clinic to discuss options and was fit with the JAWS terminal device (TRS Prosthetics, Boulder, CO) before being enrolled in the GripLock Finger<sup>™</sup> Beta Study. The JAWS unit is a heavy-duty, voluntary opening (VO), terminal device-prehensor that operates with or without a harness and cable system and requires the use of a custom-fabricated prosthetic socket. It restores power and two-digit prehensile grasps for heavy-duty activities such as kayaking and raking.





Figure A JAWS Prehensor (TRS Prosthetics Boulder, CO)

In 2019, Naked Prosthetics began beta-testing GripLock Fingers," which are intended for use following complete digit loss. Each digit is a passive, locking, mechanical prosthesis explicitly designed for individuals with metacarpophalangeal disarticulations or transmetacarpal amputations, resections, or comparable congenital presentations. GripLock Fingers<sup>™</sup> are used in conjunction with a custom-fabricated partial hand socket to restore hand function to patients by replacing the









Figure B Partial Hand Socket Featuring GripLock Fingers<sup>®</sup> and ThumbDriver<sup>®</sup> (Naked Prosthetics)

absent digits and allows users to regain prehension to assist with a variety of functional grasp patterns. The GripLock Finger<sup>™</sup> excels at providing robust strength in force opposition and restoring power grasps as well as grip stability. This device can be passively placed with the contralateral hand or against another surface and has two modes of locking release that are intuitive for the user: (1) by depressing the Pawl located at the dorsal side or (2) by fully flexing the GripLock Finger<sup>™</sup> until the reset position is reached, and then allowing it to release.

The ThumbDriver<sup>™</sup> is a body-driven prosthetic device. It uses the motion of the intact joint proximal to the amputation to actuate artificial distal joints and phalanges and mimic natural thumb motion. The ThumbDriver<sup>™</sup> is uniquely driven off both the intact CMC and MCP joints, providing IP flexion and real-time tracking of the complex, multi-axial motion of the thumb. Each device helps restore length, dexterity, and grasp to David's hand.

David was fit with a custom-fabricated partial hand socket made of ultralight carbon with a silicone skin interface and combination of GripLock Fingers<sup>™</sup> with a ThumbDriver<sup>™</sup>, by Naked Prosthetics (Olympia Washington).

#### Outcomes

As of April 2020, David has been wearing the combination of the GripLock Fingers<sup>™</sup> and ThumbDriver<sup>™</sup> for six weeks. Self-reported wear time in the socket is 8 hours daily, slowly increasing from 2 hours daily at initial fitting. He uses the prosthesis in his workshop, and to lift and hold grocery bags and luggage, citing his max load carried has been 65lbs. David can now access more Activities of Daily Living (ADLs) than previously possible, allowing for various bimanual activities. With the aid of his prosthetic hand, David can use a pen, hold silverware, use a rake, sand wood, hang plywood, and lay stone is his backyard. He cites that smaller items do provide more of a challenge, as with any prosthesis, but that small item prehension was not possible for him before using the Naked Prosthetic devices.



Utilization of the combination of GripLock Fingers<sup>™</sup> and ThumbDriver<sup>™</sup> gives David access to grip patterns that were previously not accessible to him. The versatility in grip is due in part to the way both the GripLock Fingers<sup>™</sup> and ThumbDriver<sup>™</sup> mimic natural hand motion. He now has access to a variety of grip patterns in both power and precision grasps (see Figure C). David explains that he uses the devices by Naked Prosthetics (Olympia WA) for both for ADLs and recreational



GripLock Finger<sup>™</sup> with ThumbDriver<sup>™</sup>

#### JAWS Voluntary-Opening Prehensor

Figure C Grasp Patterns Accessible to the patient using GripLock Finger<sup>M</sup> and ThumbDriver<sup>M</sup> vs. JAWS Prehensor. Blue circles represent what is available with no prosthesis, and green circles represent additional grasps that are achieved with the use of a prosthesis.





activities because each finger functions independently. The autolocking mechanism allows for the GripLock<sup>™</sup> fingers to statically sit in varying degrees of flexion, which is very useful to compensate for items of various widths and shapes. In using the ThumbDriver<sup>™</sup>, a body-driven digit prosthesis, both the remaining strength and range of motion of the amputated thumb, are harnessed. This creates a form of haptic feedback, in which David can identify the amount of force put through the driver. Haptic feedback increases overall proprioception and, therefore, reliability of grip. Comparatively, the Jaws Prehensor operates more like a clamp and does not offer this kind of versatility or feedback. It will allow David to hold a kayak paddle steadily but will not allow him to hold a drinking glass with confidence.

To assess performance, the following self-report outcome measures were administered before prosthetic intervention with devices by Naked Prosthetics (Olympia, WA) and again after a brief acclimation period. For the purposes of this case study, the acclimation period is defined as six-weeks post-intervention. The QuickDASH outcome measure is used to assess David's function and The Michigan Hand Questionnaire to evaluate aesthetics and psychosocial adjustment.

The QuickDASH is an 11 question self-report questionnaire. Scaling of the QuickDASH is ranked by percentage from O percent (indicating the least disability) to 100 percent (indicating most impairment), with the able-bodied average ranking at 11 percent. This measure asks questions about a variety of everyday manual tasks and the patient's difficulty in performing them. It is widely used in upper-extremity impairment assessment to evaluate function. Preprosthetic usage shows the highest level of disability for David. Over time, the Quick-DASH score decreases the use of his prosthesis increases. This is a strong indication that this prosthetic intervention increased his ability to perform ADLs, given his high level of impairment. Patient feedback supports this hypothesis in that David cites device usage for activities such as brushing teeth, feeding himself, and washing dishes. Overall, the patient exhibited a 27 percent reduction in disability per the QuickDASH outcome measure.



Figure D QuickDash Self Report Outcome Measure

The Michigan Hand Questionnaire (MHQ) is another patient-reported questionnaire that captures several aspects of upper extremity function. The MHQ measures a person's perception of their hands in terms of function, appearance, pain, and satisfaction. It includes six subscales: overall hand function, ADLs, pain, work performance, aesthetics, and prosthetic satisfaction. On the pain scale, high scores indicate more significant pain, while in the other five scales, high scores denote better performance. The MHQ is unique in that it includes modules on both aesthetics and workplace performance, both of which can be especially crucial for a person with a highly visible amputation such as that of partial hand affectedness.



Figure E Michigan Hand Questionnaire Results

The psychological impact of limb loss is extremely powerful, often equating the event to the loss of one's perception of wholeness. Feelings of loss, self-stigma, and difficulty in coping with the impairment can be emotionally devastating and may lead to the development of depressive disorders. Up to 94 percent of individuals with mutilating hand injuries experience symptoms associated with stress and anxiety disorders, major depression, pain syndromes, and adjustment problems, and these problems do not resolve with time (3). One's hands and face are highly visible and often used in communication as a means of connecting emotionally and socially with others, and expressing or representing feelings, thoughts, or symbolic aspects of one's self.

Improvements appear in each of the six subscales measured by the MHQ, as shown in Figure E. The MHQ appearance satisfaction score shows an overall increase of more than 50 percent between pre-intervention and post-intervention after an acclimation period of six weeks. The rise in satisfaction with appearance post prosthetic delivery is a strong indicator of the positive psychological impact of his prosthetic intervention has and will continue to have on David's life.

The MHQ uses a subscale for work performance to identify the perception of disability in work-specific tasks. According to the literature, 75 percent of heavy manual laboring men who suffered partial hand loss were unable to return to their line of work, and 26 percent left the workforce entirely (2). Moreover, because the work



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setting is often a significant source of positive satisfaction and social interaction, the traumatic effect is compounded when this source of self-esteem is lost.

Normative values of the work performance module for those with hand/wrist disease such as rheumatoid arthritis or carpal tunnel have a mean value of 74.4 percent (4). David's self-reported work performance score pre-intervention is a mere 5 percent, which highlights the extreme level of disability that this type of traumatic injury causes. The hand itself accounts for 90 percent of the function of the arm; an individual with a loss of five digits can experience up to a 54 percent whole person impairment (1). Before entering the GripLock Finger<sup>™</sup> beta study, David cited an enormous functional goal; to return to work in a full-time capacity. David's post-intervention MHQ work performance score is 20 percent.

#### Conclusion

The loss of one or more partial or full fingers forever alters the ability to sort mail, return to a vocation, or even dress oneself and cut food. The significance of this injury is harmful to those affected both functionally and psychologically. The GripLock Finger<sup>™</sup> is the first metacarpal solution by Naked Prosthetics (Olympia, Washington). This case study establishes that a combination of the GripLock Finger<sup>™</sup> and the ThumbDriver<sup>™</sup> is successful in increasing overall functionality in ADLs, recreational activities, and work tasks as well as addressing the psychosocial effects associated with partial hand loss.

#### References

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