Journal of Hand Therapy 32 (2019) 48–56

Contents lists available at ScienceDirect

Journal of Hand Therapy

journal homepage: www.jhandtherapy.org

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Scientific/Clinical Article

Psychosocial reactions to upper extremity limb salvage: A case series

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ARTICLE INFO

Article history:
Received 31 January 2017
Received in revised form
23 July 2017
Accepted 12 September 2017
Available online 1 December 2017

Keywords:
Limb salvage
Upper extremity limb salvage
Upper extremity trauma
Psychological
Psychosocial

ABSTRACT

Study Design: Case series.
Introduction: A salvaged limb is one that has undergone a major traumatic injury, followed by repeated surgical attempts in order to avoid amputation. Psychological recovery for individuals with lower extremity limb salvage has been examined in a number of studies. However, psychosocial reactions for individuals with upper extremity (UE) limb salvage are understudied in the literature.
Purpose of the Study: The purpose of this study was to explore the process of psychosocial adaptation for 3 trauma cases after UE limb salvage.
Methods: The Reactions to Impairment and Disability Inventory was used to assess psychosocial adaptation. Physical function outcomes (pain, range of motion, edema, sensation, and dexterity) are presented. The Disabilities of the Arm, Shoulder, and Hand measure was used to assess perceived disability. Medical and rehabilitation history are discussed for each case, in order to provide in-depth understanding of the impact of these injuries.
Results: Reactions to injury varied across the cases; however, outcomes suggest that psychosocial adaptation may be influenced by the experience of pain, the ability to participate in valued roles and activities, and having a supportive social network.
Discussion: For this population, therapists may consider emphasizing pain management, focusing on client-centered goals and interventions, and facilitating peer support. Providers should closely monitor patients for signs of poor adaptation, such as hand-hiding behaviors.
Conclusions: This study is among the first to examine psychological outcomes for the UE limb salvage population. Future research would be beneficial to provide deeper understanding of the psychosocial challenges for these individuals.

Introduction and background

Following a severe traumatic injury, a mangled limb may be amputated or undergo reconstruction, known as limb salvage. Due to the fact that upper extremity (UE) prosthetics do not restore function to the same extent as lower extremity (LE) prosthetics do, limb salvage is typically the default treatment for traumatic UE injuries.[1-3] UE limb salvage is poorly defined in the literature; therefore, the authors along with an orthopedic hand surgeon have defined a salvaged upper limb as: one that has sustained damage to multiple tissues (skin, bone, muscle, tendon, ligament, blood vessels, or nerves), required numerous surgical procedures, and caused permanent impairment.

Research involving individuals who have undergone LE limb salvage reports an increased risk for poor medical outcomes, including numerous complications (eg, osteomyelitis, infection, and nonunion/malunion), multiple surgical procedures, and rehospitalizations.[4-11] After LE limb salvage, physical function outcomes tend to be equal or worse as compared to amputees, and pain levels may be higher.[4,5,8,12-14] In some instances, despite multiple surgical procedures and intensive rehabilitation, an individual may be left with an insensate, painful, and stiff limb, which may necessitate delayed or "late" amputation.[2] Individuals with LE limb salvage also tend to have psychosocial outcomes that are similar to amputees, although those with limb salvage tend to have a higher likelihood of post-traumatic stress disorder and substance abuse disorders.[4,8,9,13,14] Despite the potential for poor outcomes after LE limb salvage, literature discussing outcomes for UE limb salvage is minimal.

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https://doi.org/10.1016/j.jht.2017.09.003

The results of a LE study should not be applied to an UE population, as trauma to the upper limb creates a unique set of challenges that are not factors after LE salvage. All tasks requiring 2 fully functioning hands (self-care, child care, driving, and certain fine motor activities) are impacted.[15-18] The ability to work and generate income may be affected, creating financial distress.[19] As the hands are used to interact with the environment, a salvaged UE tends to be highly visible and less easily hidden with clothing. The visibility of the UE may serve as a constant reminder of the trauma. Cosmetic concerns regarding the UE may also affect body image and self-esteem, impacting social interaction.[19]

Psychosocial outcomes specific to UE limb salvage were first examined in a previous survey study by the current authors (Sposato et al., 2017, accepted for publication in the Journal of Hand Therapy). A modified version of the Reactions to Impairment and Disability Inventory (RIDI) was used to evaluate psychosocial adaptation for individuals with a severe unilateral UE trauma. Those individuals who had less than a college degree, were over the age of 23 years, had more pain, and who were less than 6 months after injury were observed to have worse psychosocial outcomes. Additionally, individuals whose dominant limbs were affected were observed to have increased levels of denial. The current manuscript is a detailed expansion of 3 of the cases from the original survey study. Psychosocial outcomes are presented alongside medical history and physical outcomes to provide in-depth understanding of the psychological impact of UE limb salvage. In addition to the original RIDI score, a follow-up RIDI survey was completed with each participant to help conclusions drawn from the outcomes of these 3 cases.

Methods

Operational definitions

The definition of limb salvage used in this case series is given in Table 1. Psychosocial adaptation refers to acceptance to an acquired disability, based on the 8-stage model proposed by Livneh and Antonak.[20-22] Five of the stages: shock, anxiety, depression, internalized anger, and externalized hostility, are referred to as nonadaptive reactions to disability. The final 2 stages, acknowledgment and adjustment, are referred to as adaptive. The reaction of denial is considered neither adaptive nor nonadaptive and is somewhat intermediate. With the exception of denial, the first nonadaptive stages are a prerequisite to achieving the final 2 adaptive reactions. Stages do not necessarily occur in a set sequence, and it is possible to experience multiple reactions at once. For a full description of the 8 stages, see Table 1.

Case selection

The cases described were from a military treatment facility in San Antonio, Texas. All patient cases were also participants in the original limb salvage survey study and were invited to participate in the case series. Pseudonyms were used to maintain confidentiality of the participants. Institutional review board designated this case series as “exempt” because all cases were from the authors’ clinical caseloads, and informed consent to participate in the case series was given by each participant.

Clinical assessments

As part of clinic standard of care, participants underwent a series of physical and psychosocial assessments. The Disabilities of the Arm, Shoulder, and Hand (DASH) outcome measure assessed perceived physical function and symptoms in the presence of UE musculoskeletal disorders.[23] Pain was assessed with an 11-point numerical rating scale with 0 indicating no pain and 10 indicating the worst pain imaginable. Active and/or passive range of motion (AROM/PROM) was measured using a goniometer. Semmes-Weinstein monofilament testing was used to assess sensation. Edema measurements were performed with circumferential taping. Manual dexterity was measured with the use of the Box and Block Test and Nine-Hole Peg Test.[24,25]

Psychosocial adaptation was measured with the RIDI, which was developed by Livneh and Antonak.[20-22] The RIDI is a self-report outcome measure based on the stages which form the operational definition for psychosocial adaptation used throughout this case series. The RIDI consists of potential reaction statements relating to a disability and uses a Likert-style scale to determine how often this specific reaction is experienced (never, rarely, sometimes, or often). Each statement corresponds to 1 of 8 stages of adaptation. For example, the statement “I find myself arguing more with people” is associated with externalized hostility. The RIDI was chosen as the primary outcome measure as it allows researchers to examine multiple reactions within a given participant. Rather than generating a unidimensional score for adaptation to disability, participants receive 8 subscale scores, with each subscale corresponding to a stage. A higher RIDI subscale score indicates that a participant identifies more with this reaction.

Table 1
Operational definitions

Operational definitions	
Limb salvage	
1. A single traumatic injury, which	
2. Affects two or more tissues types (skin, bone, tendon, ligament, blood vessels, or nerves), and	
3. Requires three or more surgical procedures within a nine month period, and	
4. Results in permanent impairment	
Stages of psychosocial adaption	
1. Shock	Psychological numbness and cognitive disorganization that occur as the result of a sudden and overwhelming traumatic event with subsequent physical impairment.
2. Anxiety	Sense of panic as the consequences of the traumatic event start to become apparent.
3. Depression	A reaction of grief as the individual begins to mourn the loss of his or her previous physical abilities.
4. Internalized anger	Anger that is directed inward, resulting in feelings of self-blame, bitterness, and guilt over the traumatic event.
5. Externalized hostility	Reaction of outwardly directed anger at new physical limitations, which is manifested in hostile thoughts and behaviors against other people or objects in the environment.
6. Denial	Psychological defense against the painful realization of the limitations of one’s new physical impairment and expected recovery.
7. Acknowledgment	Intellectual recognition of the implications and permanency of the disability and integration of new functional limitations into routines.
8. Adjustment	Marked by emotional acceptance and behavioral adaptation to new functional limitations. The disability is fully integrated into the sense-of-self.

Aside from its unique ability to examine multidimensional reactions, the RIDI was selected as an outcome measure as its development and psychometric properties are well-described. Content validity was established through an exhaustive review of literature surrounding adaptation to physical impairment, as well as through review by a panel of subject matter experts.[21,22] Reliability of the RIDI was established through its use in a number of disability studies. Reliability was found to be acceptable for 7 of the 8 subscales as indicated by Cronbach's alpha coefficients. With the exception of the denial subscale ($r = 0.64$), median coefficients ranged from $r = 0.71$ (externalized hostility) to $r = 0.83$ (depression).[22] A 53-question version of the RIDI was slightly modified for this study to include language related to UE limb salvage (eg, "I am embarrassed about my impairment" was modified to "I am embarrassed about my upper limb condition"). Face and content validity of the modified questions were evaluated by an occupational therapist and physical therapist. Permission to modify the scale was granted by an original RIDI author. A notable limitation of the RIDI for clinical use is the lack of an established metric for minimal clinical detectable change.

Results

Case study 1

History

Paul was a 33-year-old, left-handed male who presented with a 9-year history of left UE pain, surgical procedures, and dysfunction. In 2006, Paul sustained a traumatic injury to the left wrist and hand while serving in the United States military. During an overseas combat deployment, he was involved in a mortar attack and fell from a building. He was diagnosed with a left wrist sprain and was returned to duty. Several months later, upon returning to the United States, Paul sought care for a still-painful left wrist. According to patient report (medical records unavailable for verification), he was diagnosed with a fracture malunion and mid-carpal instability. From 2006 to 2015, Paul underwent 11 surgical procedures. These included multiple arthroscopic procedures, a 4-corner fusion without scaphoid excision, and later removal of hardware. He also underwent multiple revisions to the fusion site using iliac bone crest grafts, a Guyon's canal release, and a Darrach procedure. Each surgical procedure failed to stabilize the wrist or adequately relieve pain. In October 2015, Paul went to the operating room for a final salvage procedure. He underwent an interposition arthroplasty with Achilles tendon allograft (see Fig. 1), which may be used after a Darrach procedure fails to provide satisfactory pain relief.[26] After this final procedure, the wrist was sufficiently stabilized to decrease pain.

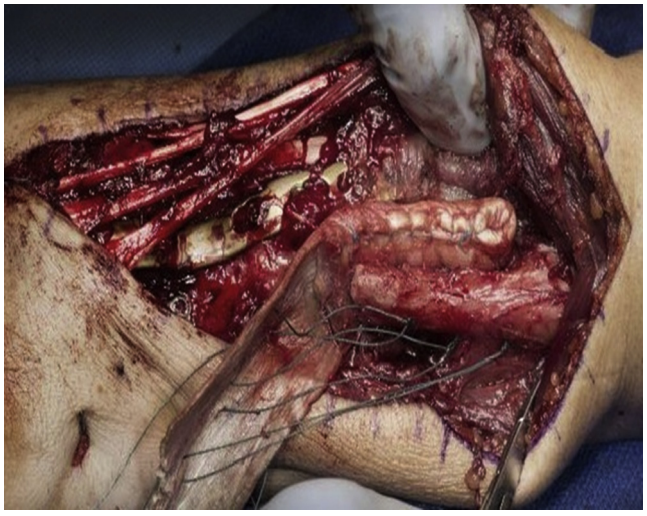

Fig. 1. Photograph from case study 1 depicts his final surgical procedure, an interposition arthroplasty with Achilles tendon allograft.

UE presentation and function

Paul was evaluated by occupational therapy in September 2015, prior to his final surgical procedure. At rest, Paul reported 7/10 "throbbing" pain in the left wrist and hand. Pain often reached 10/10 with activity and was described as constant and unrelenting. Paul displayed pain-related behaviors, including grimacing and guarding. The limb was hypersensitive to light touch, and Paul often put the hand in his pants' pocket to protect it. The left UE was edematous which limited AROM; pain limited Paul's tolerance of PROM. While he was independent with activities of daily living (ADLs), Paul stated that he completed all tasks with his right hand due to pain in his left. After undergoing the interposition arthroplasty, Paul reported substantial pain relief. Once pain was well controlled, occupational therapy treatment focused on improving AROM and dexterity of the hand. Treatment incorporated activities that were meaningful to Paul and that would fully engage the hand, such as cooking and woodworking. Upon discharge, Paul had full AROM of his left hand and more readily incorporated it into his daily activities. He also stated that he had noticed his hand dominance was slowly returning to his affected left hand for the first time in 9 years. See Table 2 for a full summary of physical outcomes.

Psychosocial presentation

Paul initially took the RIDI prior to his final surgery before his pain was sufficiently managed. The psychosocial impact of living with a painful, nonfunctional UE for 9 years was evident in his RIDI scores and clinical presentation. Paul scored high on the DASH, indicating a high level of self-perceived disability and low level of function. He scored low on the RIDI adjustment subscale, which may suggest he had not successfully adapted to his disability. His scores were noted to be high on several nonadaptive reactions. Paul's high external hostility score may in part reflect frustrations with years of surgery and therapy that were unsuccessful in providing adequate relief to his symptoms. He verbalized that he felt his twenties had been "taken" from him. His career in the military was terminated prematurely with a medical retirement due to the severe pain from his injury. Additionally, he was unable to perform many valued activities that he associated with being a young man: he had trouble playing with his 2 children and could no longer exercise or be active in the outdoors to the extent he was accustomed. Paul verbalized that he was frustrated and angry by the constant pain and lack of function and expressed a desire for an amputation. He reasoned that once the hand was gone, the pain would also be gone. He felt the hand was basically useless, as it was too hypersensitive to be used and that an UE prosthesis would be more functional. After discussions with the surgical team, the decision was made to avoid amputation, and an interposition arthroplasty procedure to salvage the limb was completed. After this procedure and subsequent pain control, Paul's psychosocial affect improved. However, he still demonstrated anxiety-related behaviors. Paul frequently wore compression sleeves or sweat bands over the surgical scar. He stated that it was difficult for him to look at the injury, as it reminded him of the initial trauma.

Paul completed a follow-up RIDI survey approximately 1 year after completing the initial survey. There were notable decreases in all of the nonadaptive reaction subscales and an increase in the adaptive reaction subscale of adjustment. See Table 3 for a full summary of psychosocial outcomes.

Table 2
Assessment scores at the initial evaluation and most recent follow-up

Assessment	Case 1[a] 31-year-old, left-handed male, left upper extremity affected		Case 2 52-year-old, right-handed female, right upper extremity affected		Case 3 21-year-old, right-handed female, right upper extremity affected	
	Initial	Follow-up (9 mo)	Initial	Follow-up (11 mo)	Initial	Follow-up (8 mo)
DASH (0-100)	69.2	57.8	70	21.7	72.5	25.8
Pain (0-10)	Rest 7 Activity 10	Rest 4 Activity 4-10	Rest 4 Activity 4-8	Rest 0 Activity 0-5	Rest 0-8 Activity unable	Rest 5-6 Activity 3
Range of Motion	AROM Forearm 30/80; wrist fused; digits TAM (IF/MF/RF/SF) 220/140/80/95	AROM Forearm 75/70; wrist fused; digits TAM (IF/MF/RF/SF) 250/235/200/195	AROM Forearm 10/15; wrist 20/30; digits TAM (IF/MF/RF/SF) 60/105/35/40; opposition unable	AROM Forearm 85/75; wrist 65/55; digits TAM (IF/MF/RF/SF) 245/280/255/235; opposition tip of RF	PROM Shoulder: extension 20, flexion 85, abduction 80; elbow 25/80 wrist 30/30; digits TPM (IF/MF/RF/SF) 275/260/275/250	AROM Shoulder: extension 50, flexion 150, abduction 155; elbow 0/40 PROM Wrist 35/85; digits TPM (IF/MF/RF/SF) 255/255/245/260
Sensation (SWM)	4.31 digits 3-5; 2.83 digits 1 and 2	4.31 digits 2-5; 2.83 digit 1	4.56 ulnar distribution; 2.83 median nerve distribution	3.61 ulnar distribution; 2.83 median nerve distribution	No sensation distal to replant	3.61 proximal to elbow; 6.65 distal to elbow
Edema	Moderate to wrist and digits	Minimal edema wrist and digits	Moderate dorsal wrist and hand	Trace, varies with activity	Severe edema distal to the level of injury	Minimal, varies with positioning
Box and Blocks (R/L)	60/42	56/33	44/70	65/80	Unable	Unable
Nine-Hole Peg (R/L)	20.25/27.92 s	23.56/32.08 s	71/25.34 s	29.11/16.49 s	Unable	Unable

AROM = active range of motion; DASH = Disabilities of the Arm, Shoulder, and Hand; TAM = total active motion; IF = index finger; MF = middle finger; RF = ring finger; SF = small finger.
For all cases, strength testing was initially deferred due to pain and precautions. DASH: a lower score indicates lower levels of perceived disability and more function. Pain: rated on a numerical scale, 0 indicating no pain and 10 indicating greatest imaginable pain. Semmes-Weinstein monofilaments (SWMs): 2.83, normal sensation; 3.61, diminished light touch; 4.31, diminished protective sensation; 4.56, loss of protective sensation; and 6.65, deep pressure sensation only. Box and Blocks: a larger score indicates greater dexterity of the hand. Nine-Hole Peg: increased time indicates less dexterity.
[a] These data are from the most recent operation.

Case study 2

History

Ellen, a 52-year-old female, presented with severely limited functional use of her right dominant UE. Her injuries were sustained in December 2015, when she was attacked by 3 dogs while running near her home. She sustained bite wounds to bilateral UEs and LEs, with the right UE receiving the most significant injuries. The injuries to her right UE included significant soft-tissue loss to her volar and dorsal forearm to include complete loss of extensor digitorum communis (EDC) and extensor pollicis longus (EPL) muscle bellies (see Fig. 2). On the day of injury, Ellen was taken to the operating room for wound debridement and primary closure. In the following days, Ellen underwent flexor carpi radialis (FCR) to EDC and palmaris longus (PL) to EPL tendon transfers due to loss of metacarpal phalangeal joint extension and thumb extension. She also underwent application of a collagen matrix to areas of soft-tissue loss. She returned to the operating room 3 weeks after injury for placement of split-thickness skin graft (STSG) over the collagen matrix.

Table 3
Initial-modified and follow-up–modified RIDI scores for case series

Stage	Case 1		Case 2		Case 3	
	Initial	Follow-up	Initial	Follow-up	Initial	Follow-up
Shock (5-20)	17	15	8	9	13	11
Anxiety (5-20)	18	13	7	8	12	11
Denial (6-24)	15	9	20	16	20	17
Depression (8-32)	23	17	9	10	16	14
Internalized anger (7-28)	26	20	12	9	12	12
Externalized hostility (8-32)	29	18	12	11	14	17
Acknowledgment (8-32)	24	25	25	25	27	23
Adjustment (6-24)	14	20	23	24	20	21

UE presentation and function

Ellen was initially evaluated by occupational therapy 7 weeks after injury. She reported 4/10 “sharp, radiating” pain to her right hand, wrist, and forearm at rest. Ellen reported pain as high as 7/10 with movement but often would not voluntarily report pain or show overt signs of discomfort. She required minimum to moderate assistance with ADLs and relied on her husband for transportation. She also had a loss of protective sensation to the ulnar nerve–innervated aspect of her right hand. Through rehabilitation, Ellen made steady ROM and strength gains. She gained adequate active thumb extension with the PL to EPL transfer within the first month of the therapy. However, due to scar tissue from the overlying STSG at the point of the FCR to EDC union, as well as delayed wound healing, her active wrist extension was slower to progress. Her treatment sessions consisted of wound care, PROM to address joint capsular tightness, tendon gliding to address significant tendon adherence, and strengthening exercises. Ellen also progressed through several orthoses during her treatment: a custom post-operative tendon transfer orthosis with wrist and digits in slight extension to protect the healing tendon transfer and skin graft, a resting hand orthosis after she was cleared for flexion of her wrists and digits to wear at night to promote functional positioning, as well as a static-progressive metacarpal phalangeal joint flexion orthosis several times per day to address joint capsule tightness and tendon adherence from her injury and period of immobilization after surgery.

A number of functional tasks were also incorporated into occupational therapy. Ellen’s personal goals during occupational therapy included being able to cook meals for her family without assistance, returning to running outdoors for exercise, and learning to shoot a pistol as a new leisure activity. These personal goals helped Ellen to stay motivated during her long course of therapy. She would often come to therapy and report new functional gains: tasks she was able to complete in the kitchen, shooting skills she

Fig. 2. Photograph from case study 2 demonstrates the soft-tissue loss sustained in her initial traumatic injury.

was able to master during her time with the firearms specialist in recreational therapy, or a successful run outdoors with the use of a compression sleeve to prevent swelling and discomfort in the right UE. Functionally, Ellen progressed from almost full-time use of her nondominant left hand for daily tasks to writing and signing her name with her right hand. She was also able to complete self-care tasks, light housekeeping, and driving at a modified independent level for increased time. See Table 2 for a full summary of physical outcomes.

Psychosocial presentation

Ellen completed the RIDI 2 months after her initial injury. Her RIDI scores were in the high range for the adaptive reactions of acknowledgment and adjustment and low for the nonadaptive reactions of shock, anxiety, and depression. Ellen displayed strong motivation and dedication to recovery as evidenced by her focus during rehabilitation sessions and excellent compliance with her home exercise and orthosis wear programs. During her initial therapy visits, Ellen was tearful when discussing the events of her injury, her decreased control of her dominant hand, as well as the long course of recovery she faced. Ellen was receptive to the idea of attending counseling sessions with a clinical psychologist where she was able to process the events of the attack and resulting injuries. Her acknowledgment of her new limitations was highlighted in her ability to adapt her daily routines to accommodate the decreased function of her dominant hand (ie, completing her hand and wrist stretches throughout the day to allow increased use of her hand, as well as allowing increased time to complete her daily tasks). Her faith and supportive relationships with her husband and grown children were a source of encouragement for her and helped with adjusting to a severe, life-changing injury. As a result of her injuries, Ellen decided to retire from her fast-paced job 1 year early to seek more quality family time. She also became involved with a new hobby of range shooting with others who had sustained severe extremity injuries for hand and eye dominance retraining, and has expressed a desire to volunteer to help patients with severe extremity injuries.

Ellen completed a follow-up RIDI survey approximately 11 months after her initial injury. Many of her scores remained consistent with the results of her original survey. The most notable changes were slightly decreased scores in the denial and internal anger subscales. See Table 3 for a full summary of psychosocial outcomes.

Case study 3

History

Jessica, a 21-year-old, right-hand dominant female presented after a traumatic right transhumeral amputation and replantation. In April 2016, Jessica lost control of her car when she was driving home from her job in the early morning hours. In the ensuing accident, a guardrail protruded through the vehicle and transected her right UE at the proximal humerus (see Fig. 3). Her severed limb was recovered, and she was transported to the hospital, where her amputated limb was evaluated. After careful consideration, the surgical team decided to move forward with a replantation, with the understanding that the limb salvage could fail and an amputation might ultimately be necessary. She underwent a series of surgical procedures during the initial replantation, including extensive irrigation and debridement, vascular reconstruction, forearm and hand fasciotomies, and an open reduction and internal fixation of the humerus. Additional procedures followed the days after the replantation, including an ulnar nerve primary repair, allograft repair of the median nerve, oxygen nerve graft to the radial nerve, and an open reduction and internal fixation of the ulna and radius. Soft-tissue defects to the extremity were repaired with STSGs and a latissimus dorsi muscle flap.

UE presentation and function

Jessica was evaluated by occupational therapy 3 weeks after injury. After the replantation, sensation and motor function distal to the level of repair were absent. AROM in the right shoulder was limited due to swelling and postoperative dressings. There were moderate limitations in the PROM of the elbow and wrist due to edema, but the digits were supple and PROM was within normal limits. Jessica reported moderate pain (6/10) at rest. Despite lack of use of her dominant hand, she required minimal assistance with basic ADLs; however, she required maximum assistance from her boyfriend and family for the care of her 2 young children. Rehabilitation focused on positioning, custom orthoses fabrication, edema management, ROM, and extensive education on a home program. Jessica was provided with an elbow hinge orthosis (to allow for alternating flexion/extension throughout the day) and a resting hand orthosis to position digits in an intrinsic plus position. Edema was managed through compression wrapping and manual edema mobilization. Jessica performed AROM of the shoulder, whereas the elbow, wrist, and hand were ranged passively. She was educated on the use of 1-handed techniques for ADLs, including the use of adaptive equipment. Jessica's boyfriend was also educated on wound care, edema management, and PROM exercises to encourage treatment compliance outside of the clinic. Her children would often attend her therapy sessions and often participated with games and crafting activities. Jessica reported that it was

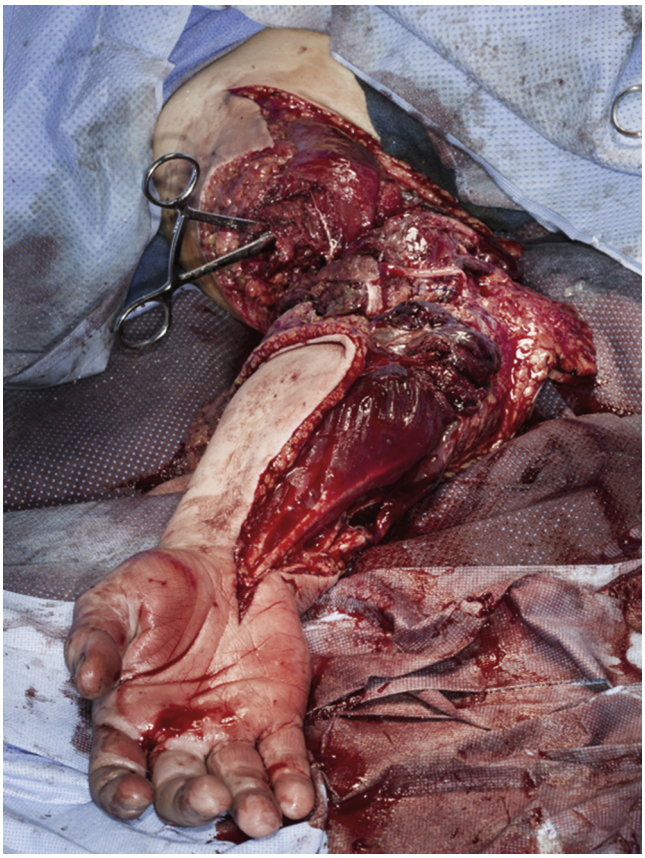

Fig. 3. Photograph from case study 3 depicts the severed limb prior to replantation.

important for her to be able to interact and play with her children as she did before injury.

Given her extensive injuries, Jessica made excellent gains in therapy. She quickly incorporated 1-handed techniques into her routines. Her skin grafts healed with minimal complications, and edema decreased dramatically over the first few weeks. Approximately 6 weeks after injury, Jessica began to report painful sensations over her elbow. Additionally, she began to regain limited elbow flexion in a gravity-eliminated plane. As this was distal to the level of repair, it suggested early nerve regeneration. See Table 2 for a full summary of physical outcomes.

Psychosocial presentation

Jessica completed the RIDI 4 weeks after injury. Overall, she scored highest on adaptive reactions to disability (acknowledgment and adjustment). While she scored low on the majority of the nonadaptive reactions, she did score relatively high on the denial subscale. This indicates that Jessica may not have yet realized the full extent of her new limitations or fully accepted the guarded prognosis that is generally expected after limb replantation. Jessica's affect in therapy was consistent with her high levels of adaptive reactions. She was optimistic and cheerful and was able to view her limb without discomfort. Jessica was open to speaking with others about her injury and was even able to joke about it (she shared a story that she was given a discount at a nail salon, due to only having 1 arm). Jessica stated that she was able to cope with her injury due to the support of her family and boyfriend. Aside from helping with childcare, her boyfriend and grandmother have acted as her primary caregivers and provided assistance with transportation to and from therapy appointments. As Jessica would be unable to return to work as a waitress, she began to make alternate plans for her future, including returning to school to pursue higher education.

Jessica completed a follow-up RIDI survey approximately 8 months after her initial injury. The most notable changes were an increase in the externalized hostility subscale and a decrease in the acknowledgment subscale. These scores may reflect an increased realization of her injuries and the impact it has on her life. See Table 3 for a full summary of psychosocial outcomes.

Discussion

As the dexterity and sensory feedback of the hand can only be marginally replicated with a prosthesis, limb salvage is typically attempted whenever possible after traumatic UE injury.[1,2] It is important to address the physical and psychosocial needs of the patient who has undergone UE limb salvage. Findings from this case series offer important insights.

The concept that limb salvage may result in late amputation was explored in Paul's case. For the first 9 years after his initial injury, the salvaged limb was hypersensitive and painful. Paul requested an amputation, arguing that this would end his pain and increase his function, as he would be able to use a prosthesis more effectively than his damaged and painful extremity. Paul's desire for amputation is consistent with existing literature, which has indicated that pain is typically a major factor in the consideration of an elective amputation.[2,8,27,28] However, surgical teams may not agree that amputation is the most appropriate treatment, as it is generally accepted that a "bad hand" is still more functional than a "good prosthesis."[1] Paul's case suggests that pain management is of high importance, and placing priority on this aspect during therapy may be very beneficial to those who have experienced UE limb salvage procedures. Pain levels may be very high, but elective amputation may not always be indicated, desired, or even result in adequate management of the pain. When typical pain management techniques have limited impact (ie, medication, physical agent modalities, and injections), psychological intervention may be beneficial. Pain has a strong psychological influence, and the experience of pain is often increased by depression, anxiety, and poor coping skills—traits that were apparent in Paul.[29,30] Providers may consider exploring psychological interventions, such as cognitive behavioral therapy, which may help to address pain and its contributing maladaptive thought patterns.[31] Paul was referred for psychological intervention while he was undergoing postoperative therapy which focused on cognitive and behavioral strategies to address pain, anger, and anxiety.

In a literature review of psychosocial issues after traumatic hand injury, Hannah[19] discussed that poor adaptation may manifest itself in behavioral symptoms, such as gaze avoidance. In hand therapy, gaze aversion occurs when a patient is unable to look at the injured hand for prolonged periods of time. Patients may engage in "hand-hiding" behaviors, such as covering the hand with bandages or scarves even after the wound has healed.[19] In this case series, Paul often positioned his hand out of sight in his pocket or under a sweat band, stating that it was difficult for him to see his injured hand. In contrast, Ellen and Jessica were less disturbed by the appearance of their limbs and felt less of a need cover them, despite obvious deformities. In this instance, Paul exhibited nonadaptive reactions to his injury, whereas Ellen and Jessica had more adaptive behavior patterns. Gustafsson et al[32] found that in individuals with trauma to the UE, negative reactions to the sight of the hand were predictive of mood disorders, such as depression and anxiety. Therefore, it may be helpful for providers to monitor a patient's reaction to the sight of the salvaged hand and/or limb during therapy. Patients who demonstrate hand-hiding behaviors that interfere with therapeutic recovery may benefit from a referral for greater psychological support.[19,32]

It is interesting to note that in the current case series, time since injury was not necessarily indicative of psychosocial adaptation to UE limb salvage. This is in contrast to the original UE limb salvage survey study by the authors, which suggested that those more than 6 months after injury tended to have better psychosocial outcomes. While Paul had been living with his salvaged UE for 9 years, his reactions on his initial RIDI survey were primarily nonadaptive. Jessica, who was only 4 weeks after injury, demonstrated the most adaptive reactions out of the cases. Gustafsson et al[33] examined psychological distress after traumatic hand injury over a 10-year period. The authors suggested that psychological distress is a natural reaction after injury and that most individuals recover naturally during the first 3 months. However, the authors also suggest for providers to remain aware of a patient's adaptation to UE trauma through a "watchful waiting" technique.[33] Those who show continued (or increasing) symptoms of psychosocial distress after the first several months, as in Paul's case, may benefit from psychological consultation. Providers should also be aware that delayed onset psychological distress is also possible following a traumatic injury.[33] While Jessica scored high on adjustment and acknowledgment at 4 weeks after injury, her follow-up scores in the acknowledgment subscale decreased at 8 months after injury. It should also be noted that Jessica initially scored high in the denial subscale, suggesting that she may not have realized the full extent of her limitations and prognosis—realizations that could be challenging weeks or months in the future. Additionally, as individuals begin to return to roles and activities after traumatic injury, new physical limitations could continue to present themselves, threatening psychosocial adaptation. As a result, psychological assessment should be ongoing.[33]

As UE limb salvage causes permanent physical impairment, the ability to participate in daily activities and fulfill meaningful life roles may be altered. These role changes had variable effects on the patients in this case series. Unable to resume her typical job duties due to new functional limitations, Ellen used her injury as a sign to "slow down." She decided to retire from work and focus her attention on her other roles. Ellen verbalized that she viewed these role changes as positive, which correlates with her high scores on the adaptive RIDI subscales. Like Ellen, Jessica also used her injury as an opportunity to make positive changes and take on new roles. Unable to return to her job as a waitress, she decided to go to college. In contrast, Paul struggled with the loss of his roles as a military member, father, and athlete, which was evident in his nonadaptive RIDI scores. Schier and Chan[34] discussed intervention after hand injury and resultant role changes. Many hand therapists use a biomechanical "bottom-up" approach, focusing on performance components such as ROM and dexterity. Schier and Chan[34] suggest adapting a "top-down" approach for individuals with hand trauma, focusing on evaluation of performance in roles, activities, and habits *first*, and then funneling down to these performance components. Hannah recommended patient-centered assessments, such as the Canadian Occupational Performance Measure and the Patient-Specific Functional Scale to allow patient and therapist to work together to identify meaningful and achievable goals.[19] While ROM, strength, and dexterity must be addressed in therapy, activities that are valued by the patient should be the major focus of treatment. Incorporating activity modification, compensatory strategies, and adaptive equipment alongside biomechanical interventions may help patients return to valued roles, improving adaptive reactions.[19]

Finally, this case series highlights the importance of adequate social support. Ellen and Jessica demonstrated adaptive reactions to their new disabilities, and both largely credited their well-being to the support of their families. Social support has long been recognized as a key factor in positive psychosocial outcomes following trauma,[35-39] and individuals who lack adequate social support have been found to be at risk for poor psychosocial outcomes after LE limb salvage.[4,14] In practice, it may be beneficial for providers to monitor for isolating and socially avoidant behaviors, as these could potentially contribute to nonadaptive reactions to UE limb salvage. Referral to support groups for trauma survivors or individuals with hand injury may be helpful.[19]

Future research

This study was among the first to examine psychosocial reactions after limb salvage caused by UE trauma. As there is potential for nonadaptive reactions with certain variables in this population, future research is indicated to better understand risk factors and effective interventions. Future studies related to UE limb salvage may include volumetric measurement of UE edema to improve accuracy over circumferential measures, which would support correlational analysis with pain. The Michigan Handedness Questionnaire may be helpful to incorporate information not gained through the DASH, such as the influence of hand dominance on function and components related to cosmesis. The Canadian Occupational Performance Measure or the Patient-Specific Functional Scale may also be useful instruments in this population, as their format for self-directed goal establishment may help direct providers toward a focused, holistic care plan.

Conclusions

This case series detailed the psychosocial adaptation process of 3 individuals with UE limb salvage. Reactions to injury varied across the cases; however, these outcomes suggest that psychosocial adaptation for this population may be influenced by the experience of pain, the ability to participate in valued roles and activities, and having a supportive social network. Hand therapists should emphasize pain management, focus on client-centered goals and interventions, and facilitate social support. Providers should also monitor patients closely for signs of poor adjustment to UE limb salvage, such as hand-hiding behaviors, and provide additional psychological support when indicated. As this study is among the first to examine psychosocial reactions to UE limb salvage, future research would be beneficial to provide deeper understanding of the psychosocial challenges for this population.

Acknowledgments

This study was funded by the U.S. Army Research Institute of Environmental Medicine (USARIEM), the Military Operational Medicine Research Program (MOMRP), Research and Analysis Division (RAD3). The funding amount was for $70,000 and the grant number was 13990. The funding sources had no role in data collection, analysis and interpretation of data, the writing of the report, or the decision to submit the article for publication. The views expressed herein are those of the authors and do not reflect the official policy or position of Brooke Army Medical Center, the U.S. Army Medical Department, the U.S. Army Office of the Surgeon General, the Department of the Army and Department of Defense, or the U.S. government.

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1. The following were used to assess patients' psychosocial recovery
   a. MMT & PROM
   b. RIM & DoJ
   c. VAS & Short DASH
   d. DASH & RID
2. A typical sign of poor adaption is
   a. weight gain
   b. unkempt appearance
   c. hand-hiding
   d. risk taking
3. The RID has been criticized for its
   a. lack of an established way to determine MDC
   b. lack of reliability
   c. lack of validity
   d. difficulty to administer
4. The study design is
   a. RCTs
   b. a case series
   c. a case study
   d. prospective cohort
5. The authors claim that this research is definitive for the management of appropriate psychosocial adaptation following upper extremity trauma and salvage
   a. true
   b. false

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