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Physical Therapy Management Of Gross Function Loss Following Gunshot Wound To Left Hand: A Case Report

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1 **Physical Therapy Management of Gross Function Loss**
2 **Following Gunshot Wound to Left Hand: A Case Report**

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10
11 The author acknowledges faculty mentor Tara Paradie, PT, MS for assistance with case report
12 conceptualization, Michelle Turner, PT, DPT, FAAOMPT for supervising and assisting with
13 clinical patient management, and the patient for his participation in this case report.

14
15 The patient signed an informed consent allowing the use of all medical information and
16 photographs taken for this case report and received information on the institution's policies
17 regarding the Health Insurance Portability and Accountability Act.

18
19 Key Words: Rehabilitation, Physical Therapy, Gunshot, Hand, Wrist, Return to work.

23 **Abstract**

24 **Background and Purpose:**

25 Nonfatal gunshot emergencies occur regularly within the United States but do not
26 often lead to patients entering outpatient physical therapy clinics for rehabilitation. The complex
27 musculoskeletal injuries which result from gunshot wounds may require prolonged rehabilitative
28 care to best achieve functional outcomes, but clinicians may find a gap in the current literature
29 for guidance. The purpose of this case study is to describe the outpatient rehabilitation treatment
30 interventions for a gunshot wound to the hand, including manual therapy, therapeutic exercise,
31 therapeutic activity, and neuromuscular reeducation.

32 **Case Description:**

33 The patient was a 34-year-old, left hand dominant, white male who presented to physical
34 therapy after accidentally discharging his handgun on the ventral side of his left hand. During
35 initial examination, the patient presented with gross dysfunction of the musculoskeletal,
36 neuromuscular and integumentary systems which limited his ability to use his left hand while
37 performing activities of daily living (ADLs) and work tasks.

38 **Outcomes:**

39 The patient improved towards all set goals including strength, pain rating, and range of
40 motion (ROM). AROM wrist flexion improved from 20 degrees to 70 degrees, PROM forearm
41 supination improved from -45 degrees to 64 degrees and average PROM metacarpophalangeal
42 flexion improved from 29 degrees to 75.8 degrees. Wrist extension remained highly restricted,
43 limiting the patient's ability to fully return to ADLs, IADLs, and all necessary job functions.

44 **Discussion:**

45 The patient displayed improvements in ROM as demonstrated by handheld goniometry
46 values, strength as demonstrated by MMT grades and dynamometry, and progressed

47 exceptionally well towards all chosen goals. These outcomes suggest that a comprehensive
48 approach to the PT rehabilitation of a gunshot wound to the hand appears to be successful in
49 promoting functional patient gains.

50 **Manuscript Word Count:** 2444

51

52 **Introduction Background and Purpose**

53 In 2018, the CDC estimated 18,921 emergency department visits were due to
54 unintentional nonfatal gunshot emergencies within the United States.¹ Gunshot wounds inflict
55 damage to bones, joints, neural structures, and soft tissues making musculoskeletal injury
56 common.² Traditionally, gunshot wounds may require complex medical care and it is a unique
57 circumstance for survivors to receive treatment in an outpatient physical therapy facility,
58 subsequently, there is a gap in the literature regarding similar cases. The purpose of this case
59 study is to describe the outpatient rehabilitation treatment interventions for a gunshot wound to
60 the hand, including manual therapy, therapeutic exercise (therex), therapeutic activity (theract),
61 and neuromuscular reeducation.

62 The review of successful skilled therapy interventions following a gunshot wound to the
63 hand is important to understand due to the significant role that the hands perform during
64 activities of daily living (ADLs) and instrumental activities of daily living (IADLs). As
65 demonstrated in this case, limitation in hand function is strongly related to restricted participation
66 and impacted quality of life.³

67 **Patient History and Systems Review**

68 A 34-year-old, left hand dominant, white male who presented to physical therapy after
69 accidentally discharging his handgun on the ventral side of his left hand. The patient, who
70 reported living with his longtime girlfriend and their two young children, underwent emergency

71 surgery to repair tissue damage on 3/27/2020. He was employed by the sanitation department at
72 the local hospital and reported requiring the use of his upper extremities to perform his daily job
73 duties. The patient also stated that he enjoys fishing, and that he spends much recreational time
74 playing with his children.

75 The patient reported that his main goals for physical therapy were as follows: improved
76 range of motion (ROM), improved strength, and increased motor control of both fine and gross
77 movement of his left hand. He hoped to participate in his prior level of ADLs, IADLs, and job-
78 related functions such as lifting, gripping, grasping, pushing and pulling.

79 The patient provided written and verbal consent to participate in this case study.

80 A systems review was performed on the patient which identified gross dysfunction of the
81 musculoskeletal, neuromuscular and integumentary systems. A full systems review is reported in
82 Table 1.1.

83 The patient's past medical history is significant for previous treatment of a distal L radius
84 fracture which reportedly did not result in any continued functional limitation prior to his current
85 episode of care.

86 Examination revealed ROM and strength compromises of the dominant L hand that
87 impaired the patient's ability to perform ADLs, IADLs, and job functions.

88 This patient presented as a good candidate for this case report due to the uniqueness of
89 his injury as well as the gap in published literature available to guide the prolonged rehabilitative
90 care of a gross soft tissue trauma to the upper extremity (UE).

91 **Examination – Tests and Measures**

92 Initial examination of the patient included pain ratings, neurovascular screening and a full
93 ROM assessment of his L UE. Using the visual analog scale (VAS)⁴, the patient rated his pain
94 levels as a 4/10 at best to an 8/10 at worst which occurred during active use of the L UE.

95 Neurovascular screening indicated decreased sensation following the patient's median nerve
96 distribution. Active and passive ROM measurements were performed with a handheld
97 goniometer, which identified gross, multidirectional limitations of wrist flexion and extension,
98 radial and ulnar deviation, and all metacarpophalangeal and interphalangeal motions of the hand.
99 A full ROM assessment is available in Table 1.2. Piriyaarasarth P and Morris ME⁵ have shown
100 handheld goniometers have good reliability and validity when measuring joint motion. Due to
101 patient discomfort and decreased ROM, all additional measurements, special tests, and joint
102 mobility assessments were completed in follow-up visits.

103 **Clinical Impression: Evaluation, Diagnosis, Prognosis**

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105
106 Based on the initial examination findings, the physical therapy patient diagnosis was left-
107 hand weakness (R29.898). As the injury was not complicated by fracture, tendon or ligament
108 repair, the patient was given a good prognosis for recovery and return to work. No outside
109 referrals were deemed necessary at this time.

110 Primary goals included AROM of the L hand, improved writing function and lifting
111 ability. These are included in Table 1.3. Interventions included therex such as stretching,
112 strengthening, and tendon gliding; manual therapies to improve soft tissue mobility, joint
113 mobility, and sensation; and theract such as lifting, pushing, pulling, gripping, and carrying.
114 Modalities such as moist hot packs and neuromuscular electrical stimulation (NMES) were also
115 utilized to address soft tissue restriction, pain, and weakness .^{6,7,8}

116 The patient was appropriate for this case report due to his willingness to participate, the
117 regularity of his treatment sessions, and his good potential for recovery.

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122 **Intervention and Plan of Care**

123 **Coordination, Communication, Documentation**

124 Coordination of care for the patient included communication between the treating student
125 physical therapist and his clinical instructor regarding all treatment interventions, the patient's
126 Dynasplint (Dynasplint, Stevensville, MD) representative, and his primary care physician. The
127 patient was educated on the findings of the objective examination, the plan of care (POC), and
128 the objective goals decided. He agreed to attend therapy appointments twice a week until he
129 returned to a level of functional independence with his L UE. The POC included a home exercise
130 program (HEP) which instructed the patient on appropriate frequency, duration, and intensity for
131 all exercises. He reported his compliance with his home program, response to his previous
132 treatment, and overall levels of function at each visit. There were no suspected limitations in
133 adherence during the course of his treatments. All visits were documented using an electronic
134 medical records system and cosigned by the clinical instructor.

135 **Procedural Interventions**

136 The patient began initial visits with a moist hot pack wrapped around his L wrist to
137 improve soft tissue extensibility and decrease discomfort.^{6,7} As ROM improved with subsequent
138 treatment, he used a SCIFIT PRO1031(SCIFIT, Tulsa, OK) upper body ergometer, chosen to
139 increase blood flow and improve UE and cardiovascular endurance.^{9,10} Soft tissue and joint
140 mobilizations were performed following each warmup, followed by neuromuscular reeducation,
141 electrical stimulation, therex, and theract. The duration and intensity of each individual
142 intervention varied between visits due to the patient's tolerance and the therapist's clinical
143 reasoning.

144 Therapeutic Exercise

145 A detailed list of therex interventions including parameters and purpose can be found in

146 Table 1.4. Interventions focused on AROM, PROM, self-stretching, strengthening, and motor
147 control. Progressions were made for each specific intervention regarding intensity, duration, and
148 coordination requirements as the patient regained fine and gross motor function in his L hand.

149 Therapeutic activities

150 Theract was introduced as the patient's motor control improved and promoted him to use
151 his L hand during functional tasks. Interventions included completing pencil control worksheets,
152 sentence writing practice, and towel folding during earlier sessions. Left-handed writing and
153 pencil control were specific interventions selected to address his functional goal. During later
154 sessions, he progressed to floor-to-waist and floor-to-chest lifting, selected to address strength
155 required for job performance. Detailed descriptions of each intervention can be found in Table
156 1.5.

157 Manual Therapy

158 Manual therapy techniques were integral to improve soft tissue and joint mobility.¹¹⁻¹⁵
159 Interventions included passive stretching, proprioceptive neuromuscular facilitation (PNF)
160 stretching, sensory reeducation, joint mobilization, and instrument assisted soft tissue
161 mobilization (IASTM). IASTM treatments were performed using HawkGrips (HawkGrips,
162 Conshohocken, PA) instruments. Manual treatments took a considerable amount of time during
163 each visit due to the gross mobility restrictions the patient was experiencing throughout each
164 joint in his hand, wrist, and elbow. Sensory training was an important component during each
165 visit due to the hypersensitivity the patient experienced over his surgical scar and the paresthesia
166 experienced throughout the hand.¹⁶ Detailed descriptions of each manual therapy technique are
167 described in Table 1.6.

168 Neuromuscular Reeducation

169 Neuromuscular reeducation techniques supplemented therex and theract to help

170 reestablish fine motor control of the intrinsic musculature and to improve ADLs such as
171 dressing, bathing, cooking and writing. Tapping was utilized during multiple sessions to help
172 increase the patient's capacity to voluntarily contract the intrinsic and extrinsic hand
173 musculature.¹⁷ During the tapping procedure, the therapist provided a light but firm tapping
174 stimulus over the muscle belly of the target muscle, while the patient performed a maximal
175 voluntary contraction. The tapping technique was performed for three sets of five second bouts at
176 each metacarpophalangeal and interphalangeal joint.

177 Modalities and Splinting

178 Modalities including moist hot packs and neuromuscular electrical stimulation (NMES)
179 (Zynex Medical, Meridian, CO) were implemented during initial visits to improve soft tissue
180 mobility and muscular strength. A moist hot pack was wrapped around the L wrist and hand for
181 ten minutes prior to treatment to increase blood flow and soft tissue extensibility of the forearm,
182 wrist and hand musculature. NMES was also implemented to assist in the activation and
183 strengthening of the wrist extensors.⁸ Electrodes were placed along the extensor digitorum
184 muscle belly until a contraction of pure wrist extension was isolated. With the forearm resting on
185 a chair's armrest, a hand towel was wrapped over the top of the forearm and tucked underneath
186 the patient's legs. This prevented any elbow flexion from occurring during contraction. He was
187 instructed to perform a maximal voluntary wrist extension contraction at the same time the
188 stimulus was applied. Treatment settings were set to 200 μ s, 50pps at 10sec on, 30 sec off.

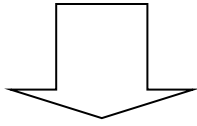
189 Following visit 14, the patient began using a Dynasplint (Dynasplint, Stevensville, MD)
190 prior to visit 15 to help improve hand and wrist ROM between visits. The splint was designed to
191 specifically improve wrist extension as well as finger flexion and extension. The tension of the
192 splint was capable of being altered to increase tension as his ROM improved. He was provided
193 written and verbal instructions regarding wear time and the frequency of tension adjustments

194 directly from his Dynasplint representative.

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196 **Timeline**

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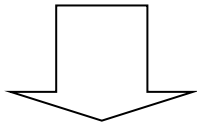
Pre-evaluation:

- Patient shot in L hand
- Undergwent emergency surgery to repair tissue damage
- Past medical history of open treatment for distal L radius fracture

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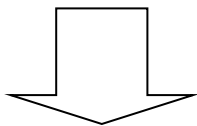
Visit 1: Initial Evaluation

- One-month status post gunshot and surgical repair
- Measurements including verbal pain rating, ROM, neurovascular screening

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Visits 2-8: Intervention Focus

- Decrease pain
- Improve soft tissue and joint mobility in the entire UE
- Initiate gentle strengthening of the intrinsic and extrinsic hand musculature
- Begin restoring fine and gross motor control

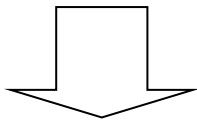
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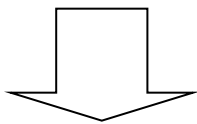
Visit 9: Re-evaluation 1

- Two months status post gunshot and surgical repair
- Verbal pain rating, progression towards impairment and functional goals, active and passive ROM reassessed

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Visits 10-18: Intervention Focus

- Decrease pain
- Improve soft tissue, surgical scar, and joint mobility
- Progress intrinsic and extrinsic hand strengthening
- Initiate UE and cardiovascular endurance training
- Initiation of hand splint use while at home

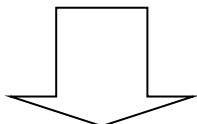
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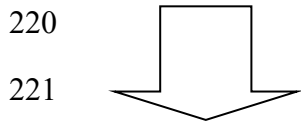
Visit 19: Re-evaluation 2

- Three months status post gunshot and surgical repair
- Verbal pain rating, progression towards impairment and functional goals, active and passive ROM reassessed

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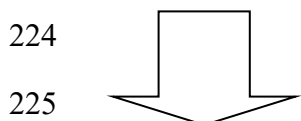
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Visits 20-25: Intervention Focus

- Continued improvements in UE joint mobility
- Progress intrinsic and extrinsic strengthening with increased focus on L UE use during functional tasks
- Improve fine motor control



Visit 26: Final Re-evaluation

- Four months status post gunshot and surgical repair
- Verbal pain rating, progression towards impairment and functional goals, active and passive ROM, and strength reassessed

Outcomes

The patient was seen for a total of 26 visits over the course of data collection and was fully compliant with his POC including completion of his HEP and splinting schedule. He had regular reevaluations to monitor improvements in pain reduction, impairment goals, functional goals, and overall UE mobility. ROM notably improved in most forearm, wrist, and hand joints. However, both active and passive wrist extension remained highly restricted, limiting the patient's ability to fully return to ADLs, IADLs, and all necessary job functions.

The patient's verbal pain rating fluctuated between re-evaluations but ultimately increased from an initial 4/10 to a final 7/10 at worst. It was specified that his pain elevated during treatment and after prolonged splint use, but he did not experience any pain when resting or performing ADLs or IADLs by the 26th visit. His decrease in pain during rest and general activity ultimately allowed him to increase the use of his L UE during functional tasks throughout the day.

Improvement of the ROM of his hand, wrist and forearm became a top priority as his function was predominately limited due to mobility restrictions. While ROM gains were less substantial in wrist extension and motions of the first digit, there were ultimately sufficient

245 improvements throughout the UE to allow increased functional use of the L UE. Progressions
246 towards the achievement of chosen impairment goals were also satisfactory. The patient could
247 achieve an estimated 45% closed fist by the final visit and had made significant improvements in
248 wrist flexion as well as forearm supination and pronation. Table 1.2 documents all ROM
249 measures at the initial evaluation and each subsequent re-evaluation.

250 Documenting accurate strength assessments was not possible during the initial evaluation
251 due to the patient's inability to tolerate standard testing positions due to pain and decreased
252 ROM. This changed over the course of treatment and ROM improvements allowed for limited
253 strength measurements to be assessed by the final examination. Strength testing during the final
254 examination included forearm supination and pronation, wrist flexion, lateral pinching strength
255 and grip strength. Wrist and forearm strength measures were assessed using manual muscle tests
256 (MMTs)¹⁸ while pinch and grip strength measures¹⁸ were taken by the Jamar Hydraulic Hand
257 Dynamometer and Jamar Pinch Gauge (Fit System Inc, Calgary, Canada). Wrist flexion
258 improved to 4/5, and forearm supination and pronation both improved to 5/5. Lateral pinch on
259 the L improved to 3lbs of force and grip strength improved to 10lbs of force. Lateral pinching
260 and gripping with the R UE were assessed to be 15lbs and 90lbs respectively.

261 The patient demonstrated improving ability to use his L hand functionally and as his pain
262 decreased, his ROM improved, and his strength progressed towards preinjury levels. This was
263 observed during pen control theract and functional lifting tasks. By the final re-evaluation, the
264 patient was able to write continuously for three minutes using a tripod grip before mild
265 discomfort occurred, a significant improvement from his initial inability to assume correct
266 prehension. He was also able to lift 10lbs to his chest and 25lbs to his waist using a hook grip in
267 order to better participate in required work activities and care for his children. The importance of
268 the tripod and hook grips as they relate to participation is noted in appendix A.

269 **Discussion**

270 The purpose of this case report was to describe the outpatient rehabilitation treatment
271 interventions for a gunshot wound to the hand, including manual therapy, therapeutic exercise,
272 therapeutic activity, and neuromuscular reeducation. This case reported demonstrated its
273 intended purpose by describing the utilization of chosen interventions and their impact on UE
274 ROM, strength, and overall function. The patient displayed improvements in ROM as
275 demonstrated by handheld goniometry values, strength as demonstrated by MMT grades and
276 dynamometry, and progressed exceptionally well towards his impairment and functional goals.
277 These findings are consistent with expected rehabilitation outcomes of those without serious
278 medical complications and help to fill the current gap in literature to support prolonged
279 outpatient rehabilitation following a gunshot wound.

280 A strength in this case was the amount of one-on-one time the therapist could provide to
281 this patient. The therapist organized his schedule to allow up to two hours of care on occasional
282 visits to perform ample assessment and treatment. The patient was also allotted 60 visits by his
283 insurance prior to beginning treatment which allowed for frequent episodes of care. A limitation
284 to this case was the lack of continued data collection following the patient's 26th visit. It is
285 unknown if the patient continued to make functional improvements within his prior POC.

286 In conclusion, a comprehensive approach to the PT rehabilitation of a gunshot wound to
287 the hand appears to be successful in promoting functional patient gains. The primary conclusion
288 in this case report is that PT interventions should be tailored to the patient-specific limitations
289 and the activities they hope to return to due to the complex nature of hand rehabilitation. This
290 case report may help to fill the current gap in literature to support the prolonged care of patients
291 with gunshot wounds and may help to guide clinical decision making when choosing potential
292 interventions. Further research into the optimal amount of daily therapy to maximize functional

293 outcomes may better guide clinical decision-making and the development of a thorough POC.

294

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371 **Tables and Figures**

372 **Table 1.1 Systems Review**
373

Cardiovascular/Pulmonary	Intact
Musculoskeletal	Grossly impaired ROM and strength of the left upper extremity (L UE) including the elbow, wrist, and hand.
Neuromuscular	Impaired sensation and motor activity of the L hand and distal L UE
Integumentary	Moderate/severe pitting edema noted throughout the L hand, surgical scar hypomobility
Communication	Intact
Medications	None

374

375

376 **Table 1.2 ROM Measures**

Tests & Measures	Initial Eval	Re-Eval 1 Visit 9	Re-Eval 2 Visit 19	Re-Eval 3 Visit 26
Motion	AROM/PROM	AROM/PROM	AROM/PROM	AROM/PROM
Wrist flexion	20/25	40/55	70/85	70/78
Wrist extension	-5/-5	-18/-12	-15/-5	-15/-3
Ulnar deviation	0/0	0	7/8	22/25
Radial deviation	0/0	0	5/7	8/10
Pronation	50/55	NT/75	75/80	75/90
Supination	-45/-45	NT /39	55/60	53/64
Thumb CMC Radial Abduction	NT*/-30	NT /18	0/18	0/15
Thumb CMC Palmar Abduction	NT/-40	NT /28	20/23	23/26

Thumb CMC Flexion	NT/NT	NT /-5cm	/-5cm	-4.5cm/-3.8cm
Thumb CMC Extension	NT/NT	NT /10	/10	0/10
Thumb MP Flexion	NT/20	NT /35	35/35	40/50
Thumb MP Extension	NT/0	NT /0	0/0	0/0
Thumb IP Flexion	NT/20	NT /60	20/25	26/50
Thumb IP Extension	NT/0	NT /-4	-10/-5	-7/0
Digit 2 MP Flexion	NT/30	NT /65	35/60	46/84
Digit 2 MP Extension	NT/0	NT /-2	-10/-5	-5/0
Digit 2 PIP Flexion	NT/70	NT /73	58/70	52/93
Digit 2 PIP Extension	NT/-25	NT /-28	-40/-40	-45/-40
Digit 2 DIP Flexion	NT/20	NT /38	25/40	20/45
Digit 2 DIP Extension	NT/-5	NT /0	-5/0	-5/0
Digit 3 MP Flexion	NT/30	NT /66	28/65	45/74
Digit 3 MP Extension	NT/0	NT /0	-8/-4	-5/0
Digit 3 PIP Flexion	NT/40	NT /70	50/75	60/90
Digit 3 PIP Extension	NT/-20	NT /-40	-50/-45	-55/-50
Digit 3 DIP Flexion	NT/20	NT /55	40/55	45/63
Digit 3 DIP Extension	NT/-10	NT /-10	-25/-20	-25/-22
Digit 4 MP Flexion	NT/25	NT /55	40/60	65/81
Digit 4 MP Extension	NT/0	NT /10	0/15	0/15
Digit 4 PIP Flexion	NT/70	NT /70	48/75	50/85
Digit 4 PIP Extension	NT/-25	NT /-30	-40/-47	-45/-40

Digit 4 DIP Flexion	NT/30	NT /45	10/50	3/55
Digit 4 DIP Extension	NT/0	NT /0	0/0	0/0
Digit 5 MP Flexion	NT/40	NT /58	50/65	57/80
Digit 5 MP Extension	NT/0	NT /5	0/10	0/10
Digit 5 PIP Flexion	NT/55	NT /68	58/80	62/85
Digit 5 PIP Extension	NT/-30	NT /-35	-45/-40	-45/-50
Digit 5 DIP Flexion	NT/30	NT /50	10/65	10/60
Digit 5 DIP Extension	NT/-5	NT /0	-5/0	-5/0

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*Not Tested (NT)

Table 1.3 Impairment/Functional Goals

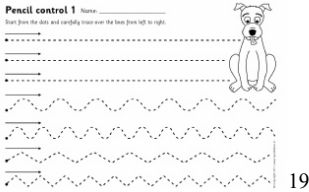
Impairment goals
60 Deg. AROM wrist flexion
50 Deg. AROM wrist extension
50 Deg. AROM supination
70 Deg. AROM pronation
90% AROM gross grasp
Functional goals
Symptom-free writing with a pen for 3 minutes
Perform 25# floor to chest lift in order to take care of young daughter

381 **Table 1.4 Therex Interventions**

Intervention	Parameters	Purpose	Visit # Performed
Elbow flexion/extension AROM	X30	Improve elbow ROM	1,2,3,4
Forearm supination/pronation AROM	X30, -x10 following visit #8	Improve forearm ROM	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22
Wrist flexion/extension/radial deviation/ulnar deviation/fist making	X30, -x10 following visit #8	Improve wrist/hand ROM	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22
Towel gripping	6x30sec hold	Improve grip strength	1,2,3,4,5,6,7,8
PROM finger flexion/extension	3x10	Improve finger flexion/extension ROM	1,2,3,4,5
Fine motor with peg board	Lift single peg out of board and place in another hole with 1 st and 2 nd digits 5 minutes. -1 st and 2 nd + 1 st and 3 rd following visit #10 -1 st and 2 nd + 1 st and 3 rd + 1 st and 4 th following visit #13	Improve fine motor control	4,5,6,7,8,10,11,12,13,15,16
Cone lift and transfer	3 cone stacking x30	Improve gross grasp and fine motor control	4,5,6,7,8,10,11
Lateral pinching	Yellow clothes pin 2x5 5sec hold, -Red clothes pin following visit #11	Improve lateral pinch strength	5,6,7,8,11,13,14,15,16,18,19,20
Stress ball gripping	5sec holds, 5 minutes	Improve grip strength	9,10,11,12,13,14,15,23,25
Combined finger and wrist extension stretch	4x30sec hold	Improve wrist and finger flexor length	9,11,12,13,14,15,16,17,18
Resisted finger extension	One rubber band wrapped around middle phalanx of all 5 digits. 3x5 5sec hold -two rubber bands following	Improve MCP and IP extension strength	11,18,19,20,21,24

	visit 18		
Resisted pronation/supination	Red Theraband (Theraband, Akron, OH) Flexbar 2x10 -3x10 following visit #16	Improve pronation/supination strength	14,15,16,17,18,19,20,21,22,23,24,25
Putty gripping	Multidirectional gripping 7 minutes	Improve hand intrinsic and gripping strength	17,20,21,22,24,25
Upper body ergometer	-visit 18: Level 1, 3min. anterograde + 3min. retrograde -visit 19,20,22: Level 1 4min. anterograde + 4min. retrograde -visit 23: Level 3 4min. anterograde + 4min. retrograde -visit 24,25,26: Level 4 4min. anterograde + 4min. retrograde	Improve UE endurance, bloodflow	18,19,20,22,23,24,25,26
Resisted wrist extension/flexion	Red Theraband Flexbar 2x10	Improve wrist extension/flexion strength	18,20,21,22,23,24,25
Digi-flex gripping	-visit 21: Yellow(1.5lb) 3x10 -visit 24,25: Red (3.0lb) 3x10	Improve hand dexterity and pinching strength of each finger	21,24,25
Resisted thenar flexion	Small orange therapy ball 10sec. hold, 3 min	Improve thenar strength	23,25
Standing single-arm bicep curl	3x10 5lb	Improve UE strength	23,24,25,26
Standing single-arm triceps extension	-visit 23: 3x10 15lb -visit 24: 3x10 20lb	Improve UE strength	23,24,25,26
Standing single-arm mid row	-visit 23,24: 3x10 15lb -visit 25: 3x10 20lb	Improve UE and shoulder girdle strength	23,24,25,26

Intervention	Parameters	Purpose	Visit # Performed
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Writing practice	Short sentence writing practice with pen on paper 8min. total	Improve writing function	21	
Towel folding and unfolding	L UE only 5min. total	Improve UE motor control	22	
Pencil control practice	 <p>Pencil control 1 <small>Trace</small> Start from the dots and carefully trace over the lines from left to right.</p> <p>19</p>	Straight- and curved-line tracing 5min. total	Improve writing function	24
Floor to waist lifting	-9lbx1 -10lbx3 -15#x3 -20#x3 -25# 3x3 -all lifts performed with hook grip	Improve lifting mechanics and functional UE use for required work activities	26	
Floor to chest lifting	10lbx3 -all lifts performed with hook grip	Improve lifting mechanics and functional UE use for required work activities	26	

383 **Table 1.4 Theract Interventions**
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387 **Table 1.6 Manual Therapy Interventions**

Intervention	Parameters	Purpose	Visit # Performed
Radiocarpal distraction	-Visits 1-10: Grade I/II 5sec. holds -Visit 11: Grade II/III 5sec. holds -Visit 15-: Grade III 5sec. holds	Improve wrist joint mobility	1,2,3,4,5,6,7,8,9,10,11,15,16,17,18,19,20,21,22,23,24
PROM: Wrist flexion/extension Wrist ulnar/radial deviation Finger flexion/extension Forearm pronation/supination	30sec holds	Improve forearm, wrist and hand soft tissue mobility	1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20
PNF Contract-relax stretching to wrist flexors	15sec. passive stretch followed by 5sec. active contraction of wrist flexors. 5min total	Improve wrist extension ROM	7,8,9,10,11,12,13,14,16
Anterior and posterior glide of proximal radius on ulna	Grade III oscillations. 5min. total	Improve proximal radioulnar joint mobility	9,10,11,12,13,14,19,21,22,23,24
Anterior and posterior glide of distal Radius on Ulna	Grade III oscillations. 5min. total	Improve distal radioulnar joint mobility	9,10,11,12,13,14,15,16,17,18,20,21,22,23,24
PNF contract-relax stretching for supination/pronation	15sec. passive stretch followed by 5sec. active contraction of the muscle being stretched. 5min total	Improve forearm supination/pronation ROM	11,12,13,14,16,18,19,20,21
IASTM to thenar musculature, wrist flexor musculature	5min total Instrument: Hawkgrrips Scanner tool	Improve hand and wrist soft tissue mobility	12,13,14,15,16,17,18,19,20,21,22,23,24
IASTM to surgical scar	5min total Instrument: Hawkgrrips Scanner tool	Improve scar mobility	12,13,14,15,16,17,18,19,20,21,22,23,24
PNF contract-relax stretching for MCP and IP	15sec. passive stretch followed by 5sec. active	Improve MCP and IP flexion/extension ROM	16,17,18,19,20,21

flexion/extension	contraction of the muscle being stretched. 5min total		
Anterior and posterior glides of 1 st -5 th carpometocarpal joints	Grade III oscillations	Improve carpometocarpal joint mobility ²	22,23,24,25,26
Anterior glide of proximal carpals on distal radioulnar joint with passive extension	Grade III oscillations	Improve wrist extension	25,26
Anterior glide of scaphoid and lunate on distal radioulnar joint	Grade III oscillations	Improve wrist extension	25,26
Anterior and posterior glide of 1 st -5 th metacarpophalangeal joints	Grade III oscillations	Improve MCP flexion and extension ²	25,26
Lateral glide of proximal radius/ulna on distal humerus	Grade III oscillations	Improve supination	25

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APPENDICES

Appendix 1: Prehension Grips

Prehension types describe the way the fingers and thumb grasp objects. The patient in this case demonstrated an improved ability to perform a tripod grip while writing and a hook grip while performing lifting activities. The tripod grip is a modified precision pinch grip that is commonly used in writing activities and provides the user with fine control of objects between the index finger and thumb. The hook grip includes holding an object, often a handle or strap, between partially flexed fingers and the palm. This grip allows the user to maintain a static position for longer periods of time and is necessary for the patient to perform his typical work activities.²⁰

401 **CARE Checklist**

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CARE Content Area	Page
1. Title – The area of focus and “case report” should appear in the title	1
2. Key Words – Two to five key words that identify topics in this case report	1
3. Abstract – (structure or unstructured) a. Introduction – What is unique and why is it important? b. The patient’s main concerns and important clinical findings. c. The main diagnoses, interventions, and outcomes. d. Conclusion—What are one or more “take-away” lessons?	2,3
4. Introduction – Briefly summarize why this case is unique with medical literature references.	3
5. Patient Information a. De-identified demographic and other patient information. b. Main concerns and symptoms of the patient. c. Medical, family, and psychosocial history including genetic information. d. Relevant past interventions and their outcomes.	3,4
6. Clinical Findings – Relevant physical examination (PE) and other clinical findings	4,5,16,17 18
7. Timeline – Relevant data from this episode of care organized as a timeline (figure or table).	9,10
8. Diagnostic Assessment a. Diagnostic methods (PE, laboratory testing, imaging, surveys). b. Diagnostic challenges. c. Diagnostic reasoning including differential diagnosis. d. Prognostic characteristics when applicable.	5
9. Therapeutic Intervention a. Types of intervention (pharmacologic, surgical, preventive). b. Administration of intervention (dosage, strength, duration). c. Changes in the interventions with explanations.	6,7,8,21 22,23
10. Follow-up and Outcomes a. Clinician and patient-assessed outcomes when appropriate. b. Important follow-up diagnostic and other test results. c. Intervention adherence and tolerability (how was this assessed)? d. Adverse and unanticipated events.	10,11
11. Discussion a. Strengths and limitations in your approach to this case. b. Discussion of the relevant medical literature. c. The rationale for your conclusions. d. The primary “take-away” lessons from this case report.	12,13
12. Patient Perspective – The patient can share their perspective on their case.	2
13. Informed Consent – The patient should give informed consent.	1

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