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Restoring Motion and Sensation: Physiotherapeutic Strategies for Humeral Shaft Fracture with Radial Nerve Palsy

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Abstract

Humeral shaft fractures, though relatively uncommon, pose distinct challenges, especially when accompanied by radial nerve palsy. This case report outlines the successful management of a mid-shaft humerus fracture with radial nerve palsy in a 53-year-old male involved in a road traffic accident. The patient underwent open reduction and internal fixation (ORIF) using plate osteosynthesis with radial nerve exploration. Postoperatively, a tailored physical therapy regimen was implemented, focusing on early range of motion (ROM) exercises, strengthening, and pain management through cryotherapy. A cock-up splint was used for wrist drop caused by radial nerve damage. Over 12 weeks, the patient demonstrated significant improvements in ROM, muscle strength, and pain levels, as evidenced by outcome measures such as the NPRS, PRWE, and DASH scores. The rehabilitation included proprioceptive neuromuscular facilitation, sensory intrigation and advanced tools like a robotic glove to optimize recovery. This case highlights the importance of a multidisciplinary approach, combining timely surgical intervention with structured rehabilitation to achieve functional recovery and independence in daily activities. The use of modern rehabilitation technologies like robotic gloves shows promise in enhancing outcomes for complex upper limb injuries.

Keywords*: Humerus shaft fracture, radial nerve palsy, physiotherapy management, open reduction and internal fixation (ORIF), plate osteosynthesis, physical therapy.*

1. Introduction:

Fractures of the humerus make up about 5-8% of all extremity fractures, while the shaft fractures constitute approximately 3% of all long bones fractures. It is estimated that the incidence rate of humeral shaft fractures per year is 13 per 100,000 individuals [1]. The anatomy of the humerus shaft includes the segment starting from below the surgical neck and ending at the level immediately superior to the epicondyles. Fractures of this type can be classified as simple, wedge, or complex, and many scientific publications report that these classifications demonstrate high intraobserver and relatively high interobserver reliability [2-3]].

Non-operative treatment

Traditionally, isolated humeral shaft fractures were treated conservatively. Due to an upright position of the body, gravity facilitates reduction of the fragments, while surrounding muscles and soft tissues maintain their stability[4]. Since the upper extremity is not weight-bearing, many of such injuries would unite successfully in spite of some deformity[5]. The use of functional bracing demonstrates consistently high rates of union and infrequent occurrence of complications, thus serving as the gold standard for treating closed shaft fractures with minimal displacement, as well as for cases of humeral shaft fractures combined with radial nerve palsy and certain selected open fractures[6].

However, in cases where there is poly trauma, obesity, large breast size, or patient non compliance to the therapeutic regimen, non operative management is not recommended[7]. Even under such limitations, non operative management is superior to surgical treatment in terms of cost-effectiveness, lower risk of infection, and reduced risk of nerve injury during the operation[8].

Indications for Surgery and Surgical Technique

Some conditions necessitate the use of surgical intervention, namely open fractures, high energy injury with vascular impairment, segmental fractures, fractures associated with the forearm, pathological fractures, and polytrauma patients requiring early mobilization of the upper limb[9].

Another surgical procedure used is intramedullary nailing[10]. The older type of intramedullary nail, like the Seidel nail, suffers from drawbacks like rotational instability, second fractures, and damage to the shoulder joint[11]. Recent intramedullary nails have been found appropriate for use in comminuted fractures, segmental fractures, and pathological fractures. The main advantages of intramedullary nailing include minimal invasiveness, load bearing capabilities, preservation of local bone biology, and the use of bone reaming as an autologous bone grafting procedure[12].

Radial Nerve Palsy

The incidence of humeral shaft fracture along with radial nerve palsy is 12%. The risk is judged based on the type of fracture[13]. The risk is more when the fracture involves the distal part of the humerus commonly around lateral supracondylar ridge[14]. An systematic proved that plating has higher risk of nerve injury as compared to IM nailing [15].

Rehabilitation: early start of physical therapy is suggested in operative cases like MIPO and IM nailing. As soon as the pain and swelling reduced the patient is advised to undergo range of motion exercises of shoulder and elbow to improve the functionality. Along with exercises patient is explained about not to lift heavy suitcases, put excessive wet on the limb [16].

Matrix rhythm therapy: MRT uses a vibration at frequency of 8 to 12 Hz[17]. Which is in phase with body natural vibrating frequency which helps the tissue to heal faster and better[18].

2. Case Presentation:

A 53-year-old man met with a road traffic injury and admitted to the hospital. The man sustained a fracture to the right humerus after being run down by a four wheeler and an X-ray confirmed mid shaft fracture of the right humerus. Pain in the right arm was experienced and described as excruciating and increased when moving and relieved through resting and pain medication. The pain was sudden in onset, constant and non-radiating. The shoulder was adducted, elbow flexed to 45 degrees and the

forearm semipronated with the presence of bony deformity. The patient's medical history showed a past injury to the head. The patient was operated upon using Open Reduction and Internal Fixation (ORIF) with plate osteosynthesis and radial nerve exploration under nerve block.

3. Clinical Finding:

Consent was sought from the patient prior to the examination. He was cooperative, kind, and had time, place, and person orientation. The patient's hemodynamic parameters were stable; he had no fever. The use of the sling was recommended for the patient when he was observed. No swelling or previous surgical incision on the distal part of his arm was evident. Palpation revealed that the regional temperature was afebrile. Grade 2 tenderness on the midshaft of the humerus was noted. Flexion and extension of the wrist and fingers, but not the extensor muscles, were observed. The patient exhibited a right wrist drop, full range of motion on the wrist joint, and restricted movement of the shoulder joint on internal and external rotations, flexions, and abduction. His right upper limb had decreased strength. The intensity of pain during activity and at rest was rated as 6/10 and 3/10, respectively, based on the Numerical Pain Rating Scale (NPRS). It was characterized as intermittent and dull. Sensory deficits were present.

4. Radiological Findings:

A closed displaced distal 1/3rd humerus fracture was discovered during the patient's investigative arm X-ray, as seen in Figure 1.

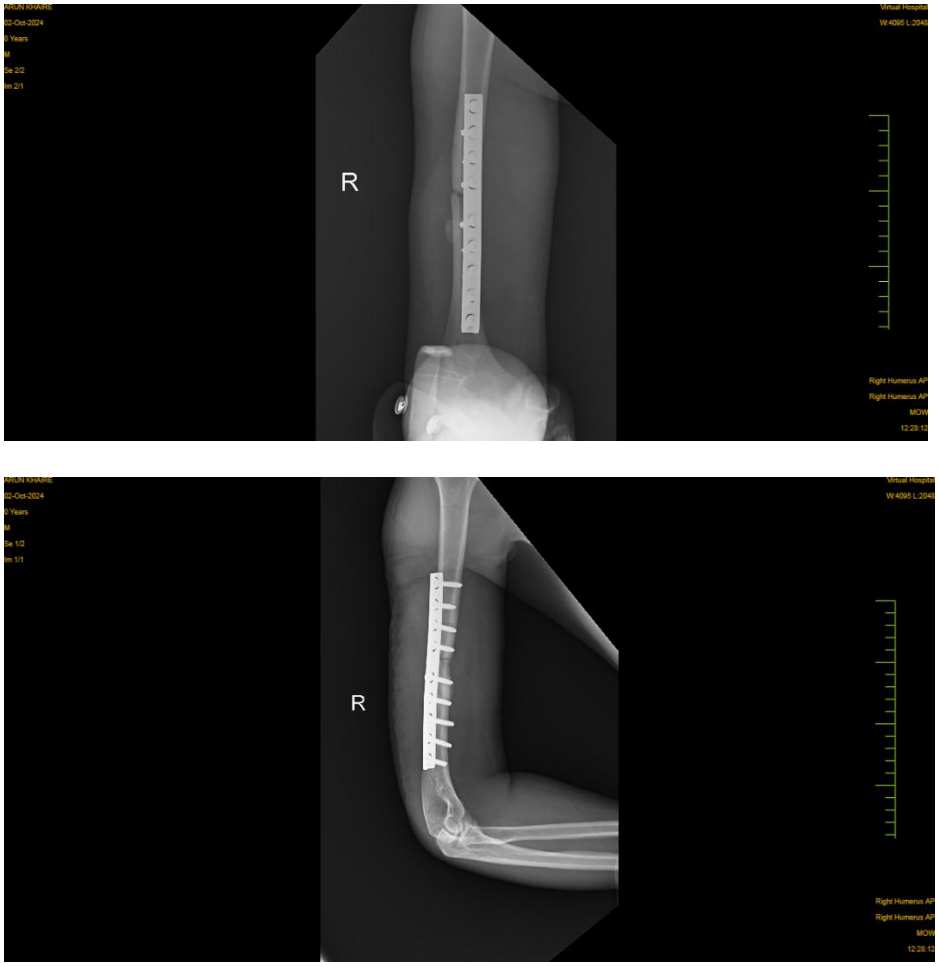

Figure 1: Shoes X- Ray of Right Arm

5. Therapeutic intervention

The physiotherapist created individualized exercise programs depending on the patient's clinical condition. Table 1 shows the physical treatment protocol. On the second postoperative day, the patient began vigorous, aided physical therapy with elbow motions, wearing a dressing and a wide-arm polysling for comfort.

Week	*Goal*	*Intervention*	*Regimen*
Weeks 0-2 (during plaster cast)	To maintain the ROM of the forearm, wrist, digits, and scapula, reduce dependent oedema and stiffness.	AAROM to the forearm, PROM to the wrist, hand, scapular depression, protraction, and retraction exercises	10 reps x 1 set (2 times/ day)
	To reduce pain	Cryotherapy	7 mins, 2 times/day
	To maintain the strength and ROM of the unaffected limb	AROM exercises for unaffected limbs	10 reps x 1 set, twice daily
	Support to prevent joint contracture and muscle-tendon lengthening	Sling, cock-up splint	
Outcome measures for 0-2 weeks	NPRS scale: on activity-4/10 *On rest-1/10*	PRWV: 130/150	DASH:75/100
Weeks 2-6	Muscle re-education	FES with galvanic current, progressing to faradic current with voluntary effort	10 minutes
	Improve sensation	Sensory integration	10min
	To improve ROM and prevent stiffness	Active and active-assisted ROM to tolerance at shoulder, elbow, PROM to wrist, and hand with robotic gloves	10 reps x 1 set, twice daily
	To increase the strength of the parascapular, wrist, and hand muscles	Gentle isometric exercises, progression: isotonic exercises to the forearm, open kinetic chain exercises, Codman exercises	10 reps x 1 set, twice daily
	To enhance the strength of the wrist musculature	PNF D1 flexion and extension	10 reps x 1 set, twice daily
Outcome measures for week 2 -6	NPRS scale: on activity-3/10 On rest-1/10	PRWV: 130/150	DASH:65/100
Weeks 6-12	To maintain ROM and prevent stiffness	Active ROM to the shoulder and elbow	10 reps x 1 set, twice daily
	To maintain the strength	Resistive exercises in open and close kinetic chain to shoulder elbow with elastic tubing and dumbbells	10 reps x 1 set, twice daily
	To maintain the ROM of the wrist joint and grip strength	Active ROM exercises and grasping activities with robotic gloves	10 reps x 1 set, twice daily

6. Follow-up and outcome measures

The patient had a systematically rehabilitation regimen for four weeks, after which they were evaluated again. Table 2 displays the results of the upper limb manual muscle test.

Muscles	Pre-intervention	Post-intervention
Shoulder flexors	3-	4
Shoulder extensors	3-	4
Shoulder abductors	3-	4
Shoulder adductors	3-	4
Elbow flexors	3-	4
Elbow extensors	3-	4
Wrist flexors	3-	4
Wrist extensors	0	3

Table 2: Upper limb manual muscle testing (right side)

0: no contraction palpated; 3-: some but not complete range of motion against gravity; 4: complete range of motion against gravity with moderated resistance

Table 3 depicts the ROM of the upper limb.

Movement	Pre-intervention	Post-intervention
Shoulder flexion	0-86	0-150
Shoulder extension	0-21	0-30
Shoulder abduction	0-85	0-150
Shoulder adduction	85-0	150-0
Elbow flexion	0-18	0-135
Elbow extension	18-0	135-0
Wrist extension	N/A	0-40
Wrist flexion	0-50	0-86
Wrist radial deviation	0-7	0-15
Wrist ulnar deviation	0-15	0-15

Table 3: Upper limb range of motion (in degrees, right side)

N/A: not assessable

The pre-and post-treatment findings (right side) of the outcome measures are shown in Table 4.

Outcome measures	Pre-intervention	Post-intervention
NPRS	On activity: 6/10 On rest:3/10	On activity:2/10 On rest:1/10
PRWV score	137/150	54/150
DASH score	N/A	50/100

Table 4: Outcome measures
DASH: Disabilities of the Arm, Shoulder, and Hand; NPRS: Numerical Pain Rating Scale; PRWE: Patient-Rated Wrist Evaluation, N/A: not assessable

7. Discussion

Although they represent a small number of all long bone fractures, fractures of the humeral shaft have some complications which complicate the treatment process especially if accompanied by radial nerve palsy. This report highlights the management strategy employed for a 53-year-old male who had a midshaft humeral shaft fracture after sustaining an injury from road traffic accidents, and he also had radial nerve injury. In his case, he was managed with ORIF plate osteosynthesis in addition to radial nerve exploration and physiotherapy. A gradual physical therapy regime will help achieve a successful early restoration of elbow range of motion. Wrist drop is addressed with a cock-up splint, and physical therapy is commenced on the next day after surgery. There is a high probability of spontaneous recovery when it comes to humerus fractures-related radial nerve palsy. This report highlights the management strategy employed for a 53-year-old male who had a midshaft humeral shaft fracture after sustaining an injury from road traffic accidents, and he also had radial nerve injury.

ORIF was associated with post-operative pain, loss of range of motion, power, and wrist drop due to nerve injury in the radial nerves, for which physical therapy treatment was done. Strength training, range of motion exercises, stretches, and joint mobilizations could help the individual gain independence[20]. Proprioceptive neuromuscular facilitation (PNF) yielded good results as well. Cryotherapy was used to relieve post-operative pain. As per Khadijah et al., transcendence attained through cryotherapy is the change in pain perception, placing more importance on the feeling of coldness, hence improving comfort. Based on current understanding and research, cryotherapy is better than warm compresses when it comes to reducing pain perception and enhancing comfort[21]. Robotic exoskeletal glove looks like a potential assistive device or alternative treatment approach for optimizing sensorimotor deficits along with upper extremity and hand function among stroke patients who have had paresis or paralysis of their hands

8. Conclusions

The presented case describes the effective treatment of a mid-shaft humeral fracture with radial nerve palsy in a 53-year-old man who was injured in a road traffic accident. The treatment was performed by ORIF with plate osteosynthesis, radial nerve exploration, and a personalized physiotherapy protocol. Surgical treatment combined with an early physiotherapy protocol that included exercises for increasing ROM, muscle strengthening, proprioceptive neuromuscular facilitation, and using a cock-up splint to treat wrist drop led to a positive clinical outcome.

Rehabilitation post-surgery aimed at reducing pain, increasing ROM, and developing muscle strength. Cryotherapy was used to reduce pain levels. The patient achieved noticeable improvements in both strength and ROM, which can be seen in the NPRS, PRWE, and DASH results. The early start of treatment and exercise progression positively influenced the patient's treatment outcomes.

This case highlights the significance of adopting a multidisciplinary strategy for dealing with humeral shaft fractures associated with radial nerve paralysis, where prompt surgical treatment along with

physiotherapy leads to favorable results. Furthermore, the incorporation of contemporary rehabilitating gadgets like robotic gloves proves advantageous in treating complicated cases of upper extremity injury.

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