

## Slow Reversal-Hold Technique in Treating Radial Nerve Palsy Patient: A Case Report

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### ABSTRACT

**Objectives:** To demonstrate the effectiveness of slow reversal-hold technique in patients with incomplete radial nerve palsy associated with humerus fracture.

**Study design:** Case report.

**Setting:** Department of Rehabilitation Medicine, King Chulalongkorn Memorial Hospital.

**Subjects:** A 28-year-old female patient diagnosed with fracture of upper end of left humerus subsequently developed incomplete radial nerve palsy.

**Methods:** Not applicable.

**Results:** The patient presented with wrist and finger drop and intrinsic and extrinsic wrist and finger flexors tightness of her left hand, resulting in difficulties in performing activities of daily living (ADL). Adding to conventional occupational therapy, slow reversal-hold proprioceptive neuromuscular facilitation (PNF) technique was used to treat her conditions. After 12 weeks of therapy, the aforementioned conditions resolved. Her hand function improved significantly and she eventually became totally independent in ADL.

**Conclusion:** Slow reversal-hold technique PNF technique combined with conservative treatment seemed to facilitate improvement of muscle power, resolving intrinsic tightness and extrinsic finger flexors shortening in a patient with incomplete radial nerve palsy.

**Keywords:** radial nerve palsy, slow reversal-hold technique, proprioceptive neuromuscular facilitation (PNF), strengthening exercise, occupational therapy

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### Introduction

Radial nerve palsy is found in 6-15% of patients with humerus fracture.<sup>1</sup> A radial nerve injury can occur at any point along the nerve. Due to the anatomy of the arm, the nerve is vulnerable to fractures of the humerus shaft and around the elbow. Normally, injuries most commonly occur

at the middle to the distal third of the humerus.<sup>2</sup> The classic sequelae of radial nerve injuries are inability to extend the wrist, weakness of finger extensors, thumb extension and abduction.<sup>3</sup> The most concerning problem is weakness or inability to control extensor muscle group around the wrist and fingers which is also known as "wrist and finger drop".<sup>2,3</sup> Wrist drop is the hallmark of a radial nerve injury, whereby the wrist flexors are stronger than the extensor group. The hand cannot maintain the functional position, leading to loss of hand function which affects patients' activities in daily living (ADL).<sup>1</sup>

Conservative treatment plays a crucial role as radial nerve injuries commonly represent neurapraxia or axonotmesis, with a high rate of spontaneous recovery, ranging between 60% to 92%.<sup>2</sup> In contrast, surgical management is indicated in nerve transection cases, open injuries and failed conservative treatment.<sup>2</sup> Non-operative management includes rest, activity modification, vitamin therapy and a period of immobilization with a splint. One of the most important goals is to maintain range of motion (ROM) and improve strength via exercises.<sup>2</sup> In general, such treatment is based on the use of electrical stimulation to retard muscle atrophy while awaiting nerve recovery. Passive movement exercise is used if there is no muscle contraction. On the contrary, active assistive exercise is applied if there is some muscle contraction. Once the muscles become more active, active resistive exercise will be implemented.<sup>4</sup> However, this overall exercise program takes a long time to achieve the goal and has a tendency to cause complications, such as intrinsic muscles tightness, extrinsic finger flexors shortening, extensors elongation or joint stiffness.<sup>1</sup>

Another technique for treating extrinsic flexors shortening and strengthening extensor muscles is the method of slow reversal-hold, one of the proprioceptive neuromuscular facilitation (PNF) strengthening techniques.<sup>5</sup> This slow reversal-hold technique involves isotonic contraction of the agonist followed immediately by an isometric contraction with a hold command given at the end of each active moment, to develop

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strength at a specific joint ROM.<sup>5</sup> In this case, we combined conservative occupational therapy with this slow reversal-hold technique. The consequences after radial nerve injury resolved and the patient resumed their independence in performing activities of daily living (ADL). Therefore, we would like to demonstrate our experience in employing the slow reversal-hold technique as an adjunctive therapy to facilitate motor recovery and treat complications following incomplete radial nerve injury.

## Case study

A 28-year-old Thai nurse was involved in a car accident on July 31<sup>st</sup>, 2017. She suffered from the left proximal humerus fracture, which was treated with open reduction and internal fixation on August 4<sup>th</sup>, 2017. After the surgery, she still had left wrist drop and finger drop, and was able to grip only light objects. There was evidence of incomplete left radial nerve injury supported by electrodiagnostic study. The study revealed incomplete left radial nerve degeneration with signs of regeneration, up to branches of triceps brachii muscle. Rehabilitation consultation and occupational therapy started after surgery on August 15<sup>th</sup>, 2017.

### The first occupational therapy assessment

The patient came in for the first occupational therapy assessment on August 17<sup>th</sup>, 2017. She was left-handed. The evaluation of grip and grasp strength for picking and holding objects with a dynamometer found that the patient could not perform all of the functions. The patient was asked to self-report pain and difficulties in performing ADL by completing

the Patient Rated Wrist/Hand Evaluation (PRWHE) questionnaire. Table 1 shows high scores of both pain and difficulties in ADL, with 141 points before therapy. Pain was the main limitation of difficulties in using hand. In addition, ADL was assessed with modified Barthel ADL Index and the score was 17 points out of 20. The patient could not take a shower or get dressed by herself, due to the affected dominant hand. She had to use the non-dominant hand for eating, washing her face and brushing her teeth. On the initial assessment, there were other complications such as hand edema, intrinsic finger flexors tightness and extrinsic finger and wrist flexors shortening.

After planning for treatment and goal setting with the patient using the Canadian Occupational Performance Measure (COPM) (Table 2), the first priority for the patient was to improve her wrist and hand movements and then her function performance such as taking objects, showering, getting dressed and working, respectively. The patient rated her satisfaction with the first assessment, 6 out of 50.

### Problems-based approach in occupational therapy

The main problems of this patient were muscle weakness, impaired left-hand functions, and difficulties in performing ADL and work-related tasks. All were interrelated to one another and required treatments. According to the problem-based approach, the assigned occupational therapist planned a 90-minute session three times per week over a period of 12 weeks, for a total of 36 sessions. Slow reversal-hold PNF strengthening technique was combined with conventional occupational therapy to facilitate motor neurons of the weak extensor muscles, and improve ROM of wrist and finger,

**Table 1.** The Patient-Rated Wrist/Hand Evaluation (PRWHE)

Patient rated wrist/hand evaluation	Scores	Before	After
1. Level of pain			
1. While resting	10	7	3
2. While moving hand & wrist repeatedly	10	8	4
3. While lifting heavy objects	10	10	9
4. When the patient felt most painful	10	10	9
5. How often the patient felt pain?	10	6	4
	Pain score	50	41
2. Work difficulty			
6. Turn door knob with affected hand	10	10	6
7. Using cutleries with the affected hand	10	10	6
8. Buttoning	10	10	5
9. Use affected hand to support when getting up from the chair	10	10	7
10. Lift an object around 5 kg. with affected hand (1 bag of rice)	10	10	10
11. Clean oneself with affected hand	10	10	7
12. Doing daily activities (bathing, dressing etc.)	10	10	3
13. House work	10	10	5
14. Regular job	10	10	5
15. Hobbies	10	10	4
	Work difficulty score	100	100
Total		150	141
			87

Before, 1<sup>st</sup> occupational therapy assessment; after, after completion of 36 sessions

In pain domain, high score means more pain.

In work domain, lower score means less difficulty or improvement in function.

**Table 2.** Patient's performance and satisfaction evaluated by COPM

COPM and satisfaction activity	Points	Before			After		
		Imp	Perf	Sat	Imp	Perf	Sat
Movements in hands & wrists	10	10	0	0	10	8	8
Hand function	10	10	0	0	10	8	9
Bathing	10	10	3	3	10	9	9
Dressing	10	10	3	3	10	8	9
Working	10	10	0	0	10	5	7
Total	50	50	6	6	50	38	42
Average	10		1.2	1.2		7.6	8.4

COPM, Canadian Occupational Performance Measure; Imp, important; Perf, performance; Sat, satisfaction  
Before, 1<sup>st</sup> occupational therapy assessment; after, after completion of 36 sessions

together with and hand and arm use in daily life. In this case, the therapist employed the slow-reversal-hold PNF strengthening technique with the flexors group (flexor carpi radialis, flexor carpi ulnaris and flexor digitorum superficialis) first and then with the extensor group (extensor carpi ulnaris, extensor carpi radialis longus, extensor carpi radialis brevis and extensor digitorum). The technique was performed with five repetitions per set with a break between sets. The whole process took approximately thirty minutes and was followed by a 20-minute session of biofeedback training.

Once the weak muscles gained more muscle power, the therapist then continued to the next step of improving the patient's hand function by grasping as well as holding light-weight hand-sized objects such as tennis balls then sizing it down to table tennis balls or beads respectively. Furthermore, strength training was done by grasping objects through various activities with resistance such as turning knots or opening bottle caps. To improve performance of ADL, adaptive devices were recommended to facilitate the affected hand, such as using a larger handled spoon and toothbrush. The patient was also encouraged to use the affected hand to do more challenging daily activities such as rubbing arms, taking food, and moving objects. The last training was performing tasks related to work as a nurse, for instance, using mock-up activities such as opening bottle caps, lifting objects as well as giving injections.

#### Occupational therapy outcomes

After 12 weeks of combined therapy, according to COPM, the patient's performance improved and satisfaction score increased in every aspect as shown in Table 2. According to the Medical Research Council (MRC) muscle power grading system, the affected arm muscles showed a higher grade as shown in Table 3. Her left-hand grip strength and lateral pinch strength improved to 2.27 kilograms and her tip pinch to 0.45 kilograms. According to PRWHE test, the difficulty in using hand and arm decreased when compared with the first assessment as shown in Table 1. The modified Barthel ADL index scores also increased from 17 to 20 because of improvements in bathing (showering) and dressing.

**Table 3.** Muscle power according to MRC muscle grading system

Muscle power grading	Before	After
Elbow flexors	4 <sup>+</sup>	5
Elbow extensors	4 <sup>+</sup>	5
Wrist flexors	4 <sup>+</sup>	5
Wrist extensors	2 <sup>+</sup>	4
Finger flexors	3 <sup>+</sup>	5
Finger extensors	2 <sup>+</sup>	4
Thumb flexors	3 <sup>+</sup>	5
Thumb extensors	2 <sup>+</sup>	4

MRC, Medical Research Council

Before, 1<sup>st</sup> occupational therapy assessment; after, after completion of 36 sessions  
\*Muscle power assessment was limited by marked pain.

## Discussion

Radial nerve palsy results in muscle power impairment of elbow, wrist and hand muscles which are essentially responsible for performing ADL.<sup>6</sup> Although radial nerve palsy has some potential for spontaneous improvement, other complications may occur over time. Therefore, occupational therapists are advised to consider other possible complications in order to prevent them and decide a proper treatment program. We believe that the PNF technique of slow reversal-hold not only strengthens the weak muscles by stimulating its motor neurons but also prevents the intrinsic hand muscles tightness and extrinsic finger flexors shortening in this patient with incomplete radial nerve palsy. According to clinical decision making in therapeutic exercise recommended by Sullivan PE,<sup>5</sup> therapists should start the slow reversal-hold PNF technique with isotonic contraction of the stronger agonist muscle followed by isometric contraction at the end of the session; then a second isotonic contraction of the weaker antagonist muscle and followed immediately with isometric contraction at the end of the session. There is no rest period between contractions. Quick stretch could be applied to facilitate muscular activity which aims to develop strength of antagonist muscle.

In this case study, after the completion of 36 sessions of the 12-week combined therapy of slow reversal-hold PNF technique, conventional occupational therapy training and

biofeedback, muscle power of the wrist and finger extensors improved from grade 2 to 4, the pain level decreased by approximately about half at rest and when moving hand and wrist repeatedly, and performance in activities was markedly improved. We believe that such improvements were facilitated by the slow reversal-hold PNF technique as PRWHE scores decreased similar to the study reported by Keerthi, et al.<sup>7</sup> who conducted a randomized controlled trial in patients diagnosed with distal radius fracture, by comparing between conventional therapy and combination of conventional therapy and slow reversal-hold PNF technique. Significant improvement was found in both groups evaluated by PRWHE, numerical pain scale and ROM but the combined therapy group showed better results.<sup>7</sup> Generally, incomplete radial nerve injury with axonotmesis like in our case, complete motor recovery takes about 12 months.<sup>8</sup> To be noted, our case had nearly complete recovery within 3 months after surgery which lead us to believe that slow reversal-hold PNF technique facilitates motor neurons and enhances motor recovery.

The slow reversal-hold PNF technique employed in this case of incomplete radial nerve injury with intrinsic tightness and extrinsic finger flexors shortening seemed effective. Although the wrist and fingers ROMs of the affected hand were not measured objectively, we observed an increase in ROMs as the patient performed activities with less difficulty. One should be reminded that there are two groups of PNF techniques, strengthening and stretching. Birinci et al. used a structured exercise program combined with the PNF technique of hold-relax stretching in patients with post-traumatic elbow stiffness and reported improvement of elbow flexion ROM and pain.<sup>9</sup> The PNF hold-relax stretching technique aims to gain ROM quicker than static stretching due to reciprocal inhibition.<sup>9</sup> In addition, voluntary contraction of the opposite muscle can lead to reduced activation level in the target muscle through development of reciprocal inhibition.<sup>10</sup>

Lastly, this case report is written to support the idea of treatment for improving muscle power and reducing intrinsic and extrinsic tightness of the hand with the slow reverse-hold PNF technique, which has not been commonly used in conventional occupational therapy, and to raise awareness among occupational therapists and physiatrists about the benefit of this PNF technique. In addition, favorable outcomes in this case are merely the beginning for future research of case series or randomized controlled trial to compare between conventional therapy and the slow reverse-hold PNF technique in patients with radial or other nerve palsy.

## Conclusion

Although radial nerve palsy has a potential of spontaneous recovery in some degree, however other complications may

occur and affect functional recovery. Therefore, physiatrists and occupational therapists are advised to consider all possible complications in order to prevent or treat them and prescribe the most appropriate treatment. The PNF slow reversal-hold technique employed in this case with incomplete radial nerve palsy not only facilitated the wrist and fingers extensors muscle power but also improved the intrinsic muscle tightness and extrinsic flexor shortening. This technique combined with conventional therapy correspondingly with problem-based approach treatment seems effective in improving patient's independence in daily living.

## Disclosure

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