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Case report

Short-term outcomes following peripheral magnetic stimulation in post-partum carpal tunnel syndrome

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Abstract

Bilateral carpal tunnel syndrome (CTS) was diagnosed in a 38-years-old with 3 months after labour. The patient has numbing sensation in both hands and weakness of intrinsic muscles of hand especially hand grip activities such as bottle opening or door knob turning without reported of pain (on 1st - 3rd fingers and half of 4th finger) for 12 weeks. Electromyography showed severe degree of CTS on right hand and moderate degree of CTS on left hand. The patient has been receiving peripheral magnetic stimulation as physical therapy modality twice a week for four weeks. The nerve conduction velocity, intrinsic muscles strength (hand grip test, tip pinch test, lateral pinch test, tripod pinch test), numbness numeric rating scale and pain numeric rating scale was recorded as primary outcome. After treatment the numbness scale and severity of CTS has been reduced, the strengthening of intrinsic muscles, the numbness numeric rating scale and pinprick sensation were improved in both hand also.

Keywords: Carpal tunnel syndrome, electromyography, peripheral magnetic stimulation, physical therapy, rehabilitation treatment.

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Carpal tunnel syndrome (CTS) is the most common occurring in working age and it is currently increasing incident.[1] A typical symptom of CTS is related to the sensory and motor innervation of median nerve usually numbness of thumb, index, middle and radial half of ring fingers. The other symptom often reported is weakness of intrinsic muscles which innervated with median nerve such as abductor pollicis brevis (APB), opponens pollicis and superficial portion of flexor pollicis brevis muscles. The patients usually complaint with grip and pinch difficulty.[2]

The patients were usually diagnosed with CTS by history taking, physical examination.[3] and electrodiagnostic of the median nerve.[4, 5] The physical therapy and rehabilitation. Various physical therapy management can apply on CTS patients such as ultrasound therapy with/without phonophoresis, laser therapy and magnetotherapy.[6, 7]

Peripheral magnetic stimulation (PMS) is a non-invasive treatment which deliver rapidly pulsed and high-intensity of magnetic field for various neurological and musculoskeletal conditions.[8] PMS directly activate sensorimotor nerve fibers and also indirectly activate mechanoreceptors in the muscle fibers.[9] Clinically, PMS is used in spasticity reduction[10] , strength improvement[11] and pain control.[12]

PMS was used to relieve pain in mild to severe CTS patients.[12] However, the effect of PMS in nerve conduction velocity, strength of intrinsic muscles increasing and numbness have never been reported in CTS patients at King Chulalongkorn Memorial Hospital. This is the first report of PMS on severe and moderate CTS in Physical Therapy Unit, Department of Rehabilitation, King Chulalongkorn Memorial Hospital.

Case presentation

A 38 years-old post partum women presented with numbness of both hands (right side over left side), weakness of hand grip activities such as bottle opening or door knob turning without reported of pain. The physical examinations found impaired pinprick sensation (PPS) both dermatome of median nerve innervation in hand, motor power of APB grade 4, opponens pollicis grade 4+, Durkan's test was positive both hand at 10 seconds, Phalen's test was positive at 30 seconds, 40 seconds (right and left, respectively), negative result of both Tinel's sign and Spurling's test.

The needle electromyography showed severe degree CTS on right side and moderate degree CTS on left hand.

The sensory nerve conduction study showed prolonged onset distal sensory latency (DSL), low sensory nerve action potential amplitude (SNAP) and slow sensory nerve conduction velocity (SNCV) of right median nerve across wrist and forearm segment. The sensory nerve conduction study shown prolonged DSL, normal SNAP and normal SNCV of left median nerve.

The motor nerve conduction study showed prolonged distal motor latency (DML), low compound motor action potential amplitude (CMAP) and normal motor nerve conduction velocity of median nerve (m-MNCV) across wrist and forearm segment at right side. The motor nerve conduction study showed prolonged DML, normal CMAP and normal m-MNCV across wrist and forearm segment at left hand (Table 1 and 2).

Physical examination found numbness in both hands, reduce strength of right and left hand grips, tip pinch, lateral pinch and tripod pinch without pain (Table 3).

Materials and methods

The patient was treated with physical therapy and occupational therapy programs.

Physical therapy program

PMS was applied twice a week for 4 weeks with 2 days resting between treatment at both palmar side of wrists and hands. The protocols of PMS was 1 TESLA electromagnetic field frequency 10 Hertz, pulse time 2 seconds, pause time 2 seconds and duration 8 minutes for both palmar side of wrist. 1 TESLA electromagnetic field frequency 30 Hertz, pulse time 3 seconds, pause time 6 seconds and duration 5 minutes for both palmar side of hands. The intensity was properly adjusted depend on patient tolerance. The intensity of PMS in this case report average is 78.0% at right side and 65.0% at left side (Figure 1).

Occupational therapy program

Paraffin wax was applied at both hands, was temperature is 56 - 58 oC, the patient was received treatment 1 - 2 times/week, 15 minutes/time. In additional, patient was suggested to wearing wrist support at both wrists as long as possible (average 16 - 18 hours/day).

Table 1. Sensory nerve conduction study in median nerve.

Sites	DSL (ms)	SNAP (μV)	Distance (cm)	SNCV (m/s)
Before treatment				
Right-Digit II (Antidromic) Wrist	5.5	5.6	13.0	23.6
Right-Digit II (Antidromic) Elbow	9.2	3.6	18.0	48.0
Left-Digit II (Antidromic) Wrist	3.8	13.8	13.0	34.2
Left-Digit II (Antidromic) Elbow	6.6	13.5	17.5	62.2
After treatment				
Right-Digit II (Antidromic) Wrist	4.0	22.7	13.0	32.5
Right-Digit II (Antidromic) Elbow	7.6	11.1	21.0	57.6
Left-Digit II (Antidromic) Wrist	3.2	27.7	13.0	40.6
Left-Digit II (Antidromic) Elbow	6.7	19.0	21.0	60.2

Table 2. Motor nerve conduction study in median nerve.

Sites	Muscle	DML (ms)	CMAP (mV)	Distance (cm)	MNCV (m/s)
Before treatment					
Right-Wrist	Abductor pollicis brevis	6.4	3.6	8	12.5
Right-Elbow	Abductor pollicis brevis	9.8	3.4	17.5	51.7
Left-Wrist	Abductor pollicis brevis	4.6	5.7	8	17.4
Left-Elbow	Abductor pollicis brevis	8.1	5.9	17.5	50.10
After treatment					
Right-Wrist	Abductor pollicis brevis	4.9	8.0	8.0	16.3
Right-Elbow	Abductor pollicis brevis	8.5	8.0	19.0	52.1
Left-Wrist	Abductor pollicis brevis	3.9	9.4	8.0	20.5
Left-Elbow	Abductor pollicis brevis	7.3	9.7	17.0	50.2

Table 3. Physical examination.

Sites	Pain numeric rating scale	Numbness numeric rating scale	Hand grip (kg)	Tip pinch (kg)	Lateral pinch (kg)	Tripod pinch (kg)
Before treatment						
Right hand	0	10	19.9	3.1	2.8	3.4
Left hand	0	6	14.1	2.6	3.0	2.4
After treatment						
Right hand	0	3	24.6	5.0	4.3	5.0
Left hand	0	1	21.6	4.7	4.8	4.2

Outcome measurements

The needle electromyography (EMG) was tested before and end of physical therapy treatment program. The numeric pain rating scale, numbness rating scale and intrinsic muscles strengthening were recorded at pre-post treatment of each session.

The numerical pain rating scale and numbness rating scale were described as 0 for no symptom and 10 for highest degree of symptom.

Jamar hand dynamometer was used for testing intrinsic muscles strength in various positions. The hand grip test was performed on elbow flexion 90 degree with neutral position of shoulder. The tip pinch test was tested with pinched position of 1st and 2nd fingers on dynamometer. The lateral pinch test was recorded in side pinched position with 1st, 2nd and 3rd fingers on dynamometer. The tripod pinch test was measured in pinched of 1st, 2nd and 3rd fingers on dynamometer in each position as maximum effort for three times (Figure 2).

Results

Physical examinations after treatment found decreased pinprick sensation (PPS) and light touch sensation (LTS) at right 2nd, 3rd finger, left intact. Motor power of intrinsic muscles grade 5 all excepted right Abductor pollicis brevis (APB) grade 4+, opponent bravis grade 4+, Durkan's test was positive at 15 seconds right side, left negative, Phalen's test positive at 20 seconds and 50 seconds (right and left, respectively), Spurling's test negative.

The needle electromyography (EMG) reported moderate degree CTS on the right side; sensory nerve conduction study shows prolonged onset latency (DSL), normal sensory nerve action potential amplitude (SNAP) and normal sensory nerve conduction velocity (SNCV) of both median nerves. Motor nerve conduction study showed prolonged latency (DML), normal compound motor action potential amplitude (CMAP) and normal motor nerve conduction velocity (MNCV) of right median nerve. Mild degree CTS on the left side; sensory nerve conduction study showed prolonged DSL, normal SNAP and normal SNCV of left median nerve, motor nerve, normal MNCV of left median nerve (Table 1 and 2).

Physical therapy assessments found decreased numbness visual analog scale of both hands, increased muscles strength of right and left intrinsic muscles of hand by hand grip, tip pinch, lateral pinch and tripod pinch test without pain (Table 3). The peak of numbness visual analog scale and intrinsic muscles strength test in each week of physical therapy treatment program was plotted in graph from week 0 to week 4 (Figure 2 and 3).

Discussion

The present case report aimed to investigate the changes of in severity of CTS, numbness numeric rating scale and hand muscles strength induced by peripheral magnetic stimulation in carpal tunnel syndrome (CTS).

The peripheral magnetic stimulation (PMS) or repetitive peripheral magnetic stimulation (rPMS) is a non-invasive device that can produce muscles contraction and sensory afferents through depolarization of conductive structures with in the peripheral nervous system.[13] The rPMS at the area of

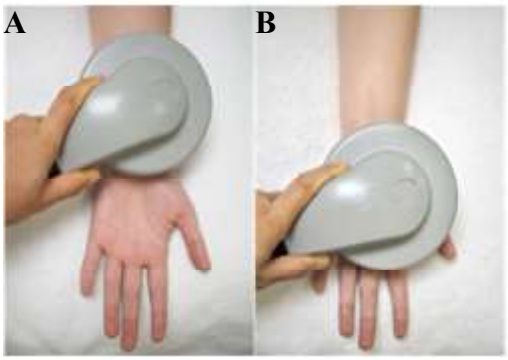

Figure 1. The area of PMS applied at wrist **(A)**, and hand **(B)**.

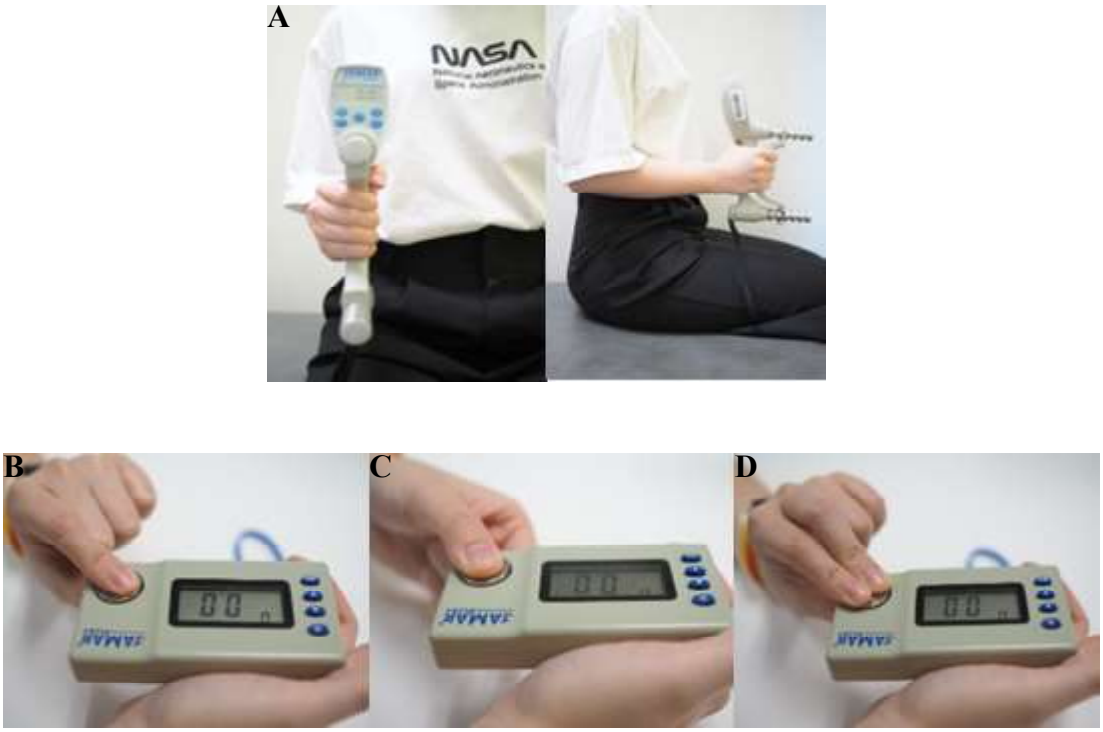

Figure 2. (A) Hand position for strengthening testing of intrinsic muscles of hand: hand grip test, **(B)** tip pinch test, **(C)** lateral pinch test, and **(D)** tripod pinch test.

terminal branches elicits a proprioceptive in put to the central nervous system (CNS) in two different ways, first is indirectly activation of mechanoreceptors (muscles fiber groups Ia, Ib, II) during the rhythmic contraction and relaxation as well as vibration of the muscles and second is directly activation of sensory motor nerve fibers with orthodomic and antidromic conduction[14] that may shows in electromyography report via DLS, AMP, SNCV, CMAP and MNCV after treatment.

This report use frequency of PMS treatment along with El Gohary A, *et al.* (2016) that used the rPMS in CTS with frequency of 10 Hertz, intensity as tolerate at mid palmar side of affected wrist for relieve pain visual analog scale in early CTS.[12] But no strong evidence can describe the physiology of PMS in numbness visual analog scale. It was hypothesized that low frequency of PMS over the area of nerve entrapment could inhibit neural hypersensitivity and thus reduce numbness visual analog scale.

In this report of muscles strength of hand though hand grip test, tip pinch test, lateral pinch test and tripod pinch test were increased. PMS over the muscles belly can trigger muscles contraction with less contaminated by cutaneous in flows and depend more on muscular proprioceptive afferent[13] and may also contribute to synergistic control of muscles acting at a different joint in humans.[9] The frequency of 30 Hertz is a tetanic muscles contraction with maximum intensity was apply in this protocol because sustained contraction may induce more strengthen muscles and massive proprioceptive inflows. Jia Y, *et al.* (2021) found that after one session of repetitive peripheral nerve magnetic stimulation on the median nerve increased the corticomotor excitability in contralateral primary motor cortex and may associate improved hand dexterity function in healthy young individuals.[15]

However, there were limitations of this case report that it included just only one patient who was experienced in CTS and was treated by PMS. Further study should try different of PMS protocol with large sample size and randomize control trials for CTS cases.

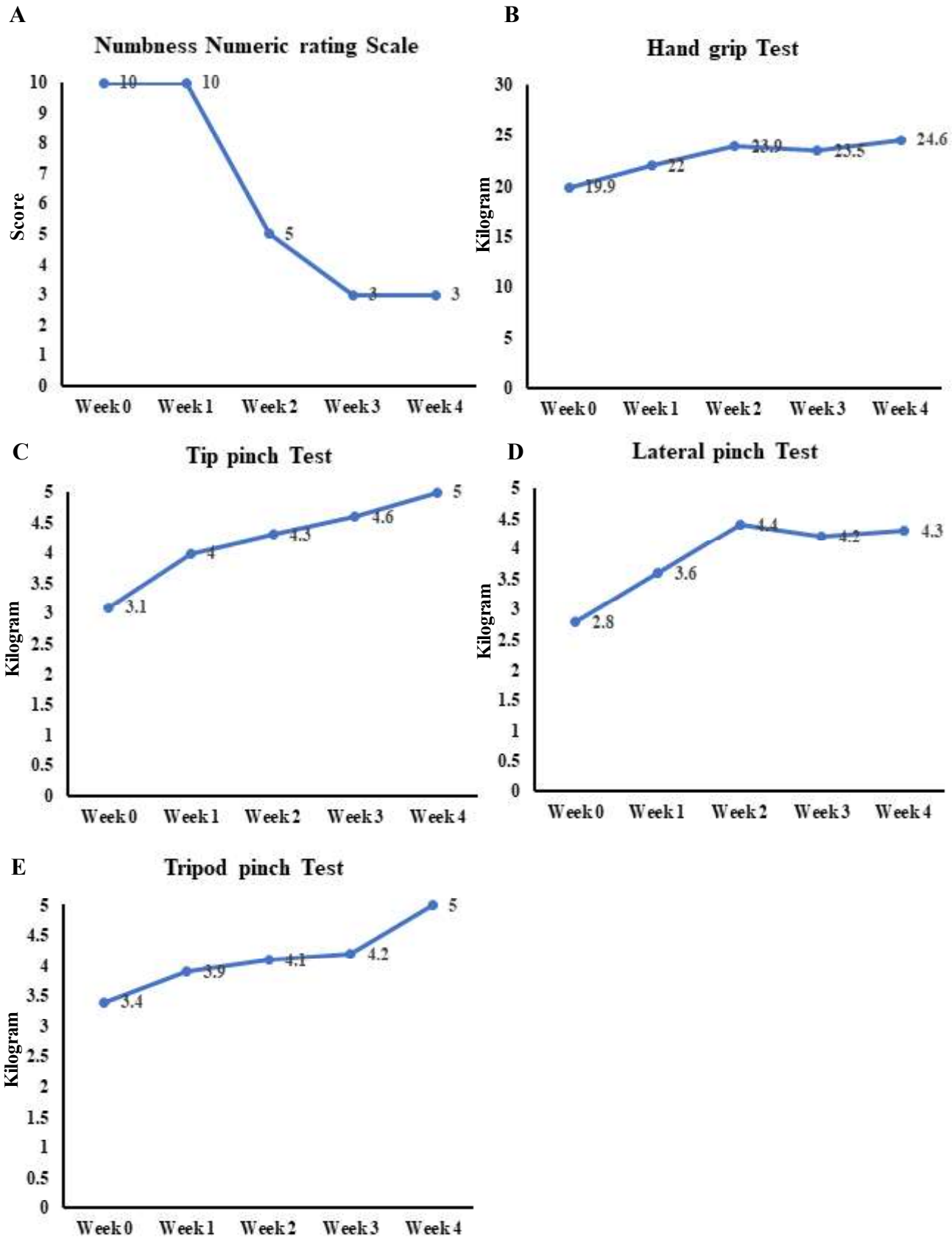

Figure 3. **(A)** The level of numbness numerical rating scale **(B)** strength of intrinsic muscles of hand tested by hand grip **(C)** tip pinch **(D)** lateral pinch and **(E)** tripod pinch test at right hand in each week of physical therapy program.

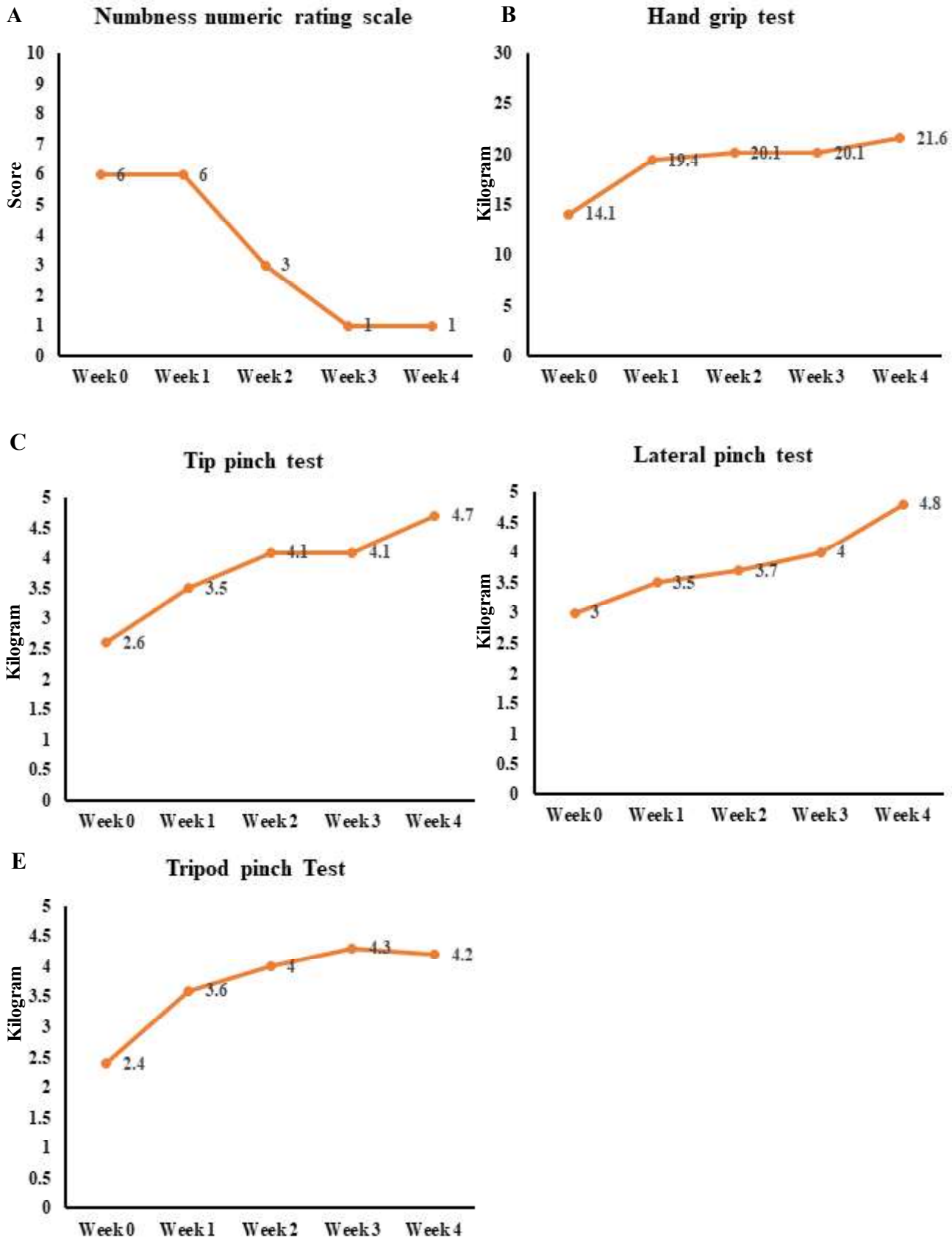

Figure 4. (A) The level of numbness numerical rating scale **(B)** strength of intrinsic muscles of hand tested by hand grip **(C)** tip pinch **(D)** lateral pinch and **(E)** tripod pinch test at left hand in each week of physical therapy program.

Conclusion

PMS protocol in the case report can decrease numbness visual analog scale, increase muscles power of hands and decrease severity of CTS degree from severe to moderate and moderate to mild degree of CTS.

Conflicts of interest statement

Each of the authors has completed an ICMJE disclosure form. None of the authors declare any potential or actual relationship, activity, or interest related to the content of this article.

Data sharing statement

The present review is based on the references cited. Further details, opinions, and interpretation are available from the corresponding authors on reasonable request.

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