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Abstract

Twitch Obtaining Intramuscular Stimulation (TOIMS) is useful in the management of chronic nerve-related pain. The best understanding of the mechanism of action of TOIMS can occur on treating acute nerve-related symptoms. An opportunity to use TOIMS treatments in an acute, partial left radial palsy within 24 hours of onset did occur. Following treatment to the affected triceps and brachioradialis muscles, there was an immediate improvement in the amplitude, area and conduction velocity of the left radial motor and sensory nerves at the lower arm level. There was also improvement in numbness and all symptoms abolished after four treatments. Serial multiple motor unit action potential (multi-MUAP) analysis performed in the triceps and extensor communis (EDC) showed signs of motor unit enlargement. The triceps MUAPs showed an increase in duration and size index (area/amplitude) by the 3rd month. Both parameters stabilized at 18 months. Phases increased at the 6th month only. In EDC, the size index increased progressively by the 3rd month. The duration increased at the 6th month with stabilization by the 18th month. Phases and turns increased on day 3 examination only. EDC showed reduction in the firing rate with time. By relaxing the muscles through the effects of intramuscular exercise and also by improving local ischemia, TOIMS averted prolonged conduction abnormalities and probably a more serious axonal injury.

Key-words: Acute partial neuropraxia – Twitch-obtaining intramuscular stimulation (TOIMS) – Electrodiagnosis

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Introduction

A hypothesis on radiculopathy related myofascial pain includes presence of muscle fiber shortening which can mechanically cause a large variety of pain syndromes. This is presumably from the muscles' unrelenting pull on various pain sensitive structures such as intramuscular nerves, blood vessels, bones, joints, tendons and adjacent ligaments (2). The novel version of twitch-obtaining intramuscular stimulation (TOIMS) described by the author involves elicitation of twitch responses from the motor end-plate zones. This is performed using oscillatory movement of the treatment pin similar to the pin movements used during electromyography (4, 6). The treatment at a chosen point involves manual oscillation of the pin until there is disappearance of twitches. Muscle tissue away from the end-plate zone does not elicit the twitch property using the manual pin stimulation method. However, it is the author's observation that in the presence of denervation supersensitivity, twitches are easily elicitable from many muscle areas that normally will not twitch.

A twitch contraction is the simplest form of muscle contraction accompanied by muscle

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relaxation (10). In addition, the twitches can increase local circulation (2, 23) and therefore aid in improving nerve function. The improvement of nerve function should be electrophysiologically documentable when using TOIMS in acute nerve palsy.

Case history

On 7/12/96, the patient fell asleep for 1.75 hours while sitting in a rocking chair, with the left arm against the edge of the wooden armrest. Numbness in the dorsal forearm and the first three digits with weakness of elbow and wrist extension occurred on awakening. Left elbow extension regained full strength immediately; left wrist and finger extensors remained weak. Within 1/2 hour, forearm numbness improved but dense numbness remained over the dorsal wrist and first two digits.

On examination on 7/13/96, tenderness was felt in the left triceps and dorsal forearm. Significant reduction of sensation for light touch and pinprick in the dorsal lower forearm, first two digits and first web-space occurred. The left wrist extensor strength was 4/5 and EDC was 3+/5. After the first TOIMS treatment on 7/13/96, the numbness remained only over the first web-space and first two digits. By the second treatment on 7/16/96 near-total subjective and objective numbness relief occurred. Strength testing showed left wrist extensors (5/5), EDC (4+/5) and extensor indices [EI] (3+/5). Total numbness relief occurred after the third treatment on 7/23/96. Strength of EI improved to 4/5 and EDC remained at 4+/5 strength. The final treatment on 7/25/96 resulted in gradual return of strength to normal in the following week.

Methods and materials

Left radial sensory and motor nerve conduction studies (see table), were serially done in standard fashion before and after TOIMS treatment. The recording for the sensory conduction studies was with a bar electrode from the first web space and the reference was at the base of the first digit. The recording for the motor conduction studies, also with a bar electrode, was from the extensor indicis with the reference distally at the level of the ulnar styloid process. The stimulations were done at the lower dorsal forearm, elbow crease and the spiral

Table 1. – *Radial nerve conduction studies*

sensory nerve conduction studies

Date	Treat (no)	STIM. DIST (mm)	LAT (ms)	AMP (uV)	STIM DIST (mm)	LAT (ms)	AMP (uV)	STIM. DIST (mm)	LAT (ms)	AMP (uV)
7/13/96	1BT	140	2.8	35	280	4.6	17	380	6.2	13
7/13/96	1AT	140	2.6	56	280	5.1	29	380	6.3	17
7/16/96	2AT	140	2.7	66	280	5.1	48	380	6.2	26
8/05/96	3AT	140	2.6	66	280	5.2	54	380	6.3	25

Motor nerve conduction studies

Date	Treat (no)	Stim. below elbow DLAT (ms)	Stim. below elbow AMP (mV)	Stim. below elbow AREA (ms*mV)	Stim. elbow crease DLAT (ms)	Stim. elbow crease AMP (mV)	Stim. elbow crease AREA (ms*mV)	Stim. Spiral Groove DLAT (ms)	Stim. Spiral Groove AMP (mV)	Stim. Spiral Groove AREA (ms*mV)
7/13/96	1BT	1.7	3.0	15.4	4.6	3.1	17.4	6.5	2.6	12.7
7/13/96	1AT	1.5	3.4	16.6	4.4	3.4	18.6	5.9	3.4	18.5
7/16/96	2AT	1.6	3.9	21.3	4.4	3.8	20.3	6.0	3.9	19.8

Abbreviations: BT = Before TOIMS; AT = After TOIMS; STIM. = Stimulation groove. The stimulus duration was 0.1 ms and supramaximal stimulation was performed.

The MultiMUAP analysis program aided the performance of quantitative analysis of motor unit action potentials (MUAPs) in the left triceps and the EDC. The electromyograph used was the Keypoint (Allendale, New Jersey). Thirty accepted MUAPs from two to three sites, with rise time less than 1000 μsec had clean, clear baselines after the analysis. All rejected MUAPs were those not fulfilling these criteria. The EMG was done on days 1 & 3, 2, 6, and 18 months after injury. The MUAP parameters assessed were amplitude, duration, phases, turns, size index (area/amplitude) and firing rate.

Tight and tender myofascial bands treatment in the triceps and EDC occurred by manually oscillating a TECA MG 37 monopolar pin-electrode at these points. The twitch responses were classified by force. Grade 1: fascicular or focal contraction of muscle; Grade 2: contraction of a large area of the treated muscle without movement of the joint over which it crosses, and Grade 3: twitches forceful enough to move the joint. The treatment session for a muscle ended when 2 consecutive points did not elicit twitches. The average number of treatment points in the left triceps= 30/treatment, brachioradialis= 10/treatment and EDC=2/treatment.

Statistical Analysis: Use of a chi square testing and logistic regression testing decided significance in group differences between the MUAP parameters recorded on 5 occasions. The Pearson product moment correlation analysis detected the correlations. Significance was set at $p < 0.01$. The software used was Statistica (Statsoft Inc, Tulsa, OK).

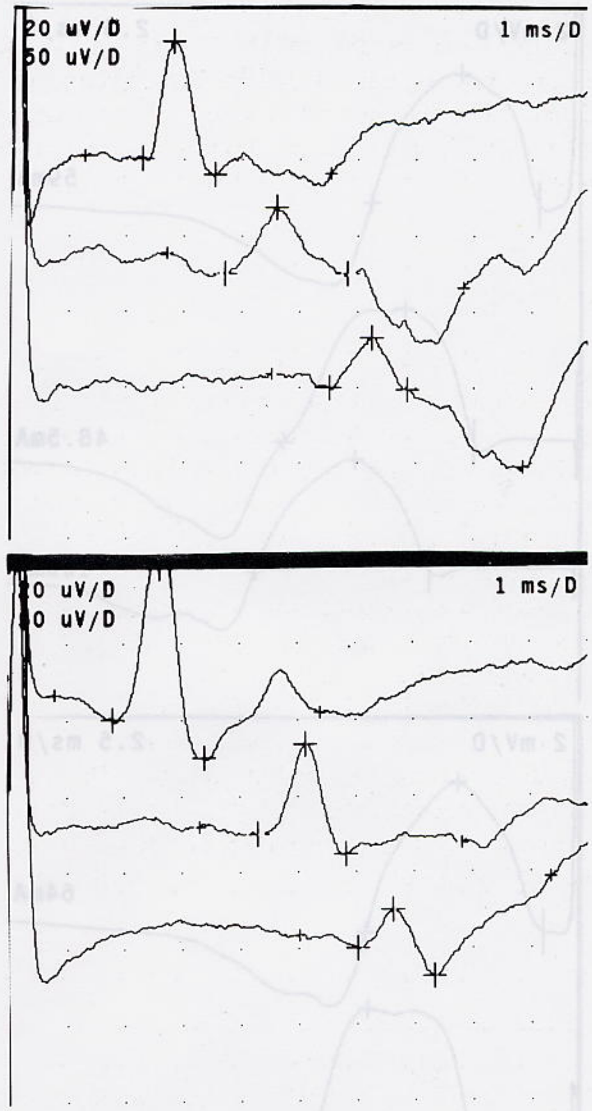

Fig. 1 – Radial sensory nerve conduction studies. Upper set of 3 traces were studies obtained before TOIMS and the lower set of 3 traces were obtained immediately after TOIMS. From the top to bottom, the set of 3 traces represents the following: trace 1 = stimulation at 140 mm, trace 2 = stimulation at 280 mm and trace 3 = stimulation at 380 mm.

Results

Immediately after the TOIMS, there was an increment in sensory amplitude of 60%, 70% and 31% on stimulation respectively at 140 mm, 280 mm (elbow crease) and 380 mm (spiral groove) from the recording electrode (see Fig.1). No significant changes occurred with further examinations on 7/16/96 and 8/05/96 and further studies were not needed (see Table). Also, motor nerve conduction studies showed a significant improvement in the amplitude (30.7%), area (45.6%) and conduction velocity (MCV 27%) on stimulation at the spiral groove immediately after treatment (See Fig. 2). There was no significant changes in these parameters on stimulation below elbow or at the elbow crease level before and after treatment. There was

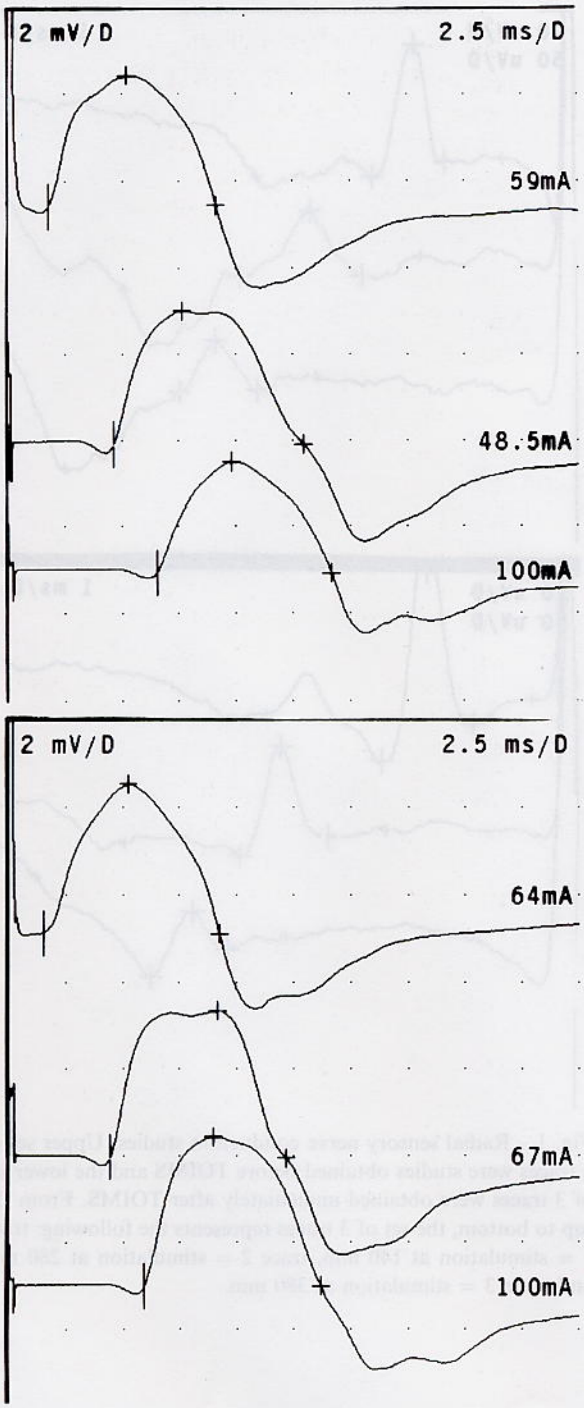

Fig. 2 – Radial motor nerve conduction studies. Upper set of 3 traces were studies obtained before TOIMS and the lower set of 3 traces were obtained immediately after TOIMS. From the top to bottom, the set of 3 traces represents the following: stimulation below the elbow, stimulation at the elbow crease, and stimulation at the spiral groove.

stabilization of conduction parameters with non-significant improvement (<15% changes of the values) with a follow-up study on 7/16/98 and follow-up MCV studies were not warranted.

EMG did not exhibit spontaneous activity in both triceps and EDC on seven occasions. This included spot testings for spontaneous activity at two weeks and three weeks after the injury. Mild reduction in the interference pattern was noted in both muscles. The triceps showed an increase in duration and the size index of the MUAPs by the 3rd month. Both parameters stabilized at 18 months. Phases increased on the examination at the 6th month only. In EDC the size index increased progressively by the 3rd month. The duration increased at the 6th month with stabilization of values by the 18th month. Phases and turns increased on day 3 examination only. EDC showed reduction in the firing rate with time.

Correlation analysis showed a direct relationship between the number of treatments and the number of Grade 2 twitches ($p < 0.01$). An inverse relationship occurred with the number of Grade1 twitches in the left triceps muscle. The brachioradialis and EDC elicited too few twitches for analysis. The left triceps muscle showed a direct correlation between time since injury and MUAP amplitude as well as the size index ($p < 0.01$). The left EDC showed a similar direct correlation between time since injury with duration ($p < 0.005$) as well as the size index ($p < 0.001$). An inverse relationship occurred with the firing rate ($p < 0.001$).

Discussion

A nerve conduction block of the radial nerve was the cardinal feature in this patient. The site of the nerve block was likely at the spiral groove since triceps was involved. However, since the recovery in sensory amplitude occurred best on stimulation at the elbow crease on all studies, there may be a secondary lesion at the lower edge of the lateral intramuscular septum, as in a Saturday night palsy. The observation of a sensory latency that was initially shorter than on subsequent stimulations at the elbow crease suggested a technical problem on stimulation at this level (280mm). This could be due to the underlying conduction block. The initial stimulus point may have been close to or at the area of the conduction block and with supramaximal stimulation, the stimulus head shifted distally. This produced a shorter latency with the initial examination at the elbow crease before the TOIMS treatment. With subsequent examinations, the conduction block already improved allowing the stimulation to occur at the appropriate site on the nerve at the elbow level.

The radial motor involvement was compatible with a combination of partial conduction block and some axonal loss of the large fibers. The concomitant re-innervation compensated for the partial axonal loss and explained the lack of spontaneous activity in the radial muscles. The axonal loss was confirmed by the increase in triceps MUAP parameters implying an increase in motor unit size by the 3rd month with stabilization by the 18th month. This suggested not only the presence of re-innervation but also the capacity to achieve maturation of the reinnervated MUAPs by 18 months.

The EDC showed the same pattern as triceps for MUAP duration. However, the size index became larger than on the initial examination up to the 18th month suggesting that re-innervation had not reached full maturation even by then. The size index is the most useful parameter for estimating of MUAP size (22). This implied that the EDC sustained more axonal loss than the triceps. The conduction block in this muscle was brief since the increase in phases and turns noted on day 3 resolved by the examination at the 3rd month.

The presence of the conduction block caused acute functional denervation of the radial muscles. This resulted in immediate shortening of muscle fibers as a response to denervation supersensitivity (1, 3, 9, 17-19). The areas of muscle shortening are identified by the presence of knots/bands which can be felt intramuscularly. Elicitation of twitches on performing TOIMS at these points confirmed them as treatment points. These areas have a high concentration of abnormally excitable motor end-plate zones and elicit twitches readily (4-7). The force of the twitches would depend on the length of the muscle fibers at these areas (10).

Extrafusal (11-15,21) and intrafusal muscle fibers (20) and musculotendinous structures (16) have a thixotropic (stiffness) effect. Stretch movements or muscle contractions (11-15, 21) can break these thixotropic bonds. The twitches would cause sarcomere lengthening from reduction of thixotropy (13). The clinical improvement in the twitch force of the triceps with subsequent treatments suggested effective reduction in triceps muscle thixotropy. The larger forces were possible when the muscle fiber length became closest to their normal resting length (10).

The muscle movements created by the force, frequency, and number of twitch responses at treatment points were beneficial. This exercise reduced the compressive effect of stiff muscle tissue on intramuscular nerves and blood vessels. Both examined muscles, the triceps and EDC sustained an axonal injury. A normalization of the parameters occurred in the triceps but not in the EDC by the 18th month. This suggested more axonal loss in the EDC. Immediate pressure release by the stiff and tight triceps on the proximal part of the radial nerve probably prevented further distal axonal injury. Immediate improvement in the conduction parameters of the left radial nerve after the treatment suggested that most of the ischemic conduction block was successfully reversed. The vasodilatation and increased blood flow caused by the twitch-induced exercise (2, 23) aided the recovery.

With this acute partial nerve palsy model, a preliminary understanding of the mechanism of action of TOIMS developed. TOIMS when used acutely averted a more prolonged period of the conduction block and probably aided in preventing a more serious axonal injury of the radial nerve.

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