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Case Study

Radial extracorporeal shock wave therapy for heterotopic ossification

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Abstract. [Purpose] To report the effects of radial extracorporeal shock wave therapy (RSWT) on heterotopic ossification (HO). [Subjects and Methods] Two cases of neurogenic HO in the upper extremity were administered RSWT using the MASTER PLUS® MP 2000 (Storz, Tägerwilen, Switzerland) and ultrasonographic guidance. The RSWT protocol consisted of 3,000 pulses at a frequency of 12 Hz during each treatment. The intensity level ranged from 2–5 bars, and it was administered 5 times a week for 4 weeks, a total of 20 treatments. [Results] RSWT improved pain, range of motion, and hand function in 2 patients with neurogenic HO in the upper extremity. [Conclusion] Further studies are needed to support these results and to understand the mechanism and to devise the protocol of RSWT for neurogenic HO.

Keywords: Extracorporeal shock wave therapy (ESWT), Heterotopic ossification, Brain injury

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INTRODUCTION

Radial extracorporeal shock wave therapy (RSWT) generates pressure waves through the collision of solid bodies[1)]. It has been widely used to treat various musculoskeletal injuries[2, 3)]. There are a few recent reports regarding the effectiveness of extracorporeal shock wave therapy (ESWT) on neurogenic heterotopic ossification (HO) in the lower extremity, but to our knowledge, the use of ESWT or RSWT to treat neurogenic HO in the upper extremity has not been reported in the literature[4)].

We report 2 cases of RSWT used to treat neurogenic HO in the upper extremities. In both cases, improvements in pain, range of motion (ROM), muscle strength, and hand function were observed.

Each patient gave their written informed consent and agreed to participate in the treatment. This case report was approved by the Ethics Committee of the Sahmyook Medical Center.

CASE A

A 49-year-old man was admitted to our physical medicine and rehabilitation (PMR) department. A subarachnoid hemorrhage (SA) occurred 10 months prior to admission and neurogenic HO of the left shoulder and elbow was diagnosed 2 months before his admission. He had been taking disodium etidronate 800 mg per day (Fig. 1). In spite of the medication, he continued to complain of constant pain, limited ROM, muscle weakness, and impaired hand function. RSWT was administered to the inferior portion of the coracoid process of the left shoulder and the medial epicondyle (ME) of the left elbow using ultrasonographic (USG) guidance. The target points of RSWT were the HO area that could be seen with USG.

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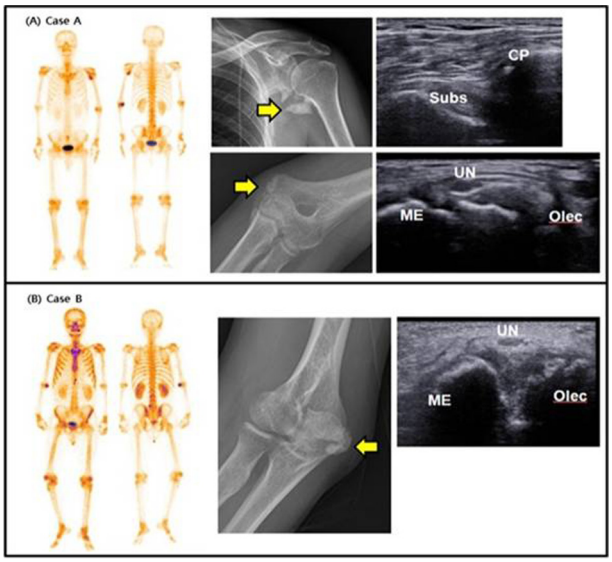

Fig. 1. (A) In case A, bone scan, X-ray, and musculoskeletal ultrasound demonstrate HO in the left shoulder and elbow. (B) In Case B, in the right elbow.
Arrows indicate the HO sites.
HO: heterotropic ossification; Subs: subscapularis; CP: coracoid process; UN: ulnar nerve; ME: medial epicondyle; Olec: olecranon

CASE B

A 52-year-old man with a 6-month history of hypoxic brain injury was admitted to our PMR and diagnosed with neurogenic HO of the right elbow (Fig. 1). RSWT was administered to the HO area including the ME and olecranon of the right elbow using USG guidance. Medications were not subsequently required due to a good response to RSWT.

In both cases, RSWT was administered using the MASTER PLUS® MP 2000 (Storz, Tägerwilen, Switzerland), and the RSWT protocol consisted of 3,000 pulses at a frequency of 12 Hz during each treatment. The intensity level ranged from 2–5 bars, and it was administered 5 times a week for 4 weeks, a total of 20 treatments. During RSWT, all other treatments, including physical and occupational therapy, were continued as usual. Both patients were allowed to take previously prescribed oral medications but additional analgesics or antispastic medications were not permitted.

Pain assessed with the numerical rating scale (NRS), ROM, muscle strength assessed with the manual muscle test (MMT), a hand evaluation test, and the Jebsen-Taylor hand function test were evaluated prior to each treatment, after treatment, and following 1 month of treatment. No side effects were noted during the study period.

In both cases, pain was reduced from 8 to 0 on the NRS, and the patients remained pain-free for 1 month after treatment.

In case A, ROM of flexion, abduction, adduction, internal rotation, and external rotation of the left shoulder and additionally, flexion of the left elbow was improved and maintained. The MMT result also showed improvement and the improvement was maintained for 1 month (Table 1). Functional testing of hand strength and speed of hand movement showed improvements that were maintained at least for 1 month after the end of treatment (Table 1).

In case B, right elbow flexion, supination, and pronation were improved, the improvements were maintained for 1 month. In contrast to case A, improvement in the MMT result was not seen (Table 1). In the hand function test, the strength of the hand and speed of hand movement improved, and these improvements were maintained at least for 1 month after the end of treatment (Table 1).

DISCUSSION

HO is a complicated and significant medical problem characterized by abnormal growth of bone in soft tissues, commonly around large joints. In its severe form, the condition causes pain, limited ROM, and loss of function in the affected joint.

Several categories of HO exist, based on the event triggering its formation. Known causes include traumatic, neurogenic, genetic, and idiopathic types[5]. Neurogenic HO is associated with injuries to the central nervous system, occurs 2–4 months after a neurological insult, and mainly affects the major synovial joints between spastic muscles[6].

Primary treatment is a combination of gentle passive ROM exercises and bisphosphonate medication, such as disodium etidronate or nonsteroidal anti-inflammatory drugs. Surgical excision may be considered for complicated cases, but surgical

Table 1. Range of motion, manual muscle test, hand evaluation test and, Jebsen-Taylor hand function test results

Test	Case A			Case B		
	Before	After	Follow up up	Before	After	Follow up
Range of motion(°)						
Shoulder						
Flexion	90	140*	145*			
Extension	20	20	20			
Abduction	90	130*	130*			
Adduction	10	20*	20*			
Internal rotation	60	70*	70*			
External rotation	20	60*	60*			
Elbow						
Flexion	90	100*	100*	40	80*	85*
Extension	Full	Full	Full	Full	Full	Full
Supination	70	70	70	60	65*	80*
Pronation	70	60	60	60	62*	80*
Manual muscle test						
Shoulder						
Flexion	Fair	Fair+*	Fair+*			
Extension	Fair	Good−*	Good−*			
Abduction	Fair	Fair+*	Fair+*			
Horizontal abduction	Fair	Fair+*	Fair+*			
Horizontal adduction	Fair	Good−*	Good−*			
Elbow						
Flexion	Fair	Good−*	Good−*	Fair−	Fair−	Fair−
Extension	Fair	Good−*	Good−*	Fair−	Fair−	Fair−
Hand evaluation test						
Grasp power (kg)	14	20*	18*	12	12	12
Lateral pinch (kg)	3.5	4.5*	5.5*	1.5	2.5*	2*
Tripod pinch (kg)	2	3.0*	2.5*	2	1	1.5
Nine-hole pegboard (sec)	30.6	25.7*	25.0*	138	65.1*	58.7*
Purdue pegboard test (number) †	11	12*	12*	0	3*	1*
Jebson-Taylor Hand Function Test (sec)						
Writing	55.34	45.00*	43.71*	NT	NT	NT
Card turning	9.31	7.87*	8.76*	11.04	11.07	6.9*
Small common object	12.16	10.59*	10.15*	NT	47.3*	19.5*
Feeding	13.81	12.25*	10.94*	NT	NT	25*
Stacking checkers	7.13	4.50*	4.12*	NT	NT	NT
Large light object (sec)	5.84	5.91	4.81*	8.12	5.71*	6.34*
Large heavy object (sec)	6.94	5.78*	4.63*	8.69	7.12*	5.06*

Follow up period was 4 weeks. *improved score; NT: not testable; †affected side

complications and postoperative recurrence are common[4].

ESWT has been described in several case reports as a new treatment strategy for neurogenic HO, but it has been restricted to the lower extremities[7]. ESWT has been shown to promote bone healing in stress fractures, avascular necrosis, and delayed and/or bony nonunion, and it has been widely used for managing the pain of various musculoskeletal conditions[8]. ESWT consists of a sequence of single sonic pulses characterized by high peak pressure (100–1,000 bars) of short duration (0.2 μs) and has a focused pressure field with deep penetration depth.

Compared with ESWT, RSWT is characterized by 1–10 bars of pressure of 0.2–0.5 ms duration and has a radial pressure field with shallow penetration depth. Despite the physical differences, the stimulation effects and therapeutic mechanisms of ESWT and RSWT are almost the same[1].

In our cases, pain, ROM, muscle strength, and hand function improved although imaging studies with radiographs and bone scans showed no changes. This result is consistent with previous studies that reported improvement in pain and function

without changes in imaging studies[7, 8]. Based on the results of these studies, it is our opinion that imaging findings do not accurately reflect the pain and function caused by neurogenic HO.

The mechanism of pain reduction with ESWT or RSWT is not well known and there are several hypotheses[9]. ESWT or RSWT generates oscillations in tissue that lead to improvement of microcirculation and metabolic activity[1]. Immediate pain reduction after ESWT could be the result of a hyperstimulation analgesic effect[10].

The improvements observed in ROM, MMT, and hand function of the present two cases could be associated with pain reduction, since proper management of pain caused by neurogenic HO with RSWT could have been the cause of the improvements in ROM and hand function.

As reported by previous studies, in our cases, the improvements in pain, ROM, MMT, and hand function were maintained for 1 month after the RSWT treatment[7]. The mechanism of the long-term maintenance of the improvements is not known but RSWT in the early phase of neurogenic HO is effective at preventing progression.

Our target HO sites were located using determined with USG guidance. They were the inferior part of the coracoid process of the left shoulder and the ME of the left elbow in case A, and the ME and olecranon of the right elbow in case B. Imaging guidance when administering RSWT for treating neurogenic HO could help to correctly focus on the HO site and avoid the other vulnerable structures such as vessels and nerves[2, 10].

In conclusion, RSWT improved the pain, ROM, and hand function of two patients with upper extremity neurogenic HO. Further studies are needed to support these results and to understand the mechanism behind the effectiveness of RSWT, as well as to devise a protocol for RSWT for neurogenic HO.

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