# The Use of Long-Arm Serial Casting to Manage Multiple Sclerosis Spasticity: A Case Report

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## ABSTRACT

Spasticity is common among individuals with multiple sclerosis (MS) and can have negative implications. Casting is a treatment intervention that is used to manage spasticity. The use of casting has been studied in individuals with brain injury and stroke, but no publications were found for its use in persons with MS. An individual with MS with upper extremity spasticity participated in long-arm serial casting, bivalve cast fabrication, and additional targeted therapeutic interventions over the course of 17 visits. Spasticity, pain, strength, passive range of motion (PROM), skin, and function were assessed. Spasticity and PROM improved. Increased strength was found in shoulder flexion, elbow flexion/extension, and supination. Active range of motion with resistance was possible and pain-free after the intervention for abduction, horizontal abduction, horizontal adduction, and external rotation. Furthermore, increased functional use including feeding, dressing, and bathing was achieved.

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Individuals with multiple sclerosis (MS) may experience debilitating symptoms including spasticity, "a motor disorder characterized by a velocity-dependent increase in muscle tone with exaggerated tendon jerks, resulting from hyperexcitability of the stretch reflex."[1] A meta-analysis found that 60% to 80% of individuals with MS are negatively impacted by spasticity.[2] Up to one-third of individuals with MS may experience spasticity that negatively impacts their quality of life and ability to participate in activities of daily living.[3]

Contractures, a loss of complete passive range of motion (PROM) due to limitations at the joint, muscle, or soft tissue,[4] are a potential negative implication of spasticity. Weakness and spasticity may contribute to the development of contractures.[5] It has been shown that contractures are common in people with MS, and the level of disability, type of MS, and weakness may all correlate with having a contracture.[6]

Interventions that are commonly used for managing spasticity and its resulting limitations in individuals with MS include skilled rehabilitation, neuromuscular blocks, oral agents, intrathecal management, and surgery.[7] The literature indicates that casting is used to address spasticity and contractions in individuals who have suffered a brain injury or stroke, but there is a paucity of research on the use of casting in individuals with MS. There are various types of casts that can be used to manage spasticity and contractures, but serial casting with progression in elbow, wrist, and/or digit extension was chosen for the participant in this report due its potential impact on spasticity (**FIGURE 1**).[8] In serial casting, casts are applied and removed with the goal of increasing range of motion (ROM) with each applied cast.

## METHODS

### Participant

The participant was a 52-year-old woman who was diagnosed with relapsing-remitting MS (RRMS) in 2009, and she was being treated with the disease-modifying therapy ocrelizumab. She was ambulating using a right single-point cane

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# PRACTICE POINTS

Serial casting in an individual with multiple sclerosis (MS) with upper extremity spasticity may be feasible without an increase in symptoms or skin compromise.

The use of serial casting and additional targeted therapeutic interventions may lead to therapeutic gains in individuals with MS.

Serial casting may be a beneficial therapeutic intervention to manage spasticity in individuals with MS. ■

and left low-tech foot device for foot drop. She presented with nonfunctional use of her dominant right upper extremity (RUE) and an intact left upper extremity (LUE). Due to her nonfunctional RUE, she was unable to use it effectively in activities of daily living/instrumental activities of daily living, such as feeding herself, washing her face, and typing. The participant received occupational therapy (OT) for 17 visits and participated in physical therapy through visit 11 of this OT plan of care (POC). Her RUE skin was intact throughout the POC. She presented with increased RUE spasticity and had difficulty completing both active and passive RUE movements due to pain, decreased strength, and/or increased spasticity (**TABLE 1**). The individual in this report consented to the reporting of her clinical data collected during her POC.

**TABLE 1.** Spasticity, Strength, and Passive Range of Motion Measures

| Outcome measure | Initial | After therapy |
|---|---|---|
| Modified Ashworth Scale[a] Right elbow flexors | 2 | 1 |
| Modified Tardieu Scale[a] Right elbow flexors | 2 (R1: 73, R2: 180) | 2 (R1: 122, R2:180) |
| **RUE MMT** | | |
| Shoulder flexion[a] | 2+ | 3− |
| Shoulder extension[a] | 4[b] | 4 |
| Shoulder abduction[a] | Unable to complete due to pain | 3− |
| Shoulder adduction | 5 | 5 |
| Horizontal abduction[a] | Unable to complete due to pain | 2+ |
| Horizontal adduction[a] | Unable to complete due to pain | 4 |
| Internal rotation | 4 | 4 |
| External rotation[a] | Unable to complete due to pain | 3− |
| Elbow flexion[a] | 4 | 5 |
| Elbow extension[a] | 3− | 4 |
| Supination[a] | 4 | 5 |
| Pronation | 5 | 5 |
| Wrist flexion | 4 | 3+ |
| Wrist extension | 4 | 4 |
| RUE PROM[c] | | |
| Shoulder flexion (0-170) | WFL | WFL |
| Shoulder extension (0-60)[a] | WFL[b] | WFL |
| Shoulder abduction (0-180)[a] | 0-46[b] | WFL |
| Internal rotation (0-70)[a] | 0-50[b] | WFL |
| External rotation (0-90)[a] | 0-37[b] | 0-70 |
| Horizontal abduction (130)[a] | 0-113[b] | WFL |
| Horizontal adduction (0-40)[a] | 0-16[b] | WFL |
| Elbow flexion/extension (0-135-150) | WFL | WFL |
| Pronation (0-80-90) | WFL | WFL |
| Supination (0-80-90) | WFL | WFL |

MMT, manual muscle test; PROM, passive range of motion; R1, initial resistance in response to stretch; R2, end range of stretch; RUE, right upper extremity; WFL, within functional limits.
[a]Denotes improvement in spasticity, MMT, pain, or PROM.
[b]Reported pain.
[c]PROM range indicates the full potential degrees of movement with the end range number being normal PROM.

### *Procedures*

The OT POC consisted of 17 visits, including an evaluation and discharge visit, all of which took place over 20 weeks (**FIGURE S1**). The visits took place in an outpatient clinic in a metropolitan area of the southeastern United States and lasted 60 to 75 minutes each. The individual had an evaluation during visit 1 and traditional therapeutic interventions during visits 2 through 9 with limited success in improved function of the RUE. Traditional therapeutic interventions included splinting, functional training, neuromuscular reeducation, neuromuscular electrical stimulation, scapular mobilization, PROM, cupping, vibration, weight bearing, sleep hygiene, managing heat intolerance, and upper extremity (UE) strengthening.

It was determined that RUE spasticity was a barrier to RUE function. Consequently, the participant was assessed for appropriateness of serial casting in visit 9, and it was determined that long-arm serial casting (LASC) with bivalve fabrication and targeted therapeutic interventions following LASC could potentially be beneficial for the RUE (Figure 1). The overarching goals of LASC were to decrease spasticity, prevent a contracture from forming at the elbow joint, and increase functional use of the participant's RUE.

The first cast was applied during visit 10 on Monday of week 13 and removed during visit 11 on Thursday of the same week. A new cast was immediately applied after removal of the first cast. The second cast was removed and turned into a bivalve splint during visit 12 on Wednesday of week 14. The cast was turned into a bivalve splint by cutting it in half and modifying it with padding and strapping to allow it to be removed and reapplied with the goal of maintaining the gains in ROM. The participant wore the bivalve at home briefly (ie, 30-60 minutes) to assess skin integrity, and then was instructed to wear it while sleeping each night.

**FIGURE 1.** Serial Cast (A) and Bivalve Splint (B)

A B

She reported inconsistent adherence to wearing the bivalve splint while at home. How this affected trial results is not known.

At the conclusion of LASC, the participant participated in the following targeted therapeutic interventions during visits 13 through 17: neuromuscular reeducation, scapular mobilization, energy conservation, neuromuscular electrical stimulation, UE strengthening, and functional training. In addition, she engaged in strengthening, stretching, and functional use of her RUE outside of the visits as part of a home exercise program. Skin integrity was monitored throughout the POC.

### *Materials*

The following materials were used for LASC: 3-in stockinette dressing, 1/4-in orthopedic felt, tape, cast padding, 3-in and 2-in fiberglass cast tape, bucket of water, scissors, permanent marker, gloves, towels, cast saw, and cast spreaders. A trained occupational therapist applied all casts to the participant's dominant RUE with each cast progressing in elbow, wrist, and/or digit extension.

Spasticity, muscle strength, PROM, pain, and functional use of the participant's RUE were assessed throughout the POC to determine her response to treatment and the appropriate next steps. The Modified Ashworth Scale (MAS) was used to measure spasticity of the right elbow flexors and was completed during visits 9 through 13 and again on visit 17.[9] In addition, the Modified Tardieu Scale (MTS) was used to measure spasticity of the right elbow flexors at slow and fast speeds, which included the initial resistance in response to a stretch (R1) and then the end range of the stretch (R2).[10] The MTS was completed 6 times (ie, visits 8, 10, 11, 12, 13, and 17).

Muscle strength, PROM, and pain, excluding elbow flexion/extension PROM, were assessed during visits 1 and 17. PROM of right elbow flexion/extension was assessed at visits 9 and 17. Muscle strength was measured by completing a gross UE manual muscle test (MMT) with scores ranging from 0, "no muscle activation," to 5, "maximum strength."[11] During the MMT, the participant resisted shoulder, elbow, and wrist muscle movements to determine muscle strength. Spasticity, especially at the right elbow flexors, may have impacted the results of the MMT. PROM of the right shoulder and elbow were measured using a goniometer.

Pain and functional assessments of the RUE were also collected. Pain was reported during the RUE MMT and PROM assessments. Functional assessments of the RUE included writing, reaching behind her back, bringing a cup to her mouth, and simulating feeding herself with her RUE. All assessments were conducted by a trained occupational therapist.

### *Data Analysis*

Interpretations of outcomes were based on changes in spasticity, which may have impacted strength, PROM, pain, and functional use of the RUE. Statistical analysis was not completed due to this being a single-participant case report.

## RESULTS

Spasticity decreased in right elbow flexors as evidenced by the MAS and the dynamic tone measurements (R2-R1) of the MTS (Table 1). On the MAS, the participant initially scored a 2, improving to a 1 at discharge. Dynamic tone was initially 107° and improved to 58° at discharge. Outside of dynamic tone, no changes in spasticity were demonstrated per the MTS.

Strength increased for 4 of 12 muscle movements assessed in the MMT by the time of discharge (Table 1). In addition, the participant was unable to fully complete the MMT during the first visit due to pain, but she was able to fully complete it at discharge. Furthermore, PROM and pain improved based on the goniometric assessment and participant report during the PROM assessment of the RUE.

The participant increased the functional use of her RUE and was able to write, reach behind her back, bring a cup to her mouth (once the cup was in her hand), and simulate eating a banana using her RUE by discharge (Table S1). In addition, she reported being able to use her RUE to assist with typing, washing her left armpit, and donning her bra by the end of the POC.

## DISCUSSION

The primary finding was that LASC in a person with RRMS and UE spasticity is feasible without an increase in symptoms or skin compromise. Furthermore, the participant demonstrated improvement in spasticity, strength, pain, PROM, and functional use of the RUE after participating in LASC and other therapeutic interventions. To this author's knowledge, this is the first report examining the feasibility and effectiveness of LASC to address UE spasticity in an individual with MS.

The participant demonstrated an improvement in spasticity in her right elbow flexors, which is consistent with a randomized controlled trial looking at the effect of serial casting for an elbow flexion contracture vs positioning in a group of adults with brain injury.[12] In addition, Moseley et al[12] support the current findings that serial casting can have a positive impact on pain. Although not statistically significant, the serial casting group showed greater improvement in pain than the positioning group both after the intervention (2 weeks) and at follow-up (4 weeks).[12] The current participant demonstrated a decrease in pain of the affected UE per her ability to participate in the MMT and goniometric assessments by the end of the POC.

Several studies looking at casting in individuals with brain injury or stroke demonstrate an improvement in either UE or lower extremity (LE) PROM following casting.[13-16] The current participant presented with full PROM of right elbow extension prior to participating in casting to the right elbow and demonstrated improvement in PROM of the right shoulder following casting and other therapeutic interventions. This increase in PROM may have been due to a decrease in RUE pain, which, in turn, could have led to improved functional performance in adaptive skills. In addition, the participant demonstrated an improvement in RUE strength by the end of the POC.

No studies that examined the impact of UE casting on strength were found, but Leung et al[16] did study the effect of LE casting on strength. The findings do not support an increase in strength following serial casting, perhaps because the individuals in the study had their ankles casted and were limited in their ability to participate in functional tasks requiring use of the ankle. None of the individuals in the study were able to walk at baseline and only 1 individual could participate in the walking measure after the intervention.[16] Following LASC, the current participant had functional use of her RUE, which may have increased her opportunity to use and strengthen this extremity while in therapy as well as in her daily life during the POC, leading to the hypothesis that an individual with greater functional use of their casted extremity could have increased strength in this extremity. In addition, the participant's pain may have limited her performance in the initial MMT and a decrease in pain of the affected UE by the end of the POC may have allowed for improved strength in the final MMT.

## CONCLUSIONS

LASC may be effective for individuals with RRMS who have debilitating UE spasticity. In this report, the participant demonstrated improvement in function of her affected UE, which possibly resulted from an improvement in spasticity, pain, strength, and PROM following a combination of LASC and targeted therapeutic interventions.

This case report has several limitations. It included only 1 individual with RRMS; therefore, the implications cannot be generalized. Additionally, the participant's nonadherence to wearing the bivalve splint and the inconsistent therapy schedule are limitations. Potential limitations with using LASC as an intervention include patient adherence, transportation, funding, lack of trained practitioners, and lack of caregiver assistance that may be necessary because casting may temporarily limit independence. Further research with a larger sample size consisting of individuals with various forms of MS is needed to determine the efficacy of using UE serial casting in individuals with MS to improve spasticity, strength, pain, ROM, and functional use of the affected UE. ■

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**FIGURE S1.** Overview of Plan of Care

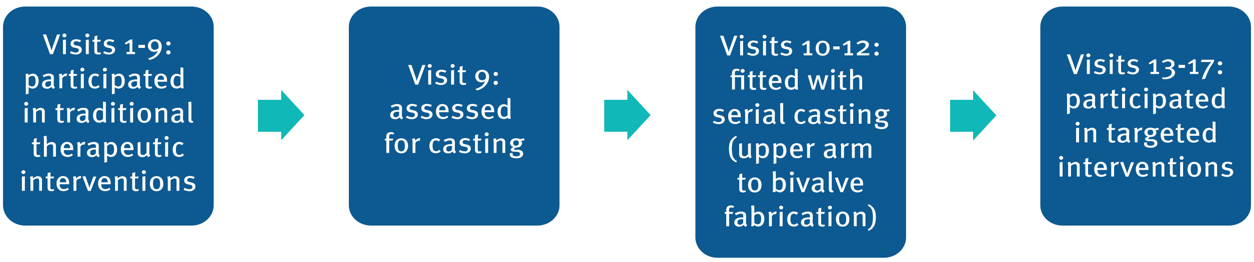


**TABLE S1.** Summary of Results

| Outcome measure/observation | Results |
|---|---|
| Spasticity | Modified Ashworth: improved.<br>Modified Tardieu: improved in R1 angle measurement and dynamic tone. |
| PROM | Improved in right shoulder abduction, internal rotation, external rotation, horizontal abduction, and horizontal adduction. |
| MMT | Improved for 4 of 12 muscle movements assessed. |
| Pain | MMT: unable to fully complete initial MMT due to pain, but was able to fully complete final MMT.<br>PROM: pain with initial PROM assessment, but pain-free during final assessment. |
| Function | Clinical observations: improved ability to write, reach behind back, bring cup to mouth (once cup was in hand), and simulate eating a banana using RUE.<br>Participant report: improved in ability to type, wash left armpit, and don bra using RUE. |

MMT, manual muscle test; PROM, passive range of motion; R1, initial resistance in response to a stretch; RUE, right upper extremity.