Plaster Splinting as a Means of Reducing Elbow Flexor Spasticity: A Case Study

(muscle spasticity, plaster casts, joint motion, inhibition)

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Patients with upper motor neuron lesions often exhibit spasticity in the extremities that limits functional use. In many cases the spasticity is mild to moderate and conventional treatment modalities—for example, neutral warmth and vibration in conjunction with purposeful activity—suffice as inhibitory techniques leading to voluntary, isolated movement. Too often, however, the spasticity is severe, and more aggressive therapy approaches must be used. Plaster splinting has been shown to be effective as an inhibitory agent in treating severe spasticity and preventing contractures.

This paper presents a case study of a patient with severe elbow flexor spasticity secondary to a cerebral aneurysm clipping. Traditional inhibitory techniques, in conjunction with purposeful activity, were used to decrease the spasticity such as vibration, tapping, manual stretch, resistance and hold/relax, with no apparent reduction in tone. A splinting program was then employed to prevent further increase in tone and subsequent loss of range of motion.

Plaster was used as the medium for the splint because it allowed for a good fit, was quick to apply, and was strong. When applied, the splint held the spastic extremity in as much elbow extension as could be gained by gentle, passive stretch. The design of the splint allowed further extension if the flexor spasticity decreased. The theoretical basis for the use of the splint lies in the autogenic inhibitory response of the Ib afferent fibers serving the golgi tendon organs. The splint would therefore supply inhibition to the spastic elbow flexors automatically every time flexor tone increased, and the patient would flex against the splint isometrically. The stockinette and cotton cast padding wrapped around the extremity before applying plaster bandage may also offer neutral warmth that could increase the inhibitory effect.

The single case study method is used in this report to detail the application of a single plaster splint design and the occupational therapy program that accompanies the use of the splint.

Method

Subject. A 46-year-old female admitted with a subarachnoid hemorrhage and intraventricular bleed secondary to an aneurysm of the right basilar artery had left hemiparesis following surgery to clip the aneurysm. Shoulder and elbow passive range of motion was decreased on the left side because of severe flexor spasticity. She had full functional use of the wrist and hand. The major goal of occupational therapy was to increase passive and active range of the left elbow for functional activities through inhibition of the spasticity.
Table
Summary of Treatment Results

<table>
<thead>
<tr>
<th>Day</th>
<th>Procedure</th>
<th>Passive Extension of Left Elbow</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (12 May)</td>
<td>First plaster splint applied</td>
<td>-90°</td>
</tr>
<tr>
<td>2 (13 May)</td>
<td>Second plaster splint</td>
<td>-75°</td>
</tr>
<tr>
<td>3 (14 May)</td>
<td>Third plaster splint</td>
<td>-55°</td>
</tr>
<tr>
<td>4 (15 May)</td>
<td>Fourth plaster splint</td>
<td>-40°</td>
</tr>
<tr>
<td>5 (16 May)</td>
<td>Plaster splint replaced</td>
<td>-20°</td>
</tr>
<tr>
<td></td>
<td>by plastic splint (2 hours on; 1 hour off)</td>
<td>-30°</td>
</tr>
<tr>
<td>6 (17 May)</td>
<td>Fifth plaster splint</td>
<td>-15°</td>
</tr>
<tr>
<td>7 (18 May)</td>
<td>Sixth plaster splint bivalved; worn at night 12 hours for 3 weeks</td>
<td>-15°</td>
</tr>
</tbody>
</table>

Treatment. A plaster splint was applied to the impaired extremity 1½ months after surgery. It was designed with a full circular portion enclosing the upper arm from the axilla distally to the olecranon process and a forearm portion of only a volar, flexor stop (see Figure). The elbow was placed in a position of maximum extension achieved through gentle, passive stretch.

The patient was seen twice daily in occupational therapy for treatment involving ranging and bilateral manual tasks. Self-ranging was done with assistance from the unimpaired extremity. The therapist also passively ranged the impaired extremity to maximum before involving the patient in bilateral manual tasks requiring active shoulder and elbow movements (e.g., sweeping with a long-handled broom from a wheelchair and completing a macrame project suspended from the ceiling). When passive range in the left elbow was gained 20° beyond the position of the splint, a new splint was fabricated to accommodate the increase. When only 15° of passive extension was lacking in the left elbow, a final splint was made with the humeral portion bivalved to allow for shorter periods of wearing time.

The bivalved splint was worn only at night (12 hours) and held in place with an Ace bandage until the patient could maintain the active and passive range achieved through daily exercise and purposeful activities.

Followup. The patient continued occupational therapy daily while an inpatient and, subsequently, as an outpatient for 4 months, to participate in bilateral upper extremity activities in order to maintain functional use of the left upper extremity.

The program the subject followed as an inpatient included self-care activities on the rehabilitation unit in the mornings to encourage independence and to increase the use of the impaired extremity in daily tasks as well as the twice daily visits to the occupational therapy clinic discussed previously. Outpatient contacts occurred approximately once every 2 weeks in order to monitor the patient for continued increase in activities of daily living independence and to see that she maintained active use of the impaired extremity with no return of spasticity.

Results
Table 1 is a summary of the treatment results. When the first plaster splint was applied, 90° of passive extension was lacking in the left elbow. During the next 4 treatment days, passive extension increased daily from 15° to 20°, and new splints were fabricated to accommodate this increase without allowing flexion. On the fifth treatment day, the patient lacked only 20° of left elbow extension, and the plaster splint was replaced by a plastic splint that en-
compassed the elbow to hold it in -20° of extension. The plastic splint wearing schedule was 2 hours on and 1 hour off.

The plastic splint did not fit definitively to maintain the range in the elbow and, per physician’s request, a plaster splint was fabricated with a flexor stop positioned at 30°. This splint was maintained for 3 days and the patient gained extension in the elbow to -15°. Three days later another plaster splint allowing only 15° flexion was applied and maintained for 4 days. The splint was bivalved after 4 days to be applied only at night for a period of 12 hours.

When the splint was not worn during the day, occupational therapy involved self-ranging of the impaired extremity before use in a purposeful activity, and physical therapy focused on ambulation training using a walker, an activity that also used the left upper extremity in a functional task. During activities without the splint the patient was able to actively extend the elbow to -30° whereas gentle, passive stretch allowed extension to -15°.

After 2 weeks of wearing the splint only at night, it was discontinued for a full 24-hour period. The patient exhibited increased spasticity that limited active extension of the left elbow to -50°. The elbow could passively be extended to -15°, but manual, passive stretch was necessary. The bivalved, plaster splint was reapplied for 12 hours each night for another week. Again it was discontinued and the patient has since maintained functional active range of motion lacking only 15° to 20° of full elbow extension.

Discussion
The patient in the case study was appropriate for this splint since the spasticity was constant and involved only the flexors. This splint would not be appropriate for a person having fluctuating tone on both sides of the joint; rather, a full circular plaster splint would need to be considered.

Other splint designs may also incorporate the wrist, hand, or both along with the elbow or be made for the wrist and hand only. Since the wrist and hand of this patient were not impaired with excessive tone, the splint design did not include them.

The splint may also be designed so that the forearm is enclosed with the flexor stop on the skin surface over the biceps. This would facilitate extension caused by the weight of the splint; however, special care must be taken in enclosing the forearm since improper wrapping of the plaster bandage tends to create more pressure problems on the forearm than on the upper arm.

Before attempting any splinting technique using plaster, it is important to become familiar with its properties and to be aware of the precautions to take and problem signs. The plaster splint worked better than the plastic splint since a better fit was achieved. Also, it could be left on 24 hours per day with no major concern for skin breakdown. The stockinette and padding may also offer additional inhibitory benefits by providing neutral warmth.

The weight and physical presence of the plaster splint were believed to attract the patient’s attention to the impaired extremity, which was useful since she tended to neglect it.

Summary
Plaster splinting was used to decrease severe elbow flexor spasticity in a patient with an upper motor neuron lesion. A series of plaster splints were applied over a period of several weeks that allowed elbow extension yet controlled the amount of flexion. The design of the splint was effective in reducing the spasticity, which was probably a result of the input from the golgi tendon organs in the spastic flexors. Initially, the splints were worn 24 hours a day. Later in the treatment process the wearing time was reduced to 12 hours at night only. Currently, the patient has voluntary, functional range in the impaired extremity.

Acknowledgments
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REFERENCES
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