CASE REPORT

Upper Extremity Inhibitive Casting in a Boy With Spastic Quadriplegia

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Occupational and physical therapists are often concerned with maintaining joint range of motion in children with neurological impairment. The presence of spastic posturing may be a serious problem that limits activities of daily living and quality of movement. Traditional therapy techniques include passive range of motion exercises, active exercises, positioning, and neurodevelopmental treatment to inhibit abnormal tone and movement. Daily stretching and range of motion exercises can be painful, however, which in turn increases the child's overall body tone and results in a time-consuming, ineffective form of treatment.

For over a decade, serial and plaster dropout casts have been used effectively to manage spasticity in adults with head injury and in children with neurological impairment (Cherry & Weigard, 1981). In a study of 42 adults with head injury at Rancho Los Amigos Hospital, Downey, California, progressive serial casting was used for the effective management of both upper and lower extremity deformities resulting from spasticity (Booth, Doyle, & Montgomery, 1983). King (1982), in describing the use of plaster dropout splints to reduce elbow flexor spasticity, suggested that the effectiveness of such splints is a result of "the autogenic inhibitory response of the 1b afferent fibers serving the golgi tendon organs" (p. 671). King also suggested that the splints may provide warmth, which could further reduce spasticity. A case study completed at the Children's Clinic and Preschool in Seattle examined the effects of upper extremity casting in a 5½-year-old child with spastic quadriplegia (Smith & Harris, 1985). The study showed that the casts were effective in maintaining extension and in preventing further increases in elbow flexion contractures. As a result of the increased elbow extension and stability provided by the casts, improvements were noted in both the handling and positioning of the child.

The present paper describes the effects of upper extremity casting in an older, more severely impaired child with spastic quadriplegia and provides guidelines for cast fabrication. Initial casts were fabricated of plaster and were similar to those used by Smith and Harris (1985). Additional casts were made of fiberglass, and the use of hand splints was attempted.

Case Description

J.H. was an 11-year-old boy with severe spastic quadriplegia due to intrauterine exposure to toxoplasmosis. His posture and movements were influenced by both the symmetrical and asymmetrical tone-neck reflex patterns, with more spasticity in his upper extremities. When in a sitting or supine position, his posture suggested a stronger influence of the asymmetrical tone-neck reflex to the left. We believed this
was contributing to a greater degree of contracture in the right elbow. J.H. could hold his head up during selected activities when properly seated, but required neck support in all other situations. Attempts to use his arms for functional activities resulted in increased upper extremity flexor tone and fisting. He was able to kick when supine but was unable to roll without assistance. He was dependent in all areas of self-care.

J.H. had received ongoing individual occupational therapy or physical therapy from various therapists, including the authors, two to three times weekly from the age of 12 months. A neurodevelopmental approach had been used in an effort to decrease the effects of hypertonicity. To provide alternative positions, a variety of adaptive equipment had been used at home and in the classroom, including a prone stander, a prone wedge, a side-lying cushion, an adapted wheelchair, a waterbed, and a beanbag chair. To encourage voluntary elbow extension, the occupational therapist had developed activities such as reaching for a treadle switch to activate a toy. J.H. also worked on active range of motion in the therapy pool with the physical therapist. Either classroom staff or therapy staff performed passive joint range of motion exercises each school day. J.H.'s parents were instructed to initiate these exercises on the weekends and on school holidays.

J.H. was enrolled in a self-contained special education classroom where he received therapy from the public school therapists, including the authors, for 120 min a week. He was also seen by a private physical therapist for home-based therapy once weekly for 45 min. Despite these efforts, the data that the treating therapists took over a 5-year period as part of routine case monitoring indicated a significant increase in elbow flexion contractures (see Figure 1). Passive elbow extension of 165° on the right and 120° on the left were recorded when the subject was 6 years old (December 1980). By the time J.H. was 11 years of age (February 1985), contractures had increased, permitting only 115° of extension on the right and 120° on the left.

The contractures made it difficult to dress, handle, and position J.H. at home and school. Inserting his arms into the sleeves of a coat was very time-consuming for his parents and classroom staff. J.H. became less tolerant of the side-lying and prone positions because his arms remained tightly flexed on his chest and his ability to actively reach and extend his elbows decreased.

Upon reviewing the historical data of this child's passive elbow extension and consulting with classroom staff and parents, we, the school occupational therapist and physical therapist, determined that previous activities and exercises had not been successful in preventing elbow flexion contractures. Alternatives such as surgery and medication were ruled out as being too invasive and as having unpredictable risks and adverse effects. On the basis of the success of Smith and Harris (1985), we decided to fabricate upper extremity casts. Casting appeared to be a relatively inexpensive method of providing ongoing therapeutic input through stretch to the elbow flexors. This treatment method would require little cooperation from the child, and the prolonged stretch would theoretically be less painful than would intermittent manual stretching. We consulted the classroom staff and J.H.'s parents, who agreed to use the casts at home and at school for the prescribed times.

Before casting, three school therapists (two occupational therapists and one physical therapist) took goniometric measurements of J.H.'s passive elbow extension for 3 days over a 1-week period to establish baseline data and intrarater reliability. The therapists were blind to each other's measurements and to any previous measurements. Each therapist used the same clear plastic goniometer. The measurements were taken while J.H. was in his adapted wheelchair, at approximately the same time of day, and in a quiet environment. On any given day, the intrarater measurements varied as much as ±11° and as little as ±4°. Interrater reliability varied as much as ±10° and as little as ±1°. This range of difference was consistent with studies evaluating goniometric reliability (Harris, Smith, & Krokowski, 1985).

Procedure

Smith and Harris's (1985) fabrication methods were duplicated for the initial set of casts. These were based on a modification of King's (1982) plaster drop-out casts and on a procedure used in upper extremity casting for patients with juvenile rheumatoid arthritis.

![Figure 1. J.H.'s passive elbow extension before casts were applied.](http://ajot.aota.org/pdfaccess.ashx?url=/data/journals/ajot/930290/ on 06/17/2017 Terms of Use: http://AOTA.org/terms)
J.H. was casted while seated in his adapted wheelchair. His elbow was extended to submaximal range. Two layers of tubular stockinette were applied, followed by a roll of soft-roll padding. A noncompressible padding was used over bony prominences. While the forearm was held in a neutral position, a circular wrap of 2 to 3 layers of plaster was applied from mid-humerus to just proximal to the ulnar styloid. After the plaster had set, the cast was cut in half. The bivalved edges were taped, and the cast was painted with white latex enamel to increase its durability. Touch-fastener straps were attached to the cast at the wrist, at the elbow, and mid-humerus (see Figure 2).

Wearing time was slowly increased. J.H. wore the casts for approximately 4 hr a day at school and for 2 to 3 hr at home. On weekends and holidays, he wore the casts for 4 to 5 hr a day. J.H. did not tolerate wearing the casts at night because of their weight. Regular physical and occupational therapy continued.

After approximately 5 months, a second set of plaster casts was made, because the first set was breaking down and was badly worn. Due to concerns regarding wrist contractures and hand position, resting hand splints were made from low-temperature thermoplastic material and were incorporated into the cast during the final plaster wrap (see Figure 3). Approximately 10° of additional elbow extension was added to these casts.

After 3 months, a third set of casts was made from fiberglass casting tape. This material was used to decrease the weight of the casts. These casts also incorporated hand splints. J.H. did not tolerate these casts as well as he did the others. He developed circulatory problems due to constant resistance to the stretch of the casts. Wearing time, therefore, was decreased to less than 3 hr a day. To increase J.H.'s tolerance of these casts, we made several attempts to modify them by decreasing the amount of wrist extensions. Because his intolerance continued, however, a fourth set of casts was fabricated after 3 months. The hand splints were eliminated in the fourth casting in an effort to alleviate the problems that seemed to be generated by the stretching of both the elbow and wrist joints.

Figure 4 shows the mean goniometric measurements of passive elbow extension taken periodically after casting was implemented. The measurements of the three therapists (the authors and another therapist) were averaged, because the use of the mean of several measurements has been found to improve goniometric reliability (Low, 1976). The same three therapists measured range of motion with the same procedures and methods used before casting began. Interrater measurements varied as much as ±15° and as little as ±1°.

Results

During the 5 months that the first set of plaster casts was worn, gains of 20° extension of the right arm and 16° extension of the left arm were attained. A loss of 3° to 5° of extension was noted during the 3 months that the second set of plaster casts was worn. These casts incorporated hand splints for improved wrist and hand position. During the 3 months that the fiberglass casts (i.e., the third set of casts) were worn, the loss of extension was 13° to 17°. J.H. had difficulty tolerating these casts, and the wearing time decreased. When the hand splints were eliminated in the fourth casting, 13° of extension was regained in both the left and right arms.

Overall, it appears that the upper extremity casts were effective in maintaining but not in improving
passive elbow extension. The third set of casts was the least effective, possibly due to lower tolerance and decreased wearing time. This may have been due to the addition of hand splints, which increased the stretch of spastic muscles across three joints, and to the change from plaster to fiberglass, which was more rigid and did not seem to provide as much overall warmth as the plaster.

Discussion

We could have improved the validity of the results by recording the goniometric measurements monthly rather than at irregular intervals. The long gap between the first and second measurements was due to an extended summer vacation during which time all three therapists were unavailable. More data after the fourth set of splints was applied would also have been valuable to determine if the increase in extension continued. All three of the therapists taking measurements were aware that casting was being done, so these measurements could be biased. Measurements taken by therapists blind to the treatment program would have improved the reliability. Interrater reliability was not good, which makes the data less valid.

In this study, we measured the effects of several treatment variables: plaster casts, fiberglass casts, and casts with and without hand splints. One treatment variable introduced at a time may provide a more accurate picture of treatment effectiveness. In addition, classroom and home activities could not be constantly monitored. The use of casts could have drawn more attention to J.H., thus making his parents, teachers, and aides more conscientious of positioning and range of motion exercises.

This study suggests that casting for the purposes of hygiene and ease of daily care in a severely impaired patient may be an effective method of controlling elbow flexion contractures. The results indicate that constant, equalized pressure combined with warmth can maintain the lengthened position of a muscle. Clinicians using casting need to consider the cause of decreased range, such as positioning, muscle tone, joint ossification, fracture, or pain. Effectiveness can depend on the skill of the therapist applying the cast and on the cooperation of the patient, the patient's family, and the staff. Casting, which provides a continuous stretch to shortened, soft tissues, warrants further investigation by therapists concerned with finding effective methods for maintaining joint range of motion.

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References


