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Serial Casting: Clinical Applications for the Adult Head-Injured Patient

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SERIAL CASTING has been used for over a decade to manage soft tissue contractures in patients with traumatic head injuries.[1,2] Its use has also extended to the prevention of contractures in extremities exhibiting potentially deforming spasticity. This article will review the causes of soft tissue contractures and discuss how serial casting can manage such deformities. It will also identify how a serial casting program can be modified and integrated with other therapeutic efforts as the head-injured patient progresses physically and cognitively. Finally, it will address the timing and priority of casting in the patient's overall program.

CAUSES OF SOFT TISSUE CONTRACTURES

In the head-injured patient, joint contractures develop most commonly as a result of interruptions in the central mechanisms controlling limb movement. The resultant spasticity and its related joint posturing are the primary factors contributing to reduced joint mobility.[1,3] Residual motor control deficits also contribute to the problem since the

patient may lack the ability to move a specific joint through its entire range of motion. Occasionally, motor deficits develop as a result of an interruption in the lower motorneuron pathway, as may be the case following a tibial or fibular fracture with damage to the peroneal nerve.[4] An additional concern with the head-injured patient is impaired cognition, which may further interfere with the patient's ability to move his or her extremities, thus contributing to the development of soft tissue contractures.

EFFECTS OF PLASTER CASTING

The effectiveness of plaster cast application in managing soft tissue contractures is most likely related to the muscle fiber's mutable nature.[5] Animal research using plaster cast immobilization has demonstrated alterations in muscle fiber length and sarcomere length and number that are specific to the length at which the muscle was immobilized.[6,7] Documentation of comparable changes in human muscle fibers is not available, but investigators have speculated that these fibers respond in a similar way to immobilization in either a shortened or lengthened position. Clinically, however, whole muscle length changes have been documented as a result of plaster casting.[3]

In addition to reducing range-of-motion deficits, plaster casting and splinting have reportedly contributed to reducing spasticity and related posturing.[3,8–10] In this sense, plaster casts can be thought of as inhibitive in that they provide a consistent environment and avoid quick stretch responses in the involved musculature.[1] The mechanism for this inhibition of muscle hypertonicity has not been thoroughly documented. Gossman et al suggest that the reduced resistance to passive movement following casting may be due to anatomical changes in the muscle rather than neurological changes in the activity of the involved motorneurons.[5,11] Specifically, they suggest that the loss of muscle tissue due to immobilization-induced atrophy may be the primary factor contributing to the reduced tension-producing capabilities of the muscle. Further research is necessary to confirm such a speculation.

CASTING PROGRESSION GUIDELINES

Booth et al clearly describe the indications and considerations for determining appropriate candidates for serial casting.[3] After a careful assessment of the patient's candidacy, objective goals are set for the expected results, and the casting program is initiated. The general guidelines for progression of casting are described briefly in Table 1.[2] These guidelines should be modified to meet each patient's unique needs.

INTEGRATION OF CASTING WITH OTHER TREATMENT TECHNIQUES

Treating the numerous problems of adult head-injured patients requires that after setting clear, objective goals, the therapist be knowledgeable and skilled in selecting and using the needed treatment modalities. While casting can improve joint range of motion and decrease spasticity, it does not directly improve motor control. Therefore, treatment techniques focusing on motor control need to be included along with the casting program. Determining the timing and priority of techniques is an ongoing process based on a careful assessment of the patient's needs and an understanding of the predictors of functional outcome.[2]

CLINICAL ISSUES

Casting for patients with low cognition

Casting can be an effective and timely treatment for patients exhibiting low cognitive

Table 1. Casting progression guidelines

Type of cast	Goal	Length of time
Resting cast positioned at end of easily obtainable range	To hold the extremity in a maximal painless range and to decrease the influence of spasticity	Seven to ten days
Repeated series (often three to four) of serial or drop-out casts	To gradually increase the range of motion of the joint and to decrease the influence of spasticity	Weekly intervals with full passive range of motion to immobilize joints between cast changes
Holding cast	To maintain the gained range of motion and decrease the influence of spasticity	Seven to ten days
Anteroposterior splint (a holding cast bivalved and converted into a splint)	To maintain the gained range of motion	Gradually decreased to night wear and discontinued when no longer needed

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capabilities who have begun to demonstrate soft tissue contractures or who have potentially deforming spasticity. Acutely, however, the management of such limb problems may need to be sacrificed to deal with more urgent medical concerns. Limb access may be required to introduce an intravenous line or monitor vital signs. Proper management of limb fractures or poor skin integrity may also take precedence over the initiation of serial casting.

Once the patient's medical status is stabilized, casting may emerge as the treatment of choice for limb positioning problems, especially if cognition remains severely impaired. If soft tissue contractures can be minimized or prevented with casting, valuable time will be saved in the overall rehabilitation process. Gaining range of motion while the head-injured patient's cognition is low will allow the therapist to concentrate on improving motor control when the patient begins to make more sense out of his or her limb movements. Neglecting range-of-motion deficits when cognition is low may necessitate limiting motion via casting at a time when the primary goal of therapy is to mobilize the patient's joints for functional tasks.

Casting may actually enhance the effectiveness of other therapeutic activities used in treating the patient with low cognition and significant physical deficits. For example, lower extremity casting may stabilize distal extremity joints so that the patient can assume a standing position on the tilt table. Such an activity can help improve alertness and facilitate motor control about the hips and trunk.

Lower extremity casting that prevents equinovarus posturing may also improve wheelchair standing transfers. Similarly, casting that prevents excessive extension posturing in the lower extremities can enhance wheelchair positioning. By breaking up such postures distally, better pelvic and trunk positioning and alignment can be achieved.

Casting can still be an effective adjunctive treatment even if the therapy is directed at providing sensory stimulation to the patient.

The use of anteroposterior splints will at least maintain joint range of motion while providing limb access for tactile intervention. If the patient has severe contractures, the treatment team might consider alternating weekly serial casting with weekly splinting so that both the sensory stimulation and range-of-motion deficits can be addressed.

Multiple extremity casting

The head-injured patient in need of multiple extremity casting requires a special coordination of efforts from all of the disciplines interacting with him or her. In order to establish treatment priorities for managing limb deformities, the team must consider how multiple extremity casting might affect the patient's handling by nurses and all other therapists. Any limitations that the proposed casting program might place on nursing's ability to position the patient in bed need to be addressed. If the patient relies on his or her extremity movement for nonoral communication, then casting of the extremity in question may not be a priority at this time. The severity of the existing extremity range-of-motion and motor control deficits and their prognosis for improvement must also be considered as treatment priorities are set. The patient's tolerance for multiple casting is an additional concern.

Some of the problems brought about by multiple extremity casting may be eliminated if the therapist uses a combination of casts and anteroposterior splints to improve the range of motion and spasticity. Splints may be chosen for the extremity with minimal contractures or hypertonicity, while a cylinder or full cast may be used on the extremity when these are severe. Splinting may also be useful in managing the extremity with the most functional motor control. If splinting is to be effective in any of these situations, interdisciplinary and family teaching are essential to ensure its proper use.

Sitting activities

As the head-injured patient's clinical picture improves, the functional goals will also be upgraded. It is important for the therapist to coordinate the casting efforts with the functional changes. As the patient develops trunk control for sitting activities, the continued use of long leg casts may interfere with therapeutic efforts to develop stability and proper trunk alignment. The extended position of the knees encourages the patient to assume a forward-head posture accompanied by a kyphotic trunk and posterior pelvic tilt as he or she attempts to maintain some stability while sitting.

In order to maximize the patient's function and continue to reduce his or her knee flexion contractures, it may be better to place the extremity in a short leg cast and use a removable anteroposterior splint for knee positioning in extension as needed. Another option is to incorporate a hinged locking joint into the long leg cast, which allows the joint to be locked in either flexion or extension (Fig 1). Sitting activities encouraging proper head, trunk, and pelvic alignment can then be included in the patient's therapy program by locking the joint in a flexed position. Following therapy, the joint can be locked in the patient's maximal knee extension range to facilitate contracture reduction.

Casting for agitated patients

Treatment of the agitated patient is often directed at diminishing the patient's restless behavior by promoting rather than restricting limb movement.[1] It may seem paradoxical, then, to advocate the use of serial casting for the agitated patient because of the restriction of movement it imposes. However, despite an abundance of limb movement, soft tissue contractures can easily develop because of the random nature of the patient's motor responses. Serial casting is therefore the key component of the contracture management

Fig 1. A hinged, locking knee joint allows for knee mobility during therapy so that an adequate sitting position can be attained.

program for these patients. An additional benefit of this approach is that it also protects the extremity should any combative episodes arise.

Consideration of the type of casting material is important when dealing with the agitated patient. Fiberglass cast material dries quickly, which may be an advantage in that it decreases the likelihood of the patient deforming the cast immediately after application. Other advantages are that it is a harder, lighter, and more resilient material than plaster. A disadvantage of this material is that it may splinter if struck against a firm surface, leaving rough edges that could be dangerous to the patient. Plaster cast material may be the better choice for patients who are especially combative or who cannot be closely supervised. Extra layers of plaster can be used to increase the durability of this cast. Despite the cast material chosen for use with the agitated patient, additional padding over bony prominences is imperative to protect them from breakdown or injury.

Anteroposterior plaster splints are not recommended for managing range-of-motion deficits in the agitated patient. Splints may not remain securely and properly fitted on the patient's limb, especially during excessive extremity movement or combativeness. Improper fit and excessive movement can cause skin irritation and breakdown. Frequent skin inspection would necessitate splint removal and reapplication—procedures that could further agitate the patient. In addition, the patient may remove the splint when not closely supervised, diminishing the program's effectiveness in maintaining range of motion.

Improvements in motor control

As the head-injured patient regains motor control in the involved extremities, the therapist must decide whether to strive for an additional range of motion at the contracture site or to develop the emerging motor control. A number of factors may shift the priority at different points in the patient's recovery process, including the patient's cognition, the severity of the residual contracture, the strength of the deforming spasticity, and the condition of the skin.

An assessment of the patient's cognition is essential in establishing priorities in this situation. Proceeding with the casting program to further increase joint range of motion may be indicated if the patient's poor cognition precludes his or her ability to cooperate with a voluntary exercise program or to incorporate the returning motor control into some functional task. Since casting does not require any active participation on the part of the patient to ensure its success, it would be the treatment of choice when significant cognitive impairments persist. If the involved joint is amenable to contracture management using a drop-out

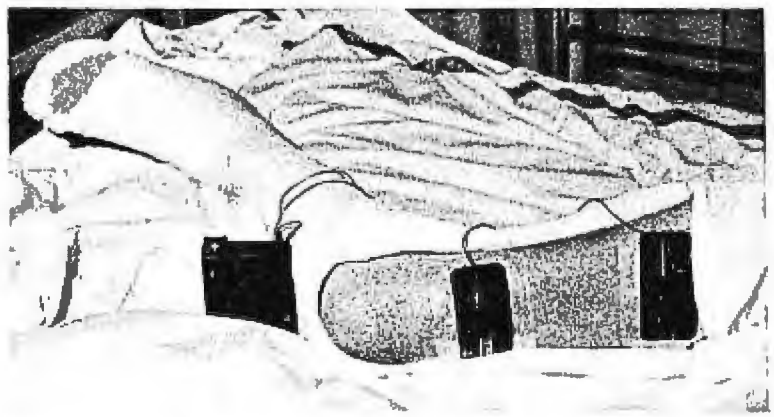

Fig 2. A knee drop-out cast can be used with quadriceps electrical stimulation to reduce a knee flexion contracture. The proximal anterior portion of the cast has been removed, allowing easy limb access for electrode placement.

cast, the therapist can easily combine this treatment with electrical stimulation to the antagonist of the contracted muscle (Fig 2). When used for reducing contractures, the success of an electrical stimulation program also does not rely on active patient participation. An additional benefit of using electrical stimulation in combination with a drop-out cast is that the former also facilitates motor control in the stimulated muscle.

Despite the persistence of joint contractures, serial casting may not be the treatment of choice for patients whose cognition allows them to actively use their recovering limb motion. Treatment priorities may shift in this case from a passive contracture reduction program to a more active approach using the motor control capabilities of the contracted muscle's antagonist to help maintain or reduce the residual contracture. The use of anteroposterior splints is recommended in this case since they maintain the patient's joint range of motion yet allow easy access to the limb for therapeutic intervention.

Patients whose cognition allows for useful limb function but who have severe contractures or severe spasticity may need to be held in a serial cast for a longer period of time than might otherwise be recommended. Splints may not be a viable option in this case since they may be very difficult to correctly and safely apply without breaking down the skin. Improper application of the splints may also limit their effectiveness at maintaining joint range of motion.

Despite the need for modifying treatment priorities as the head-injured patient progresses both cognitively and physically, long-range goals for the extremity's functional use must be established. In order to accomplish these goals, the therapist must direct his or her efforts toward eventually having both motor control and range of motion present in an extremity. If mobility is gained at the expense of motor control, it will be difficult to maintain the motion for any functional purpose. Likewise, if motor control develops without range of motion, the patient will be left with a nonfunctional limb. Surgical intervention may be indicated if hygiene, appearance, or functional deficits develop as a result of inadequate joint motion.

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Serial casting is an effective treatment for soft tissue contractures in the head-injured

patient. This approach can easily be modified to meet the needs of the patient as his or her cognitive and physical status change. The casting program can be carefully coordinated with other therapeutic efforts to maximize the functional result.

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