Hand Splinting for Infants in the Intensive Care and Special Care Nurseries

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Infants in intensive care nurseries often have hand deformities and hand dysfunction. The traditional therapeutic approaches to hand care used in the treatment of adults, young children, and older infants are not always adequate to prevent progressive deformity in preterm and neonatal infants. Medical instability, time constraints, lack of family participation in the therapeutic program, the complexity of the treatment program, and fear of harming the infant are considerations that may indicate the need for splinting as an adjunctive therapeutic intervention. A number of factors are particularly important in making splints for infants, including splint alignment and padding, strap attachment, and thermoplastic malleability.

Hand dysfunction is seen frequently in preterm and full-term infants in the intensive care nursery (ICN) or special care nursery (SCN). Trauma to lower motor neurons during the intrauterine or perinatal period can result in palsies, such as Erb's or Klumpke's paralysis, from excessive traction and stretch to the brachial plexus. Neurogenic hand dysfunction can also result from fractures, dislocations, or fracture-dislocations with concomitant nerve injury due either to traction or to direct nerve laceration (Eng, Kock, & Smokvina, 1978; Greenwald, Schute, & Shively, 1984). Problems due to increased tone resulting from central nervous system (CNS) damage associated with CNS developmental anomaly, hemorrhage, hypoxia, infectious processes, tumors, or trauma can also lead to hand deformity (Holt, 1985). Less frequently, hand dysfunction may be associated with deformity due to ingestion of a drug or toxin during pregnancy. Each of these diagnostic problems affects the hand's anatomic and functional development. Each brings different forces to bear upon the musculoskeletal and neuromuscular systems of the hand.

Traditional therapeutic approaches to these varied hand disorders include passive or assisted range of motion exercises, stretching exercises, sensory awareness programs, developmental play activities, and reflex inhibition or facilitation techniques (Anderson, Anderson, & Cohen, 1985b, 1985c; Anderson & Anderson, 1986). These approaches are often combined with education programs for staff and parents. Unfortunately, these interventions are not sufficient for all infants with hand dysfunction or progressive deformity, and splinting is needed.

In our experience at Sinai Hospital of Baltimore, 14% of all neonatal patients referred to the occupational therapist during a 12-month period required splints to augment their hand treatment programs. This figure included 25% of all infants having a lower motor disorder and 22% of those with an upper motor neuron disorder. The duration of splint use was short, from 1 to 7 weeks, most often 10 to 14 days.

Indications for Splinting

Besides progressive deformities that cannot be handled solely by a hand treatment program, there are five other indications for use of splinting in infants with significant hand deformities (Anderson, Anderson, & Cohen, 1985a, 1985c). One indication is if the amount of time needed for treatment of the hand dysfunction far exceeds the time available to the treating therapist, nursing staff, or family. Staffing limitations in the ICN or SCN, due in part to the fluctuating number of critically ill infants and severity of their conditions, may not permit enough time for the nursing...
staff to work with other than life-threatening problems or to offer more than basic nursing care (e.g., feeding, bathing, and diapering). Time constraints, dictated by the number of patients and severity of their problems may also prevent the therapist from providing the optimal frequency and duration of treatment sessions.

An unstable medical condition is a second indication for splinting. There are times when the severely ill preterm infant should not be subjected to excessive handling, which could increase stress levels and cause adverse physiologic effects. Excessive handling could result from the frequent therapy intervention needed to alter abnormal tone problems (e.g., frequent changes in positioning or techniques of facilitation and inhibition). If deformity and tonal problems increase during the time that treatments are being deferred or reduced in frequency, splinting may be necessary.

Parents who have become educated in treatment techniques can be integral members of the treatment team. They can augment the physical therapy, occupational therapy, and nursing care by providing some of the short, frequent sessions that their infants need. However, some parents may not be able to cope with the disability and are therefore unwilling to participate in a therapy program. Such unwillingness to participate is a third indication for splinting. Parents who are unwilling to participate may be experiencing an unresolved grief reaction for the "loss" of an anticipated "normal" infant, or may feel guilty for being "responsible" for the problem. Rejection of the infant, usually temporary, is not uncommon (Hawthorne, Richards, & Callon, 1978; Richards, 1978). If the hand care treatment program is not sufficient to prevent hand deformity during the period in which the parents are working through their grief reactions or guilt feelings, and therefore cannot be called on to participate in the therapy program, splinting is indicated.

Other factors may also adversely affect parental involvement and preclude parental mastery of an appropriate hand care treatment program either during the infant's hospital stay or after discharge. For example, the parents may be mentally retarded, emotionally unstable or immature, ill, or unable to spend time with the infant because of transportation difficulties, work demands, or demands for sibling care at home. Unfortunately, decreased parental participation in the neonate's care may greatly affect the ultimate outcome of the disability, particularly if the parents cannot follow through with the proposed program.

A fourth indication for splinting is a treatment program so complex the parents or staff cannot master it or cannot provide the frequency and duration of intervention necessary. Complexity is generally related to the severity of the underlying problem, that is, the more severe the problem, the greater the time requirements for intervention and the more complex the treatment regime. For example, in cases of joint contractures, it is difficult for parents and staff to master the therapeutic techniques and judge the appropriate quantity of therapeutic intervention. Training them when to continue or terminate a treatment session or how to determine the appropriate force to be used is difficult. The therapist has honed these clinical judgment skills after years of study and clinical experience; these skills cannot be taught quickly to persons who have little background preparation.

Further, the parents and staff may face more serious issues that take the bulk of their time and resources, such as feeding problems, control of body tone, and positioning problems. The time left over to participate in hand treatment may not be sufficient to prevent progressive deformity or dysfunction.

A fifth indication for splinting is fear. Parents and the nursing staff may abrogate some responsibility for follow-through of the outlined treatment by the occupational therapist because of similar fears. The infant who is severely ill, or who has a deformity or dysfunction, is frequently perceived as very fragile, and the parents and nursing staff may fear causing further damage to the tiny hands and joints. Parental and staff education, as well as regular involvement with the infant, can often overcome these fears in time. If these anxieties persist despite education, psychological counseling, and intervention designed to enhance parental or staff interactions with the child, splinting is indicated.

The following cases illustrate the factors that need to be considered when hand splinting is used with infants:

Case 1

J.W. was born prematurely to a 16-year-old single parent at 34 weeks' gestation with a normal spontaneous vaginal delivery. Other than a mild temperature, regulatory difficulty, no problems were noted. An intravenous needle was placed in the infant's left hand and secured by tape at the dorsal and lateral surfaces. A significant contact dermatitis developed. Some skin and subcutaneous tissue adhered to the tape from the fifth metacarpal-phalangeal (MCP) joint to the distal interphalangeal (DIP) joint. Skin grafting was necessary.

The infant was referred to occupational therapy after the graft had taken, and hand dysfunction had already occurred. Twenty-degree flexion contractures were present at the left fifth MCP, proximal interphalangeal (PIP), and DIP joints. Digits three through five were essentially immobile. A progressive splint-
A fifth digit splint (see Figure 1) in conjunction with gentle passive range of motion exercises was initiated. Three cloth tape straps were used to hold the splint because they were more flexible than Velcro, allowed greater hand motion, and could be quickly removed and replaced when dirty. Also, the splint's small size did not provide enough surface on which to securely attach Velcro with either adhesive or a D ring. The splint covered less of the hand's surface with thermoplastic material than similar orthoses used with adults and children (Torres, 1975). This small size permitted easier monitoring of the skin problem and greater hand flexibility. The splint required modification as the child gained joint extension through the stretching and range of motion program.

The mother was reluctant to participate in the hand treatment program during the first 3 days after referral, describing fears of "opening him up again" or of "breaking his finger." With continued supportive counseling and education, though, she did actively participate in the program. Within 1½ weeks, full range of motion had been achieved, and prior to hospital discharge the mother had mastered the home hand therapy program. At follow-up 1 week after discharge, the splint was discontinued and the home program modified to concentrate on age-appropriate hand activities.

Case 2

A. C. was born at 39 weeks' gestation with a normal spontaneous vaginal delivery and with congenital injury to the lower trunk of the right brachial plexus. At birth, distal muscles innervated by the median, ulnar, and radial nerves were flaccid, and a 15° wrist flexion contracture was present. All fingers, when placed in a neutral position, had flexor tightness varying from 5° to 15° at the MCP and PIP joints. No proximal arm or shoulder neuromuscular deficit was noted. The nurses were initially afraid to participate in the infant's range of motion program for fear of injuring the child's tiny, flaccid hand.

Using Orthoplast, a resting hand splint (Malick, 1972) was made to support the entire right hand and wrist (Figure 1). Modifications included positioning the thumb in enough abduction and extension to fit the infant's normal web space, while avoiding hyper-extension or even mild forced abduction, which in infants can easily lead to dislocation. Also, the Orthoplast was thinned and shaped to approximate the proper palmar arches. The splint was covered with a sock to prevent self-injury from any forceful motion bringing the hand and splint into contact with the face and eyes. The family was instructed in a home treatment program of range of motion, sensory awareness, and play activities prior to discharge.

On follow-up 1 week later, a trace of discrete motion was elicited from all muscle groups innervated by the lower trunk. The home program and use of the splint were both continued. By the 3rd week after discharge, the splint was worn only during naps and at nighttime. The home program was modified to include functional hand activities. At 5 weeks after discharge, the infant had outgrown the splint. The rate of recovery of motor function was not equal in all muscles; lower trunk muscles innervated by the median and ulnar nerves were of fair grade, whereas distal muscles innervated by the radial nerve were of poor grade strength. The resting hand splint was no longer appropriate. A wrist cock-up splint (Malick, 1972) was fabricated to maintain alignment for use during naps and at night, with modifications similar to those described for the resting hand splint. The home therapy program was modified to encourage wrist and finger extension. By 3 months after discharge, the splint was discontinued because the major residual deficits were sensory. At 6 months, sensation appeared to be near normal, range of motion was active, and good unilateral and bilateral play activities were noted. At 1 year, no problems were noted, but the child preferred the left hand.

Discussion

Although the basic indications for splinting are similar in all age groups, the infant population is unique and completely dependent on adults for all aspects of care. Splinting is used only as an adjunct to a basic hand therapy program, and never on a protracted basis. Splinting without exercises could lead to contractures and further hand dysfunction.

The various types of hand splints commonly used
in the infant population include the fifth finger splint, a resting hand splint, volar wrist support splint, and hand cone splint (Figure 1).

The frequency of use of splints in an ICN or SCN depends on the involvement of the rehabilitation team in the unit. At Sinai Hospital of Baltimore, initially referrals to occupational therapy were primarily for infants with obvious problems. Once the rehabilitation team had established its presence in the ICN and SCN units, however, referrals to occupational therapy were made earlier and for a broader range of patients, including high-risk infants with no hard signs of dysfunction or deformity. With this expanded population, the overall incidence of splinting fell by about 60%, although the absolute number of splints provided remained essentially unchanged.

Clinical Suggestions and Precautions

Static splints provide protection, support, and immobilization. Weakened muscles and joints may both need protection, the former from tear due to overstretching, the latter from disruption due to application of excess force across joints that lack adequate support. Orthotic splinting can passively hold a joint in a functional position or, with serial molding and reapplication, can actively force a joint into better alignment.

Guidelines are available to help the therapist design and construct an orthotic device (Malick, 1972; Trombly & Scott, 1977), but none are specific for very young infants, from 26 weeks' gestation to 6 months old. Despite the lack of guidelines, early fabrication and fitting, particularly after an injury, are required to prevent significant deformity from developing.

Injury to an infant's skin, musculoskeletal system, and nervous system can occur easily, hence safety is paramount. Premature infants and ill neonates often have diminished fat pads in their hands. Skin ulcers form at an accelerated rate, and care is needed to avoid areas of pressure that could lead to skin breakdown. The therapist, nursing staff, and family must look vigilantly for signs of irritation because an infant cannot adequately communicate the presence of pain or problems. Hourly skin checks are advised for the first 4 hours of splint use. Thereafter, the splint schedule is 4 hours on and 1 hour off. Splint weaning schedules vary, depending on the response and control of the underlying hand problem.

Following the hand's and arm's contours is more important with a splint for a young infant than with one for an older pediatric patient. Any imperfection in alignment of the orthosis must be corrected as soon as it is noted. Even a deviation of a few degrees, which could be tolerated in an older child's splint, cannot be tolerated with a young infant. Also, any irregularities or sharp points on the orthosis must be removed or covered with moleskin. Because of the relatively small size of an infant's joints and extremities, an alignment imperfection or a rough edge can produce severe problems.

The straps used to secure the splints should not be pulled too tightly, for edema occurs more rapidly in these infants than in older children and adults (Vasculov, 1979). Writing "Do Not Pull Tight" or "Not Tight" on the straps can be useful. Also, wide straps should be used to spread the pressure over a greater skin surface area. At times the straps may be as wide as the full length of the splint. Removable straps that allow for easy cleaning are recommended.

The glues used to affix straps to splints can cause contact dermatitis in infants. Therefore, the glue or tape gum should never touch the skin. Placing two pieces of tape front to back, leaving ¼ inch of exposed tape gum on each end of the strap for adhering it to the plastic, helps prevent contact dermatitis and other skin problems.

Using ¼-inch thick Velcro pile for the straps affords protection against self-injury, should a flinging movement cause the splint to strike the infant. Also, the splint should be covered with an infant's sock. The sock serves as padding to prevent injuries and also helps to hinder inadvertent removal of the orthosis by the infant.

Hand and arm exercises are performed during the times the splint is off. These exercise periods are also an ideal time to reassess joint mobility and upper extremity functioning, providing the information necessary to determine the need for further treatment and orthotic modification.

Functional aspects deserving consideration include permitting maximum mobility for the joints within the limits of desired stability, keeping the splint lightweight to permit maximum use of the extremity, and keeping encumbrances or additions to a minimum so that the orthosis can be cleaned easily and quickly.

Material Selection

Because an infant's skin burns more easily than does an older child's skin, care must be taken in constructing and fitting the splint. Low-temperature thermoplastic materials, particularly those that allow for frequent reheating and reshaping, are best. Growth and changes in joint alignment necessitate frequent adjustments.

Although some higher temperature thermoplastic materials conform better to hand contours and come in varying thickness, they are generally not recommended because the potential for burns is higher, even when a layer of protective padding is used. To
avoid this problem, the therapist may make a negative mold of the infant's hand from plaster and then a positive cast from the mold (Malick, 1972). The resulting mold can be used as a template on which the high-temperature thermoplast orthotic device can be fabricated.

A thermoplastic material that thins easily makes a relatively light splint. Although some strength is lost in the thinning process, strength is not a significant problem in this population.

Use of plaster of Paris is also an option. This material, however, requires increased time expenditure, makes subsequent modification difficult, and is untidy to work with.

Summary
Splinting ICN and SCN patients is never more than an adjunct to a basic hand therapy program. The splinting techniques used with these patients differ from those used with older pediatric and adult patients. The differences include the indications for splint usage, choice of splint materials, use of plastic-thinning techniques, more meticulous attention to splint shaping and finishing, use of wider straps, and covering the splint to prevent self-injury. Unlike older patients, infants are never active participants on the treatment team, although they do interact with the process. The team of physicians, therapists, nurses, and parents must develop the basic care program and ensure that problems or complications do not arise from their intervention.

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References