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LITERATURE REVIEW

Effectiveness of Upper and Lower Limb Casting and Orthoses in Children with Cerebral Palsy

An Overview of Review Articles

ABSTRACT

Autti-Rämö I, Suoranta J, Anttila H, Malmivaara A, Mäkelä M: Effectiveness of upper and lower limb casting and orthoses in children with cerebral palsy: An overview of review articles. Am J Phys Med Rehabil 2006;85:89–103.

The objective of this overview is to summarize from systematic reviews the evidence on the effectiveness of using upper and lower limb casting or orthoses in children with cerebral palsy. We used computerized bibliographic databases to search for systematic reviews without any language restrictions. Identification, selection, quality assessment, and data extraction were performed independently by two investigators. Of the 40 identified reviews, 23 were selected for closer consideration, and five reviews met the inclusion criteria. The quality of existing systematic reviews and original studies included in our reviews varied widely. The following evidence was found: (1) casting of lower limbs has a short-term effect on passive range of movement; (2) orthoses that restrict ankle plantar flexion have a favorable effect on an equinus walk, but the long-term clinical significance is unclear; (3) evidence on managing upper limb problems with casting or splinting in children with cerebral palsy is inconclusive. Our conclusion is that there is a paucity of evidence from primary studies on the use of orthoses in children with cerebral palsy. More original, well-designed research is needed.

Key Words: Cerebral palsy, Orthoses, Casting, Systematic Review, Effectiveness

Cerebral Palsy (CP) is an umbrella term covering a group of nonprogressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of development.[1] It is the most common movement disorder, requiring prolonged and extensive orthotic management throughout and beyond childhood.

Casting has primarily been used in the lower or upper limb for short periods of time to stretch the shortened muscles and thus increase the range of movement. Orthoses are used for upper and lower limbs often for years, although the type of orthosis may vary according to the needs of the developing child. Common aims when recommending orthoses are to correct or prevent structural deformities, address pain and discomfort, to promote function by supporting normal joint alignment, and to facilitate or substitute for function.[2–6] The materials range from dynamic to fixed, and the orthoses can cover a different number of joints. Orthoses that reach over a joint can include hinges.

The compliance of children in using casting and orthoses differs, and the demand to use these sometimes restricting and outwardly visible devices also raises ethical considerations. As children can outgrow their orthoses within months, they also incur substantial economic costs.

Various treatment protocols have been suggested[2–9] as to what kind of orthosis should be prescribed for a particular child. However, we still lack evidence-based clinical guidelines in a form that helps clinicians to select the correct orthoses for the individual child. The aim of this overview was to identify systematically gathered information on the effectiveness of using casting and orthoses in children with CP to see whether this information can be of help in clinical decision making and in producing evidence-based guidelines.

METHODS

Article Identification

We searched computerized bibliographic databases for reviews on orthosis in CP, without any language restriction, from the earliest year available—depending on the database searched—until May 2003. The databases searched were MEDLINE, PreMEDLINE, the Cochrane Central Register of Controlled Trials, the Cochrane Database of Systematic Reviews, the Database of Abstracts of Reviews of Effects (DARE), the ACP Journal Club, CINAHL, and PEDro (http://www.pedro.fhs.usyd.edu.au/index.html).

For all searches via the Ovid platform, high sensitivity and CINAHL search strategies, as outlined by the University of York (http://www.york.ac.uk/inst/crd/search.htm), were used to identify review articles. The search filters for population and intervention were "cerebral palsy" and "exp. orthotic devices," respectively. The PEDro database was searched by using the search terms "cerebral palsy" and "review." A total of 37 possible reviews were identified.

A parallel literature search on the reviews of physiotherapeutic intervention methods in children with CP was performed using the same databases with the search terms ″cerebral palsy″ and a wide variety of physiotherapeutic intervention terms (e.g., Bobath, neurodevelopmental, conductive, rehabilitation, positioning, neuromuscular facilitation, therapeutic exercise). The 18 systematic reviews identified from this search formed another source of publications.

Two investigators (I. Autti-Rämö and J. Suoranta) independently reviewed all identified review articles ($n = 55$) by their title, and by abstract when available, using defined inclusion criteria. The full texts of 23 articles judged to be potentially relevant were independently assessed by two investigators (I. Autti-Rämö and J. Suoranta) and classified as "included," "unsure," or "excluded." A consensus process was used in the case of disagreement. Five reviews[10–14] were finally accepted for the review (Table 1). The reasons for exclusions are presented in Tables 6 and 7 of the Appendix.

Data Extraction

A data-extraction sheet was formed by using Hoving et al.[15] and Khan et al.[16] as references. It contained items on validation, synthesis, results,

TABLE 1 Number of identified articles, duplicates, and included reviews according to the searched sources

Source	Identified Reviews	Duplicates	Included Reviews
MEDLINE /Pre-MEDLINE	27	0	1
CINAHL	5	1	1
Cochrane Library	0	0	0
PEDro	5	0	0
Parallel Physiotherapy Review	18	3	3
Total	55	4	5

TABLE 2 Inclusion and exclusion criteria and search strategies of the included reviews

Author (year)	Inclusion Criteria: Study Design	Inclusion Criteria: Intervention	Exclusion Criteria	Search Strategy: Information Sources and Search Periods	Search Strategy: Search Terms	Search Strategy: Search Date
Morris (2002)	Any kind of clearly described scientific methodology that compared a lower limb orthosis with an alternative, a control group, or no orthosis. Abstracts included.	Lower limb orthosis	Heterogeneous diagnoses Temporary applications of casts	Cochrane Library (Issue 3, 2001), RECAL Information Service, MEDLINE, CINAHL, Embase, Sigle, Amed, and Inspec. Unpublished studies: UK National Research Register, National Health Service Research and Development Web site, ASLIB Index to Theses, Dissertations Abstracts International, CanChild Centre for Childhood Disability Research. Hand Searches: *Gait and Posture, Developmental Medicine and Child Neurology* (from 1994 to 2000). Other sources: a consensus conference document, colleagues, researches in the field, and librarians.	Not reported	January 2001
Teplicky et al. (2002)	Randomized, controlled trials or studies with comparison group.	Casts, orthosis, and splints for upper or lower limb.	Not reported	MEDLINE, CINAHL.	Cerebral palsy, brain injury, splint, splinting, cast, casting	Not reported
Boyd et al. (2001)	Randomized trials of upper limb management of children with cerebral palsy that included any of the interventions listed. Other studies incorporating the above interventions that were studied prospectively utilizing objective outcome measures.	Physiotherapy or occupational therapy including neurodevelopmental therapy or contemporary movement training based on the movement sciences; conductive education; constraint-induced therapy; serial casting, splinting; neuromuscular electrical stimulation; intramuscular injections of botulinum toxin A, and upper limb orthopedic surgery.	Retrospective studies. All articles had to be a full publication written in English.	MEDLINE (1966 to December 2000), CINAHL (1982 to December 2000), Clinpsyc (1989 to December 2000), DARE (Vol 1, September 2000), PEDro, EBM Reviews–Best Evidence (1991 to December 2000), DARE, The Cochrane Database of Systematic Reviews (fourth quarter 2000), CENTRAL/CCTR. Abstracts from major meetings, including ESMAC, EACD, GCMA, AACPDM; hand searches.	Cerebral palsy, upper limb, spasticity, physical therapy or physiotherapy, occupational therapy, neurodevelopmental therapy, conductive education, constraint-induced therapy, botulinum toxin A, casting, and limb surgery	December 2000

(*Table continues*)

TABLE 2 Continued

Author (year)	Inclusion Criteria: Study Design	Inclusion Criteria: Intervention	Exclusion Criteria	Search Strategy: Information Sources and Search Periods	Search Strategy: Search Terms	Search Strategy: Search Date
Hur (1995)	All studies that considered the population and interventions listed, regardless of the study design.	Physiotherapeutic intervention, occupational therapy, training (walking, sitting, head control, visual, digital, and oral motor control by using biofeedback), behavior modification techniques, massage, casting, and bracing.	Not reported	MEDLINE (1966 to March 1994).	Not reported	March 1994
Vermeer and Bakx (1990)	Any studies published in a 10-yr period in selected journals.	Any kind of intervention.	Not reported	Hand search of 13 English and 4 Dutch journals since 1978: *Physiotherapy*, *Physical Therapy*, *Physiotherapy Canada*, *American Journal of Occupational Therapy*, *Neuropediatrics*, *Pediatrics*, *Developmental Medicine and Rehabilitation*, *International Rehabilitation Medicine*, *American Journal of Physical Therapy*, *New England Journal of Medicine*, *Perceptual and Motor Skills*, *Adapted Physical Activity Quarterly*, *Nederlands Tijdschrift voor Fysiotherapie*, *Nederlands Tijdschrift voor Ergotherapie*, *Tijdschrift voor Orthopedagogiek*, and *Bewegen en Hulpverlening*.	Not reported	Not reported

PEDro, The Physiotherapy Evidence database; EBM, Evidence-Based Medicine; DARE, Database of Abstracts of Reviews of Effectiveness; CENTRAL/CCTR, The Cochrane Controlled Trials Register; ESMAC, European Society of Movement Analysis in Adults and Children; EACD, European Academy of Childhood Disability; GCMA, The Gait and Clinical Movement Analysis Society; AACPDM, American Academy for Cerebral Palsy and Developmental Medicine.

TABLE 3 Material and methods of the selected reviews

Author (year)	All Articles[a]		Published Articles			
	n	Study Designs	Articles (*n*)	Population (*n*)	Reported Outcomes	Synthesis Methods
Morris (2002)	12 articles, 15 abstracts (27 total)	1 RCT (abstract), 25 observational designs, 1 case report	Lower limb: 12 orthoses	177	Classified as structural (ROM, radiography, EMG) or activity related (walking, stair climbing, sit-to-stand); specified only for a few studies (dynamic EMG, GMFM, unspecified gait analysis, force plate).	Descriptive summary of author, design, sample characteristics, orthoses, control, ICIDH-2, and key outcomes.
Teplicky et al. (2002)	21 articles, 11 not described (32 total)	5 RCTs, 27 observational designs	Upper limb: 2 casting, 3 splints	236	Quality of movement, ROM (wrist extension), hand function, parent perception, muscle tone, ability to do functional activities, and improvements in muscle activation, hand use, grasp, or visual motor performance.	Descriptive summary of titles, description of the study and the various outcomes categorized by the orthotic device.
			Lower limb: 7 casting, 6 orthoses	174	Passive ROM (ankle dorsiflexion), limitation of plantar flexion, plantar flexor strength, resistance to passive stretch, production of maximal dorsiflexion torque, foot floor contact, stride length on an ambulation measure, gait analysis, sit-to-stand performance, ankle function, energy expenditure, gait velocity, stride length, oxygen, and ventilatory cost of walking, heart rate, GMFM.	
Boyd et al. (2001)	2 articles, 3 not described (56 total)	2 RCTs, 3 observational designs	Upper limb: 2 casts	Not reported	Peabody, QUEST, wrist ROM, COPM.	Descriptive summary of ICIDH-2 (1999) and Sackett's grades (1989) of all included studies, description of patient demographics and outcome measures. and meta-analysis on effect size of the RTCs only
Hur (1995)	4 articles (37 total)	4 observational designs	Lower limb: 1 casting, 1 orthoses	40	Passive range of ankle dorsiflexion, foot floor contact, static muscle tone.	Descriptive summary of number of subjects, characteristics, duration of study, experimental control, intervention, statistical analysis, results, and follow-up
Vermeer and Bakx (1990)	4 articles (33 total)	2 observational designs, 2 case reports	Lower limb: 2 casting, 2 orthoses	36	Balance, walking symmetry.	Descriptive summary of author, test population, age, sex, medical and physical diagnosis, treatment objective, method of treatment, duration/frequency, design, reliability measurement instrument, internal and external validity and statistical evaluation

RCTs, randomized, controlled trials; ROM, range of movement; EMG, electromyography; GMFM, Gross Motor Function Measure; ICIDH-2, International Classification of Impairments, Disabilities, and Handicaps; Peabody, Peabody Fine Motor Scale; QUEST, Quality of Upper Extremity Skills Test; COPM, Canadian Occupational Performance Measure.

[a] Including abstracts and articles that were not described in the evidence tables of the reviews.

TABLE 4 Methodologic quality scores according to Hoving et al.[15] of the included review articles

Topic	Search Methods		Selection Methods		Validity Assessment		Synthesis			Total
Item number	1	2	3	4	5	6	7	8	9	
Morris (2002)	2	2	1	0	0	0	0	1	2	8
Teplicky et al. (2002)	1	1	1	0	0	0	0	1	1	5
Boyd et al. (2001)	2	2	2	0	2	2	2	2	2	16
Hur (1995)	1	1	1	0	0	0	0	0	2	5
Vermeer and Bakx (1990)	1	1	1	0	2	2	0	0	0	7

Scores: 2 = yes, 1 = partial, 0 = no.
[a] The quality criteria are presented in Table 9 of the Appendix.

conclusions, and application (Table 8 of the Appendix). Data from the five review articles were extracted independently by two investigators (I. Autti-Rämö and J. Suoranta). In addition, two other investigators (I. Autti-Rämö and H. Anttila) extracted information on study design, type of orthotic intervention, number of patients, and the outcomes of each study as reported in the reviews. The original studies were not retrieved.

Methodologic Quality Assessment

Using the modified quality scale of Hoving et al.,[15] methodological quality was assessed.[17,18] Each item in the range was scored 0 (no), 1 (partly), or 2 (yes). Consensus between the two investigators had to be reached on each item, with a third investigator (A. Malmivaara) available to resolve disagreement.

Data Analysis Methods

We used a qualitative approach to draw a synthesis of the results of the reviews. We analyzed only those results that were presented in summary tables in the reviews (information on study design, population, intervention, and outcome was available) and had been published as full articles (peer reviewed). The results were classified as having an effect on body structure (range of movement, tone), on a specified target function (ankle movement during walking, walking pattern, energy consumption, grasp), or on overall function (gross motor function, hand function). Evidence of the effectiveness of the various types of orthoses and casting is presented both as reviewers' conclusions and based on our own data extraction from the reported information of the original studies.

RESULTS

Description of the Included Reviews

The inclusion and exclusion criteria of the selected reviews and their search strategies are presented in Table 2 and review content in Table 3.

Methodological Quality of the Reviews

The quality scores are presented in Table 4. Only Boyd et al.[12] used a standardized system to assess the quality of the selected randomized, controlled trials (RCT).[19,20] Vermeer and Bakx[14] used a self-constructed quality system, evaluating the reliability of the measuring instrument, the internal and external validity, and statistical evaluation. None of the five reviews mentioned whether the included studies were assessed by one or more persons.

Designs of the Original Studies

In all, we identified 32 published studies in the five review articles. Only five of them were RCTs, and others were classified as observational designs. The sum of the total population in these studies was 551 children. Another 24 studies were included in the reviews as abstracts or referred to with no further details. These studies were excluded from our analysis.

Summary of the Reported Effects

The reviewers' own conclusions are reported in Table 5.

The reviews included no quantitative data from the original studies. We identified the limitations of the study designs and the lack of quantitative data from the original studies, and we summarized the results by the type of the intervention as follows.

Lower Limb Casting

One RCT compared short leg casting with no casting.[21] Two RCTs compared casting against botulinum type A injection.[22,23] Three studies used a before–after design,[24–26] and one study evaluated the effect of a tone-reducing design.[27] It can be concluded that lower limb casting has a short-term effect on the passive range of ankle dorsiflexion.

Lower Limb Orthoses

In six within-participant studies, different orthoses were compared against barefoot walking.[28–33]

TABLE 5 Summary of reviewers' conclusions

Reviewer	Lower Limb Casting	Lower Limb	Upper Limb Casting	Upper Limb Orthosis
Morris (2002)		Evidence to support the idea that orthoses can prevent deformities or improve activities is low; for prevention of equinus the orthoses need to restrict plantarflexion. No information on long-term benefits or harm is reported.		
Teplicky et al. (2002)	Casting has consistently been shown to improve ankle movement.	Orthoses, particularly ankle-foot orthoses, have been shown to improve ankle movement during walking, but the effect on walking pattern is less clear.	Casting improves range of motion, may have an effect on tone; the effect on hand function is less clear.	Hand splints can improve grasps, but the effect on children's ability to use their hand for functional tasks or play is not clear.
Boyd et al. (2001)			Casting combined with adjuncts may improve quality of movement in some individuals; the older children seem to achieve more.	
Hur (1995)	There are insufficient studies to evaluate the outcome.	There are insufficient studies to evaluate the outcome.		
Vermeer and Bakx (1990)	Casting had a clearly positive effect on balance and walking symmetry; to some extent, short-term effects were attained. Any generalizations would be ill-advised.	Inhibitive orthoses had a clearly positive effect on balance and walking symmetry; to some extent, short-term effects were attained. Any generalizations would be ill-advised.		

TABLE 6 Excluded articles ($n = 29$) by the titles and abstracts in the first selection

Reference	Reasons for Exclusion
Barry MJ: Physical therapy interventions for patients with movement disorders due to cerebral palsy. *J Child Neurol* 1996;11(suppl 1):S51–60	Intervention criteria not fulfilled (physical therapy)
Boyd RN, Hays RM: Current evidence for the use of botulinum toxin type A in the management of children with cerebral palsy: A systematic review. *Eur J Neurol* 2001;8(Suppl. 5):1–20	Intervention criteria not fulfilled (botulinum toxin type A)
Brown GT, Burns SA: The efficacy of neurodevelopmental treatments in children: A systematic review. *Br J Occup Ther* 2001;64:235–244	Intervention criteria not fulfilled (neurodevelopmental treatment)
Butler PB: A preliminary report on the effectiveness of trunk targeting in achieving independent sitting balance in children with cerebral palsy. *Clin Rehabil* 1998;12:281–93	Intervention criteria not fulfilled (neurodevelopmental treatment)
Caselli MA, Rzonca EC, Lue BY: Habitual toe-walking: Evaluation and approach to treatment. *Clin Podiatr Med Surg* 1988;5:547–59	Intervention criteria not fulfilled (habitual toe-walking)
Darrah J, Fan JS, Chen LC, et al: Review of the effects of progressive resisted muscle strengthening in children with cerebral palsy: A clinical consensus exercise. *Pediatr Phys Ther* 1997;9:12–7	Intervention criteria not fulfilled (muscle strengthening)
Darrah J, Watkins B, Chen L, et al: Effects of conductive education intervention for children with cerebral palsy. American Academy for Cerebral Palsy and Developmental Medicine (AACPDM). Available at: http://www.aacpdm.org/home.html. Accessed March 10, 2003	Intervention criteria not fulfilled (conductive education)
Dodd KJ, Taylor NF, Damiano DL: A systematic review of the effectiveness of strength-training programs for people with cerebral palsy. *Arch Phys Med Rehabil* 2002;83:1157–64	Intervention criteria not fulfilled (muscle strengthening)
Genaze RR: Pronation: The orthotist's view. *Clin Podiatr Med Surg* 2000;17:481–503	Descriptive review of pronation
Heiskala H: Miksi vaikeavammaisia kuntoutetaan? *Duodecim* 2000;116:2014–8	Intervention criteria not fulfilled (physical therapy)
Horn EM, Warren SF, Jones HA: An experimental analysis of a neurobehavioral motor intervention. *Dev Med Child Neurol* 1995;37:697–714	Intervention criteria not fulfilled (training programs)
Leroy-Malherbe V, Laurent-Vannier A, Brugel DG, et al: Quoi de neuf en reeducation neurologique infantile? *Arch Pediatr* 2002;9:70–7	Intervention criteria not fulfilled (pediatric neurological), population criteria not fulfilled (children with neurological diseases)
Letts M, Shapiro L, Mulder K, et al: The windblown hip syndrome in total body cerebral palsy. *J Pediatr Orthop* 1984; 4:55–62	Descriptive overview of natural history of hip problems in cerebral palsy
Ludwig S, Leggett P, Harstall C: *Conductive Education for Children with Cerebral Palsy*. Edmonton, Heritage Foundation for Medical Research (AHFMR), 2000, Report No. HTA 22	Intervention criteria not fulfilled (conductive education)
Marcinko DE, Azzolini TJ, Mariash SA: Enigma of pediatric vertical talus deformity. *J Foot Surg* 1990;29:452–8	Descriptive overview on management of talus verticalis, based on case study
Matthews DJ: Controversial therapies in the management of cerebral palsy. *Pediatr Ann* 1988;17:762–4	Intervention criteria not fulfilled (controversial therapies)
Ottenbacher KJ, Biocca Z, DeCremer G, et al: Quantitative analysis of the effectiveness of pediatric therapy: Emphasis on the neurodevelopmental treatment approach. *Phys Ther* 1986; 66:1095–101	Intervention criteria not fulfilled (neurodevelopmental treatment)
Parette HPJ, Hendricks MD, Rock SL: Efficacy of therapeutic intervention intensity with infants and young children with cerebral palsy. *Infants Young Child* 1991;4:1–19	Intervention criteria not fulfilled (physical or occupational therapy)
Pedersen AV: Conductive education: A critical appraisal. *Adv Physiother* 2000;2:75–82	Intervention criteria not fulfilled (conductive education)
Roxborough L: Review of the efficacy and effectiveness of adaptive seating for children with cerebral palsy. *Assist Technol* 1995;7:17–25	Intervention criteria not fulfilled (adaptive seating)

(*Table continues*)

TABLE 6 Continued

Reference	Reasons for Exclusion
Siebes RC, Wijnroks L, Vermeer A: Qualitative analysis of therapeutic motor intervention programmes for children with cerebral palsy: An update. *Dev Med Child Neurol* 2002;44:593–603	Intervention criteria not fulfilled (motor programs)
Supan TJ, Hovorka CF: A review of thermoplastic ankle-foot orthoses adjustments/replacements in young cerebral palsy and spina bifida patients. *J Prosthet Orthot* 1995;7:15–22	A retrospective study
Swaeson AB: Surgery of the hand in cerebral palsy and muscle origin release procedures. *Surg Clin North Am* 1968;48:1129–38	Intervention criteria not fulfilled (surgery)
Tirosh E, Rabino S: Physiotherapy for children with cerebral palsy: Evidence for its efficacy. *Am J Dis Child* 1989;143:552–5	Intervention criteria not fulfilled (neurodevelopmental treatment)
Turnbull JD: Early intervention for children with or at risk of cerebral palsy. *Am J Dis Child* 1993;147:54–9	Intervention criteria not fulfilled (early intervention)
Waters RL, Mulroy S: The energy expenditure of normal and pathologic gait. *Gait Posture* 1999;9:207–31	Intervention (gait) and population criteria not fulfilled
Westbom L, Hagglund G, Lundkvist A, et al: Nya behandlingsmetoder vid spasticitet och dystoni hos barn med cerebral pares kraver multidisciplinart teamarbete: Samlat grepp ger goda resultat [New therapeutic methods for spasticity and dystonia in children with cerebral palsy require multidisciplinary team work: Comprehensive approach yields good results]. *Läkartidningen* 2003;100:125–30	Intervention criteria not fulfilled (multidisciplinary team work)
White H, Jenkins J, Neace WP, et al: Clinically prescribed orthoses demonstrate an increase in velocity of gait in children with cerebral palsy: A retrospective study. *Dev Med Child Neurol* 2002;44:227–32	A retrospective study
Woo R: Spasticity: Orthopedic perspective. *J Child Neurol* 2001;16:47–53	Population criteria not fulfilled (neurological diseases)

Two within-participant studies compared orthoses with shoes only.[34,35] Nine different types of orthoses (rigid or hinged ankle-foot orthosis [AFO], posterior leaf spring AFO, spiral graphite AFO, hinged AFO with tone-reducing footplate and calf cut-out, rigid AFO with tone-reducing footplate, dynamic AFO, dynamic AFO with plantarflexion stop, supramalleolar orthosis) were evaluated in 12 different studies.[28–39]

Evidence to support the hypothesis that orthoses can prevent deformities is lacking, and evidence that orthoses improve function is weak. The use of different designs and materials makes a systematic evaluation difficult. Orthoses that restrict plantar flexion were more often reported to prevent equinus during walking than orthoses with supramalleolar designs. Restrictive orthosis may hamper functional activities in children with less severe motor involvement. It is unclear whether reported biomechanical changes (gait kinematics and kinetics, energy consumption) are associated with functional benefits.

Upper Limb Casting

One RCT compared casting (6 mos) and neurodevelopmental therapy of two different intensities (intensive or regular) to no casting situations with similar therapy intensities.[40] Another RCT compared casting (4 mos) and intensive neurodevelopmental therapy against regular occupational therapy.[41] One before–after study[42] observed the effect of casting (4–6 wks) followed by a nonspecified 6-mo postcasting program.

Upper limb casting combined with physiotherapeutic or occupational therapeutic intervention may have a short-term effect on quality and range of movement, but it is unclear whether the effect is clinically important.

Upper Limb Orthoses

One within-subject study design compared three different orthoses (orthokinetic cuff, short opponens thumb splint, MacKinnon splint) worn for 8 hrs/day for 6 wks with a 2-wk pause between the different orthoses.[43] A MacKinnon splint was studied in another before–after study design.[44] The effect of a nonspecified hand splint on reaching and visual motor skills was studied over three sessions in a before–after study.[45]

The research suggests that the choice of a splint or orthosis for the upper limb needs to be task specific. Their effect on children's general ability to use their hands for function or play has not been studied.

DISCUSSION

The large number of published reviews that were not based on systematic evaluation of existing research but presented more or less personal expe-

rience is of major concern. Not all members of multiprofessional rehabilitation teams are familiar with the concept of evidence-based practice. The nonsystematic reviews may lead to clinical practice being based more on the experience of opinion leaders than solid evidence.

Several methods for evaluating the quality of a systematic review exist; we used the criteria presented by Hoving et al.[15] The methodological quality of the included systematic reviews varied over the analyzed domains. With regard to the search methods, they were fair to good. The inclusion

TABLE 7 Excluded articles (n = 18) in the second selection

Reference	Reasons for Exclusion
Bill M, McIntosh R, Myers P: A series of case studies on the effect of a midfoot control ankle foot orthosis in the prevention of unresolved pressure areas in children with cerebral palsy. *Prosthet Orthot Int* 2001;25:246–50	Case studies of various orthoses
Binder H, Eng GD: Rehabilitation management of children with spastic diplegic cerebral palsy. *Arch Phys Med Rehabil* 1989;70:482–9	Descriptive review of the incidence, pathophysiology, and associated handicaps of patients with spastic diplegic children
Campbell S: Efficacy of physical therapy in improving postural control in cerebral palsy. *Pediatr Phys Ther* 1990:135–40	Search methods and inclusion/exclusion criteria not given
Condie DN (ed): *Report of a Consensus Conference on the Lower Limb Orthotic Management of Cerebral Palsy*. Copenhagen, International Society for Prosthetics and Orthotics, 1995	Search methods and inclusion/exclusion criteria not given
Eng GD: Rehabilitation of children with cerebral palsy or meningomyelocele. *Curr Opin Neurol Neurosurg* 1990;3: 733–7	Search methods and inclusion/exclusion criteria not given
Fish DJ, Crussemeyer JA, Kosta CS: Lower extremity orthoses and applications for rehabilitation populations. *Foot Ankle Clin* 2001;6:341–69	Study design: case study
Greene WB: Cerebral palsy: Evaluation and management of equinus and equinovarus deformities. *Foot Ankle Clin* 2000; 5:265–80	Descriptive review of equinus and equinovarus
Hanson CJ, Jones LJ: Gait abnormalities and inhibitive casts in cerebral palsy: Literature review. *J Am Podiatr Med Assoc* 1989;79:53–9	A short description of various types of inhibitive casts
Hoffer MM: Management of the hip in cerebral palsy. *J Bone Joint Surg* (*Am*) 1986;68:629–31	Descriptive review of various ways to handle orthopedic problems without evidence on their effect
Klingbeil FT, Whitaker B, Dunn C: Principles and clinical practice of lower limb orthotics in children. *Phys Med Rehabil* 2000;14:515–32	Search methods and inclusion/exclusion criteria not given
Knutson LM, Clark DE: Orthotic devices for ambulation in children with cerebral palsy and myelomeningocele. *Phys Ther* 1991;71:947–60	Search methods and inclusion/exclusion criteria not given
Kurtz LA, Scull SA: Rehabilitation for developmental disabilities. *Pediatr Clin North Am* 1993;40:629–43	A summary of various intervention possibilities
Patrick JH, Roberts AP, Cole GF: Therapeutic choices in the locomotor management of the child with cerebral palsy: More luck than judgement? *Arch Dis Child* 2001;85:275–9	Descriptive review of locomotor management
Sobel E, Giorgini RJ: Problems and management of the rearfoot in neuromuscular disease: A report of ten cases. *J Am Podiatr Med Assoc* 1999;89:24–38	Study design: case series
Stallard J, Major RE, Farmer SE: The potential for ambulation by severely handicapped cerebral palsy patients. *Prosthet Orthot Int* 1996;20:122–8	Descriptive review of the potential for ambulation
Taft LT, Matthews WS, Molnar GE: Pediatric management of the physically handicapped child. *Adv Pediatr* 1983;30:13–60	Descriptive review of pediatric management
Weber D: The development of an orthotic management protocol for preambulatory children with spastic diplegic cerebral palsy. *J Prosthet Orthot* 1994;6:67–73	Descriptive review of the development method of orthotic management
Zadek RE: Orthopedic management of the child and multiple handicaps. *Pediatr Clin North Am* 1973;20:177–85	Descriptive review of orthopedic management

TABLE 8 Data extraction sheet for the included reviews

Author (year) Title	
Number of all studies included_____	
Number of RCTs _____and CCTs _____separately	
A) VALIDITY ASSESSMENT	YES Unclear NO
1. Is the focus (or objective) of the review stated clearly?	Describe:
♦What are the population, intervention and outcomes?	Population: The clinical Intervention: question explicitly:
♦What is the objective of the review?	Outcome(s): Outcome measures: Review design (see items 2 and 3):
2. Are the search methods stated clearly?	Describe:
♦What databases were searched and what search strategy was used?	The information sources: Search strategy (searching terms): Any restrictions (search period, etc.):
3. Were the inclusion and exclusion criteria used for deciding which studies to include in the review?	Describe:
♦What kind of criteria was used?,	Inclusion criteria: Population: Intervention: Outcomes: Follow-up period: Study design? (control group, etc.): Exclusion criteria:
4. Was the quality of the included studies assessed?	Describe:
♦What kind of "scoring system" was used?	
♦Was the quality used as criteria for deciding which studies to include in the review?	
5. Was bias in the selection of studies avoided?	Describe:
♦Were there two or more assessors?	
6. Were the populations in the included studies heterogeneous?	Describe:
♦Sum of population of all studies in the review:	♦_____
♦If heterogeneous, how?	
7. Were any RCTs or CCTs included?	Describe:
Number of RCTs and CCTs	RCTs:_____ CCTs:_____
B) SYNTHESIS	YES Unclear NO
8. Were the findings combined in a statistical way?	Describe:
♦How?	
9. Were the findings combined in a qualitative way?	Describe:
♦How?	
C) RESULTS AND CONCLUSIONS	YES Unclear NO
10. Were the results stated clearly?	Describe:
♦What was the main result?	
♦What was the result only in RCT and CCT studies?	
11. Were the results in the included studies heterogeneous?	Describe:
♦What kind of differences there were?	
12. Were any complications described?	Describe:
♦What kind of complications?	
D) APPLICATION	YES Unclear NO
13. Are the results applicable in the Finnish population?	Describe:
14. Were there any methodological problems?	Describe:
♦What kind of problems?	
This review was excluded, why?	

RCT, randomized, controlled trial; CCT, controlled clinical trial.

TABLE 9 Criteria used to assess the scientific quality of selected review articles[a]

Criteria	Description (Maximum Score = 18)
Search Methods	**(Maximum Score = 4)**
1. Were the search methods used to find evidence (primary studies) on the primary question(s) stated?	2 points: Yes; includes description of databases searched, search strategy, and years reviewed. Described well enough to duplicate. 1 point: Partially; partial description of methods but not sufficient to duplicate search 0 points: No; no description of search methods
2. Was the search for evidence reasonably comprehensive?	2 points: Yes; must include at least one computerized database search and a search of unpublished or nonindexed literature (for example, manual searches or letters to primary authors) 1 point: Cannot tell; search strategy partially comprehensive (for example, at least one of the strategies in the foregoing section were performed) 0 points: No; search not comprehensive or not described well enough to make a judgment
Selection Methods	(Maximum Score = 4)
3. Were the criteria used for deciding which studies to include in the review reported?	2 points: Yes; inclusion and exclusion criteria clearly defined 1 point: Partially; reference to inclusion and exclusion criteria can be found in the article but are not defined clearly enough to duplicate 0 points: No; no criteria defined
4. Was bias in the selection of articles avoided?	2 points: Yes; key issues influencing selection bias were covered. Two of three of the following bias avoidance strategies were used: two or more assessors independently judged study relevance and selection using predetermined criteria, reviewers were blinded to identifying features of study (i.e., journal title, author(s), funding source), and assessors were blinded to treatment outcome. 1 point: Cannot tell; if only one of the three strategies above were used 0 points: No; selection bias was not avoided or was not discussed
Validity Assessment	(Maximum Score = 4)
5. Were the criteria used for assessing the validity of the studies that were reviewed reported?	2 points: Yes; criteria defined explicitly 1 point: Partially; some discussion or reference to criteria but not sufficiently described to duplicate 0 points: No; validity or methodological quality criteria not used or not described
6. Was the validity for each study cited assessed using appropriate criteria (either in selecting studies for inclusion or in analyzing the studies that were cited)?	2 points: Yes; the criteria used address the major factors influencing bias (e.g., population, intervention, outcomes, follow-up) 1 point: Partially; some discussion of methodological review strategy but not clearly described with predetermined criteria 0 points: No; criteria not used or not described
Synthesis	(Maximum Score = 6)
7. Were the methods used to combine the findings for the relevant studies (to reach a conclusion) reported?	2 points: Yes; qualitative or quantitative methods are acceptable 1 point: Partially; partial description of methods to combine and tabulate; not sufficient to duplicate 0 points: Methods of combining studies not stated or described

(Table continues)

TABLE 9 Continued

Criteria Search Methods	Description (Maximum Score = 18) (Maximum Score = 4)
8. Were findings of the relevant studies combined appropriately relative to the primary question the review addresses?	2 points: Yes; combining of studies appears acceptable 1 point: Cannot tell; should be marked if in doubt 0 points: No; no attempt was made to combine findings, and no statement was made regarding the inappropriateness of combining findings; should be marked if a summary (general) estimate was given anywhere in the abstract, the discussion, or the summary section of the paper, and the method of deriving the estimate was not described, even if there is a statement regarding the limitations of combining the findings of the studies reviewed
9. Were the conclusions made by author(s) supported by the data or analysis reported in the review?	2 points: Yes; data, not merely citations, were reported that support the main conclusions regarding the primary question(s) that the overview addresses 1 point: Partially 0 points: No; conclusions not supported or unclear

[a] These criteria are based on those developed by Hoving et al.[15] The table is adapted from Oxman et al.[18]

criteria and quality evaluation of included studies were poor or lacking in all but one review.[12] Only Boyd et al.[12] gave the level of evidence for their conclusions on the effect of casting of the upper limb.

The quality and reliability of an individual study depends on many factors besides the research design. Boyd et al.[12] assessed the methodological quality of the included studies using the PEDro scale. Morris[10] included all study designs and even abstracts. Very few controlled studies were reported in any of the reviews. Often, the studies included only a few children and groups were heterogeneous. This may reflect the difficulties in assessing the effect of orthoses, which by their nature are individual to each patient. The quality of the included studies often remained obscure, and except for Boyd et al.,[12] the quality of original studies had no influence on conclusions by the authors. These major flaws in a systematic review made it difficult for us to draw conclusions.

Lower Limb Casting

All study types consistently showed an increase in the range of ankle dorsiflexion after lower limb casting. It is unfortunately unclear whether the effect is of clinical significance (i.e., no operation needed) and whether it solely affects the passive range of motion or also the active range of motion either negatively (decreased strength in ankle dorsiflexors after a period of immobilization) or positively (decreased resistance in ankle plantar flexors).

Lower Limb Orthoses

A major problem when summarizing the effect of orthoses in a review is the wide variety of available orthoses. It is impossible to ascertain if the effect of a specific type of orthosis (such as hinged or tone-relieving AFO) can be generalized to all orthoses similarly named. In the within-participant studies, the effect of orthoses was most often compared against barefoot walking, which is not a meaningful control for clinical decision making. We do not know whether the observation of a more marked restriction of equinus when using an orthosis with plantarflexion restriction compared with using good, supportive shoes alone is clinically significant. The possible negative effects of orthoses with restrictive components on other areas of gross motor functions should also be considered. The role of good, supportive shoes with or without an individual foot sole therefore remains unclear and ought to be studied.

Tone-relieving design did not seem to improve any functional outcome measurements. Tone-relieving AFOs enclose the foot fully and tightly, which may better prevent structural deformities—this has, however, not been studied. These thin, well-fitting, less visible orthoses may be preferred by parents and children,[37,46] but so far, the research does not support greater efficacy than standard designs.

Different orthoses may have different "beneficial profiles" on variables of gait such as stride length, range of dorsiflexion, ability to balance, and prepositioning of the foot during swing. It can be difficult to decide which variable in each child

primarily needs to be controlled. If the use of a orthosis improves walking, it does not necessarily improve moving on the floor level, stair climbing, running, or jumping. These activities may become more difficult to master if the orthosis restricts the dynamics of joint movement necessary for these activities. In clinical reality, every child with equinus posturing may have differing combinations of spasticity and structural deformity, and the role of structural deformities increases with age. The optimum management of equinus may require other treatment options than orthosis (botulinum toxin A, serial casting, or surgery).

Future studies should define the various orthoses and the material used more clearly so that the results can be compared between various studies. Also, the method of casting or manufacturing of orthoses needs to be explained so that it can be replicated at any clinical setting.

Upper Limb Casting

The length of casting varied in the reviewed studies from 4 wks to 6 mos, but it remained unclear for how long the casts were worn per day. Casting was always an adjunct to therapy. Casting may have a short-term benefit on the quality and range of movement in some children with hemiplegic or tetraplegic type of CP. It is not clear, however, if the improvement in quality of movement is of clinical or only of cosmetic significance. Only restricted two-hand functions are possible with one hand in a cast, so the effect of casting needs to be balanced with the possible side effects.

Upper Limb Orthoses

Learned nonuse of an affected upper-limb is a clear problem. Any device that would facilitate the use of the involved limb would be greatly appreciated. Research in this field is surprisingly sparse. The number of children in the reviewed studies is small; the studied splints differed and were not always described sufficiently. The research suggests that splinting of an upper limb needs to be task specific. However, it is difficult to imagine a child changing splints according to tasks. The sparse research suggests that splinting is more helpful for children with severe upper limb involvement, and this needs to be further evaluated.

CONCLUSION

Rehabilitation teams need to learn to critically read the existing literature. The numerous published nonsystematic reviews are often based on personal experience and may mislead clinical practice. We could identify only five systematic reviews. According to these, it could be concluded that good evidence exists only for a positive short-term effect of lower limb casting on passive range of movement. There is a paucity of evidence on the effect of using upper and lower limb orthoses in children with CP.

The need for original, well-designed, and long-term studies on the effects of orthoses in children with CP is clear. In such a heterogeneous population as CP, it is difficult but not impossible to use a randomized study design, as demonstrated by the studies on casting. The outcome measurements used in original studies to observe functional gain were mostly target specific. We need to know when the observed gain is of clinical significance or whether the possible improvement in a specific motor performance happens at the cost of hindering more complex performance. We also need to evaluate when the statistically significant effect is also meaningful for the child—for example, how much walking speed needs to increase to have an effect on daily function and abilities to participate. The lack of long-term follow-ups prevents any conclusions on the protective effect of any orthotic devices or intermittent casting on structure during growth in children with CP.

The difficulties in doing research within the rehabilitation field should not allow reviewers to lower the inclusion criteria for methodological quality in the original publications, nor do they allow rehabilitation teams to trust opinion leaders. The selection of rehabilitation interventions should be based on research evidence. If it does not exist, it should be produced for the benefit of the patients.

APPENDIX

Tables 6 and 7 provide an overview of excluded review articles on the effectiveness of upper and lower limb casting and orthoses used in children with cerebral palsy. Table 8 presents the data extraction sheet used for the included reviews, and Table 9 presents the criteria used to assess the scientific quality of selected review articles.

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