

# Abstract Collection

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# Cerebral Palsy - Time is running

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## Introduction

Cerebral palsy (CP) is an irreversible and not advancing damage of the brain. It is continuously changing its effect on the control and movement functions. Orthoses as a part of the different therapy-concepts have to be considered and influence the sequelae of the brain damage.

## Topic

The cause of CP has changed. Mainly it was the birth trauma, but now it is increasingly the premature birth, which leads to CP.

An early injury means loss of development but on the other hand a youthful brain has more plasticity and potential of regeneration. This influences also the orthotic treatment.

Hip geometry as an example of development: Normal hip geometry develops in the first year of life. The risk of hip dysplasia in cerebral palsy is a well known problem. Following the example of successful early treatment of congenital hip dysplasia, we have to start orthotic treatment in the very early stage of age. Orthoses are not a specific therapy, they are rather an extension of physical treatment. This highlights the crucial factor of time. An early treatment with little power but plenty of time could prevent many DDH cases and consecutive dislocations. To prevent hip dysplasia orthotic treatment has to be done in the first year of life.

Foot deformity is a much more complex problem. In CP equinus, clubfoot or calcaneus valgus become dominant. Orthoses can be used to compensate deformity and influence function of the foot. A correction should not be expected, but prevention is possible by early and long-term orthotic treatment. It is clear that the foot shape is the basic precondition for a normal function. Some therapeutic approaches are focused on function and ignore foot shape. So, at the end the unpopular "rigid" orthoses are indicated too late.

Example of a child suffering from birth trauma: Until the trauma, shape and function of the hip and feet are normal. The aim of orthotic treatment has to be the prevention of the deformity. If we have reached the diagnosis hip dysplasia, flexion contracture, pes equinus, clubfoot, etc. we are definitely too late. If the diagnosis of orthopedic hip dysplasia, equinus, etc. already exists, the most successful period as far as orthotic treatment is concerned has been squandered.

In almost all textbooks recommendations concerning orthoses are focused on diagnoses. This is definitely too late. We have to find new criteria for the indication of orthoses.

But orthoses can do much more than prevent deformity. They compensate deformities, improve musculoskeletal function and support the independence of the patients as a central issue in the treatment of CP.

## Summary

Orthoses are not an independent therapy. It is a supportive part in the overall concept of the basic physical therapy, medical and surgical treatment. With these considerations currently orthoses are indexed too late, and therefore the beginning of correct orthotic treatment cannot be influenced by the orthotist. It is a time and diagnostic problem.

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## Therapy of Intoeing Gait in Cerebral Palsy

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Internally rotated gait is a common gait disorder in spastic cerebral palsy [1] and associated with severe functional and cosmetic gait disturbances [2]. Symmetric and asymmetric transverse plane gait deviations are typically accompanied by sagittal and frontal plane deviations in spastic diplegia [1,3]. Internally rotated gait problems include the “squinting patella sign” with an internal foot progression angle or compensatory external tibial torsion [4]. Pelvic retraction can be a compensatory mechanism to normalize the foot progression angle [5].

The pathogenesis of internally rotated gait is complex and not yet understood. It may be a compensatory mechanism for the decreased abductor lever in patients with increased femoral anteversion [6]. The anterior parts of the glutei have also been thought to be responsible for this pathology [7]. In addition, Delp showed that the lever action of the internal rotators increase with concomitant hip flexion deformity [8].

Therapy options are both operative and non-operative, whereby the non-operative treatment includes night splinting, application of botox and physiotherapy. Examples and techniques will be described in the presentation.

In a prospective study 48 children with spastic diplegic cerebral palsy and an internally rotated gait received multilevel surgical treatment, including 85 FDOs, 42 proximal and 43 distal. The changes in static (clinical examination) and dynamic (3D-gait-analysis) parameters were evaluated before and 6.1 years after surgery. The results are good, the mean hip rotation in stance after 6.1 years was 3.9°

In a second prospective study 30 children with spastic diplegia and internal rotation gait treated with femoral derotation osteotomy were examined preoperatively and 1 year postoperatively. In all patients a standardized clinical examination, torsional MRI, X-ray (Rippstein) and a three-dimensional gait analysis were performed.

A significant correlation between the anteversion angle in torsional MRI and X-ray could be found, but there were great discrepancies of the anteversion measured with MRI and with the Rippstein method. The anteversion measured by X-ray did not correlate with the mean hip rotation in stance in three-dimensional gait analyses.

### Conclusion

There are operative and conservative treatment options for intoeing gait. Dynamic aspects of internal rotation gait as seen in three-dimensional gait analyses should be considered more intensively for the best treatment.

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## Assessment of Rotational Malalignment in Cerebral Palsy

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Internally rotated gait is a typical gait disorder in spastic cerebral palsy (CP) [1] and associated with severe functional and cosmetic gait deviations [2]. Transverse plane gait deviations are typically accompanied by sagittal and frontal plane deviations in spastic diplegia [1,3]. However, unlike sagittal plane gait deviations which can be treated by orthotic management to some extent, the possibilities of conservative treatment in transverse plane gait deviations are limited. In more severe forms surgical treatment is almost always indicated.

The functional malalignment of the lower extremity in gait of patients with CP most often is associated with bony malalignment either of the tibia or the femur or both. Hence bony procedures such as femoral derotation osteotomies (FDO) are used to correct this situation. However, the exact relationship between functional and static bony rotational malalignment is still not understood [4]. This is due partly because of shortcomings in the assessment both of the static and of the functional factor. Furthermore, conceptual problems arise in the interpretation of three dimensional (3D) data when trying to correlate them with clinical assessments which are oriented along the perpendicular planes sagittal, coronal and transverse.

Transverse plane gait deviations in this context should be quantified by means of instrumented gait analysis. The functional alignment of the hip thereby typically is determined by monitoring the functional knee axis in relation to the position of the pelvis in the transverse plane. Both femoral anteversion and the functional position of the hip contribute to this measure. The orientation of the foot in the transverse plane relative to the knee axis further denotes the functional malalignment of the lower leg. Here again, bony deformation such as e.g. forefoot adduction interferes with the functional measure.

On the other hand also the (static) determination of bony deformities in the transverse plane is difficult. Conventional X-rays following the method of Rippstein are sensitive to malpositioning of the patient which may easily arise in the presence of hip and knee contractures [5]. MRI as a truly 3D method may increase accuracy significantly but in regular devices exposure times are still long and patients may move and thereby falsify the results [5].

In the hip, the clinical assessment of malalignments becomes especially puzzling when all three degrees of freedom – hip flexion/extension, ab-/adduction and int./ext. rotation – are involved. In this case, the complex joint position of the hip cannot unambiguously be interpreted as a sequence of isolated joint motions. Assessment errors in hip rotation of up to 10° may arise influencing the treatment indication for FDO [6].

In summary, the exact assessment of both the bony malalignment of tibia and femur and the functional malalignment of upper and lower leg are necessary in order to adequately treat internally rotated gait in CP.

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## Orthobionic and Bionimobility Solutions for Children affected by Cerebral Palsy

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Cerebral palsy is the main disease responsible for disabled children worldwide. The incidence and the existing diversity of this disease is challenging for the physicians, therapists, CPOs and the industry worldwide to find the best as possible solutions for providing an adequate rehabilitation and mobilisation.

After a short overview of the disease Cerebral Palsy and the incidences the lecture is concentrated on the most common disabilities like tetraparesis, diparesis and hemiparesis. The therapeutic target, the requirements to reach this target will be discussed. It is followed by the orthopaedic problems which the CPOs have to solve. The solutions and tools the industry can provide to CPOs to get an acceptable result for the children will be shown, including patient case studies.

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## Novel Orthotic Manufacturing and Treatment Concept in Spina Bifida and Cerebral Palsy

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This paper will present the latest treatment guidelines in the field of spina bifida and CP. Since 20 years, we have cooperated with the Charite / Virchow Klinikum in Berlin, where you find the biggest Centre for Paediatric Neurology.

Twenty years ago we started to follow the guidelines of Dr. Med. Adriano Ferrari from Italy. In these guidelines Dr. Ferrari had recommendations about the prospective up growth in relation to level of paralysis, and which type of orthotic will assist the up growth.

Within these 20 years we modulated these guidelines to the orthotic joints, available on the market. We invented a new "child-friendly" splint system suitable for orthoses in a unilateral construction, which are robust, consistent with the function and light enough to use for congenital, incomplete transverse lesions of the cord with paraplegia. Our many years experience supplying children suffering from spina bifida helped us to develop suitable systems and to have them manufactured under stringent quality requirements.

In the paper you will see the latest orthotic devices from AFO to HKAF0, matched to the level of paralysis. The details of the Dr. Ferrari schema will be shown. Our traditional system with unilateral joints and the manufacturing with semi-flexible acryl lamination will be explained. The energy storing Carbon "Spring" system and the benefit for the patients will also be explained.

### Schema Dr. Ferrari depending on the muscle function:

- Level S2 to L5 can be treated with AFO's with a restricted ankle joint or a spring.
- Level S1 to L4 can be treated with KAFO's with eccentric or locked knee joint and a restricted ankle joint or spring.
- Level S1 to L4 can be treated with a HKAF0 with a 3 dimensional Hip joint (Salera) eccentric knee joint and restricted ankle joint.
- Level L5 to L3 can be treated with a HKAF0 with a 3 dimensional Hip joint (Salera) locked knee joint and restricted ankle joint.
- Level L3 to TH5 can be treated with a HKAF0 with a Twister or RGO Hip system and locked knee and ankle joints.

The benefits of the new "Carbon-Spring" energy storing orthotic-ankle-joint and the manufacturing with the use of prepreg will be explained. The biomechanical differences in gait between plastic and "Spring" Orthotic's for patient with CP and Spina Bifida is a much more upright, energy-efficient gait. There is also a benefit for CP patients by using a spring, because they get light weight functional brace which could not be made of plastic. The Outcome of a study about the AFO "Spring" Orthotic will be shown.

The important criterion in the construction of HKAF0 is a directional stability. The energy waste of a too flexible HKAF0 orthotic is tremendous because the weak child has to hold the centre of mass or put it back to the level of balance. The different systems will be explained. The Salera is a 3 dimensional Hip-joint used by a level S1 to L3. The classical RGO and the reinvention named Twister are used by a level L3 -TH5. The Twister is a reciprocal Hip-joint that allows 10 degrees of Hip rotation.

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## Developments in Healthcare for Cerebral Palsy - An ISPO Consensus and Conference Report

Dirk Böcker  
ISPO Publications Committee



In 1994 ISPO convened a consensus conference on the lower limb orthotic management of cerebral palsy held at Duke University, USA. The conference considered the evidence for the use of lower limb orthoses in the physical management of children with cerebral palsy from the multidisciplinary perspective, which underlies the ethos of ISPO. The report of that conference, published the following year, became the society's most successful publication. The report has been used by ISPO as the basis for a series of nine instructional courses held around the world to disseminate the key treatment principles and clinical practices that were recommended.

There have been many developments in the understanding and management of cerebral palsy in recent years. The methods of assessment, classification and overall approach to treatment planning and coordination have become more sophisticated. New treatments have emerged; in addition research and experience with some established interventions has accumulated. This has resulted in changes in the ways in which orthoses are, and can be, used. New designs of orthoses have also become available. The need to measure the outcomes of all forms of treatment is now widely accepted. In 2007 the Executive Board of ISPO, mindful of its responsibility to ensure that orthotic practice keeps pace with advances in healthcare, resolved to convene a follow-up to the previous consensus conference. This conference would consider relevant recent research and contemporary thinking in the healthcare of people with cerebral palsy identifying the implications for orthotic research and clinical practice. The scope of the conference was additionally expanded to include consideration of the evidence regarding the management of the spine, hips and upper limbs.

An international, multidisciplinary group of 24 health care professionals and research scientists, all of whom are recognised experts in this subject area, were invited to take part in the conference which was held in Wolfson College, Oxford in September 2008. Twelve of the participants were asked to prepare and present review papers. Their topics included a global health perspective, the definition and classification of cerebral palsy, the classification of gait, and physiotherapy, occupational therapy, medical, surgical and orthotic management of cerebral palsy. The reviewers of specific treatment areas were asked to synthesise the best available published evidence and where possible to grade their recommendations according to the level of evidence on which they were based using the Oxford Centre for Evidence-based Medicine Levels of Evidence (in Appendix).

At the conference, ten participants were nominated to each lead a plenary discussion session that followed the presentation of review papers. Participants were then separated into three smaller groups with the composition varying over the course of the conference. The small groups were used to explore gaps in the evidence and consider areas of controversy. In order to structure the discussion sessions, the organisers in consultation with the chairperson of each session devised a number of questions for the groups to address. Further plenary sessions were then held to hear the reports from each group and agree upon recommendations. The whole conference, which lasted for three and a half days, was extremely rich in content and involved a great deal of hard work for everyone due to the huge amount of material which was covered.

Following the conference a first draft of conclusions and recommendations resulting from the small group reports was formulated by the organisers. This was first submitted to a previously agreed representative nominal group of the participants for comments. After modification to take account of their suggestions, this document was supplemented by the addition of the principal conclusions and recommendations contained in the reviews. The resulting composite Conclusions and Recommendations from the conference were then submitted to all participants for final comment and approval.

This Final Report contains further details of the organisation of the conference, the text of all the papers presented and the Conclusions and Recommendations. The presentations and plenary discussions were all video and/or audio recorded by our equally industrious media team. The material has been collated and made available by ISPO free of charge on the Internet – [http://www.ispoint.org/index.php?option=com\\_content&view=article&id=86&Itemid=104](http://www.ispoint.org/index.php?option=com_content&view=article&id=86&Itemid=104)

ISPO intend to use the report as an educational resource for further instructional courses and the information will be disseminated as widely as possible with the aim of improving the health care of people with cerebral palsy worldwide.

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**Franz Landauer, MD, CPO (A)**

Franz Landauer from Austria is the deputy chief at the orthopaedic department, PMU-University Salzburg. First he was trained as a CPO (A) in Salzburg. He studied medicine at the University of Innsbruck and became his certification as an orthopaedic surgeon. He is the president of ISPO Austria and member of the EPOS. His work is focused on the connection between surgery and technical orthopaedics.



**Frank Braatz, MD**

Frank Braatz is an orthopaedic surgeon at the department of orthopaedic surgery at the University of Heidelberg. He studied medicine at the University of Giessen where he received his doctoral degree. After receiving his board certification in orthopaedics in 2003 he was appointed consultant of the department of cerebral palsy and technical orthopaedics in 2005.



**Sebastian Wolf, PhD**

With a PhD degree in physics, Sebastian Wolf spent several years in fundamental research in molecular physics before he moved to the field of motion analysis in 2001. As leader of the gait analysis lab of the Department of Orthopaedic Surgery at the University of Heidelberg he supervises a scientific group which is involved in clinical applications of gait analysis including neurological disorders as well as prosthetics and orthotics. A focus is set on modelling shoulder and foot motion.



**Volker Schmidt, CP**

Volker Schmidt, CP (German Meister) has been with Otto Bock Healthcare in Germany for 8 years. He is responsible for clinical and technical orthotic training for Otto Bock. Also he oversees the patient care department orthotics at the headquarter in Duderstadt, Germany.



**Marc Damerau, CPO**

In 1997 initiate an apprenticeship for O&P at the Company F. Gottinger Orthopaedietechnik GmbH in Munich / Germany. Till 2002 working and engineering for Gottinger. In 2002 temporary employment abroad in the USA for about a year. In 2005 "Meister-school" at the BUFA in Dortmund / Germany with completion as "Meister" and ISPO certificate as CPO. Since 2007 manager of the Berlin Gottinger affiliate, in close co-operation with the Centre for Paediatric Neurology of the Berlin Charite University hospital.



**Dirk Böcker, MA**

After ten years of working for the Federal Ministry of Education and Sciences as a project and field director in publications, Dirk Böcker became Editor-in-chief of the journal ORTHOPÄDIE TECHNIK – Orthopedic Technology – in 1994. Since then, he also co-ordinates the publishing activities of the German P&O Professional Association, BIV. He is a joint member of ISPO Germany's advisory board and vice-chairs the Publications Committee of ISPO International.



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