

Researchers and practitioners from across the globe came together in Hyderabad, India, in February for the World Congress of the International Society of Prosthetics & Orthotics (ISPO). LER's exclusive coverage of the 2013 World Congress, held in India for the first time, explores the evidence-based use of lower extremity devices for conditions ranging from stroke to cerebral palsy to diabetes.

By Jordana Bieze Foster

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stroke

EIGHT WEEKS OF EARLY AFO USE SIGNIFICANTLY ENHANCES BENEFITS OF STROKE REHABILITATION

Functional balance test scores rise

Use of an ankle foot orthosis (AFO) within six weeks of stroke results in better balance outcomes and earlier independent ambulation than if AFO use is delayed, according to research from the Netherlands.

Investigators from Roessingh Research & Development in Enschede randomized 18 patients to receive AFOs at either the time of inclusion in the study (within six weeks of stroke) or eight weeks later. Both groups received the same rehabilitation, with a focus on balance and ambulation, the only difference being that the “late” group did the first eight weeks of rehabilitation without an AFO while the “early” group did all rehabilitation while wearing AFOs. Balance measures were assessed every two weeks for 16 weeks.

AFOs were prefabricated nonarticulated devices made from polypropylene in three different rigidities to accommodate a range of patient needs. Device fitting involved particular attention to the alignment of the AFO within the shoe and the alignment of the knee and hip, said Jaap Buurke, PT, PhD, scientific manager of the research cluster Restoration and Human Function at Roessingh Research & Development, who presented his group’s findings at the ISPO World Congress in Hyderabad on behalf of graduate student Corien Nikamp.

At follow up, both groups demonstrated significant improvement on the Berg Balance Scale and Functional Ambulation Categories balance tests, but improvements in the early AFO group were more pronounced and occurred earlier than in the late group. Early AFO users achieved independent ambulation earlier than those in the late group, and there was a trend toward better outcomes on the 10-m walk test, six-minute walk test, and Timed Up and Go test for the early group.

Previous research from the same Dutch institution suggests that improvement on functional balance tests with AFO use is not necessarily reflected in instrumented tests of dynamic balance. In a 2009 study published in *Clinical Biomechanics*, Buurke and colleagues found that 20 chronic stroke patients performed significantly better with AFOs than without on five functional balance tests but not on platform-based force plate tests of dynamic balance.

The current study addresses some limitations of the earlier one, Buurke said.

“In a cross-sectional study, the patients are almost always chronic stroke patients and the intervention often involves not providing the AFO but removing it,” he said.

In a separate study presented in Hyderabad, researchers from the University of Strathclyde in Glasgow, Scotland, used 3D motion analysis

to assess the effect of polypropylene solid AFOs on gait mechanics in three patients, beginning within two months from stroke onset and continuing for six months.

Stephanos Solomonidis, BSc, CEng, FIMechE, senior lecturer in biomedical engineering at the university, and colleagues found that the AFOs improved joint kinematics in both the paretic and sound limbs, facilitated heel strike, and reduced toe drag during swing. In addition, one patient was analyzed wearing an instrumented AFO, which confirmed that the device reduced the net ankle moment by assisting the dorsiflexor muscles during the first half of stance phase.

SOURCES:

Nikamp C, Buurke J, Nederhand M, et al. Timing of ankle foot orthoses after stroke: First results of a randomized longitudinal study. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

Simons CD, van Asseldonk EH, van der Kooij H, et al. Ankle-foot orthoses in stroke: Effects on functional balance, weight-bearing asymmetry and the contribution of each lower limb to balance control. Clin Biomech 2009;24(9):769-775.

Papi E, Solomonidis S, Bowers R, Rowe P. Effect of ankle foot orthoses on gait biomechanics of early stroke patients. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

pediatrics

IN HYPERPRONATORS, FUNCTIONAL SCOLIOSIS RESPONDS TO DISTAL ORTHOTIC TREATMENT

What appears to be idiopathic scoliosis may actually be functional scoliosis that can be effectively treated with foot orthoses in children who are hyperpronators, according to research from Chungnam National University in Daejeon, South Korea.

In 38 patients, investigators found that use of rigid foot orthoses combined with stretching and strengthening exercises significantly reduced pelvic height asymmetry from 8.7 mm at baseline to 5.8 mm at 12 months and 5.1 mm at 18 months.

“This may be misdiagnosed as idiopathic if not recognized while children are young,” said Bong-Ok Kim, MD, a researcher in the department of rehabilitation medicine at the university, who presented her group’s findings at the ISPO World Congress in Hyderabad. “Initially you might think this is just functional and you don’t have to treat it because it will just go straight when the kids get older. But that’s not necessarily true.”

All children had an initial Cobb angle greater than 10°, a pelvic height differential of 5 mm or greater, and a resting calcaneal stance position

of at least 2° of eversion. Children with pure leg length discrepancies were excluded.

Children were encouraged to wear the orthoses with shoes during all outdoor activities, at school, and at home when not in bed—which can be a challenge in Korea, where shoes are not typically worn at home, Kim said.

“We encouraged parents to wear shoes in the house when their kids needed to be wearing the shoes,” she said. “We need to change the culture to improve compliance.”

SOURCE:

Kim B, Chang I, Park I, Sim E. Effect of custom molded rigid foot orthosis on the functional lumbar scoliosis in children. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

WALKERS' EFFECT ON PROXIMAL BIOMECHANICS VARIES DEPENDING ON DESIGN CHARACTERISTICS

Tibial inclination appears significant

Orthotic walkers have significant effects on proximal joint mechanics during gait, the extent of which appear to depend on individual device design, according to research from the University of Central Lancashire in the UK.

Investigators analyzed the kinetic and kinematic effects of two different orthotic walkers on hip and knee function in 11 healthy volunteers. The two devices differed from one another primarily with regard to positioning of the heel rocker and inclination of the tibial component: Device A featured a slightly more anterior heel rocker and a slightly anterior tibial inclination; Device P featured a slightly more posterior heel rocker and a slightly posterior tibial inclination.

Compared to walking in normal footwear, both walkers were associated with significantly greater knee flexion angle during stance phase, but only Device P was also associated with a significantly increased knee flexion moment. Knee extension moment was significantly higher for both rockers than for normal footwear, but was also significantly higher for Device P than for Device A.

At the hip, both walkers were associated with significantly greater hip extension angles and significantly decreased hip extension moments

compared to normal footwear. In both cases, the deviations were more pronounced with Device P than Device A.

These effects are likely related to the relatively posterior positioning of the heel rocker and the posterior tibial inclination in Device P, said James Richards, BEng, MSc, PhD, professor of biomechanics at the University of Central Lancashire, who presented his group's findings at the ISPO World Congress in Hyderabad, India.

The concept of an association between tibial inclination and gait mechanics was also discussed during several ISPO sessions by Elaine Owen, MSc, SRP, MCSP, superintendent and clinical specialist pediatric physiotherapist at the Child Development Centre in Bangor, North Wales, UK.

In her work with children with cerebral palsy, Owen consistently advocates that the shaft of an ankle foot orthosis be slightly inclined relative to vertical, with inclinations varying in degrees depending on the patient's natural inclination, stiffness, and any observed shank reversal. Owen described these evidence-based concepts in a 2010 paper published in *Prosthetics & Orthotics International*.

"An optimal alignment is always one where they can incline the thigh," Owen said. "It's the inclined alignment that will give the optimal performance."

Richards believes that similar biomechanical concepts may be at work with regard to the proximal effects of orthotic walkers.

"A better tibia inclination angle seems to be a dominant factor in knee and hip

mechanics, although the rockers are also very important," he said.

Richards emphasized, however, that manufacturers are constantly redesigning devices and probably have done so since the launch of his group's study.

"The take-home message is that not all walkers are the same," he said. "Further research is needed on the effects of orthotic walkers on knee and hip joint mechanics with a focus on the effects of changing the tibial angle and rocker profiles. This should help to inform future designs of walkers, with a greater focus on obtaining a more normal gait pattern."

And, when it comes to at least one variable, an orthotic walker's effect on the knee may actually be positive. The Central Lancashire group found that both devices were associated with significant reductions in knee adduction moment, which is commonly used as a surrogate for medial knee loading in studies of patients with medial compartment knee osteoarthritis, compared to normal footwear.

SOURCES:

Richards J, Payne K, Myatt D, Chohan A. Do orthotic walkers affect knee and hip function during gait?

Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

Owen E. The importance of being earnest about shank and thigh kinematics especially when using ankle-foot orthoses. Prosthet Orthot Int 2010;34(3):254-269.

ARCH STRUCTURE IN CHILDREN WITH TALIPES PLANOVALGUS IMPROVES WITH SHOE INSERTS

Orthotic management of pediatric talipes planovalgus starting at an early age is associated with significant improvement in weightbearing arch structure, according to research from Saga University in Japan.

Investigators analyzed 102 children treated for talipes planovalgus starting from a mean age of 2 years 9 months. Children were given shoe inserts with arch supports, metatarsal pads, and lateral wedges ranging in height from 3 mm to 7 mm depending on the degree of valgus deformity. Parents were advised to have children

wear the inserts with shoes with hard heel counters that could be firmly tied or otherwise fastened. The children were also prescribed exercises, including walking barefoot on unstable surfaces and walking on their tiptoes.

Children wore the inserts for a mean of three years seven months. More than half (57.8%) of patients achieved a weightbearing longitudinal arch by the end of the treatment, compared to 2.9% at baseline. A similar improvement was seen with regard to the weightbearing transverse arch, improving

from 2% of patients at baseline to 22.5% of patients after treatment.

Toyoko Asami, PhD, clinical professor in the department of rehabilitation medicine at Saga University who presented the group's findings at the ISPO World Congress in Hyderabad, noted that there is still room for more improvement.

"After the orthotic treatment had been provided, more than 40% of children at an average age of six and a half still have talipes planovalgus, indicating the need for further management," Asami said.

SOURCE:

Asami T, Kodama K, Akiyama N, et al. Orthotic treatment using shoe inserts for talipes planovalgus in children. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

diabetes

MORE RESULTS SUPPORT USE OF FOOT ORTHOSES TO SIGNIFICANTLY DECREASE PLANTAR PRESSURES

Swedes also find low ulceration rate

Research from Sweden and Egypt provides more evidence that foot orthoses can significantly decrease plantar pressures in patients with diabetes, theoretically reducing the risk of foot ulcers and lower extremity amputation.

Investigators from the University of Gothenberg in Sweden found that both custom and prefabricated insoles significantly reduced in-shoe plantar pressures in patients at risk of ulceration, effects that were maintained after one year. And researchers from Ain Shams University in Cairo, Egypt, also documented significant plantar pressure reductions with the use of a custom-molded foot orthosis in diabetic patients who had previously undergone first ray amputation.

The Swedish team randomized 114 diabetic patients to receive one of three types of insoles: a custom device made from 35-shore ethylene vinyl acetate (EVA), a custom insole made from 55-shore EVA, or a prefabricated device with support in the medial arch, a metatarsal pad, and a 25-shore A Poron cover. Patients wore the designated insoles with their own standard walking shoes. The researchers did not track patient compliance with insole wear.

No patient had an active foot ulcer at baseline; one patient developed an ulcer in the first six months, but that one case was the only ulcer to occur in the 12-month study period. Although the study did not include a control

group, the ulceration rate of .9% was lower than most rates reported in the literature.

All three types of orthoses were associated with peak plantar pressures of less than 272 kPa after one year. Peak plantar pressures for the custom orthoses were significantly lower than for the prefabricated orthoses in the heel region only, said Ulla Tang, CPO, a doctoral student at the University of Gothenberg's Institute of Clinical Sciences and an orthotist-prosthetist at Sahlgrenska University Hospital, who presented the findings at the ISPO World Congress in Hyderabad, India.

"All three types of inserts effectively distribute pressure under the sole in order to minimize the risk of ulcers," Tang said.

The Egyptian group created custom foot orthoses for 20 patients with first ray amputations secondary to diabetic foot ulcers—a particularly challenging population with regard to preventing ulcer recurrence.

"Every foot after an amputation is usually abnormally shaped," said Rana El-Hilaly, MD, a lecturer in rheumatology and rehabilitation at Ain Shams University, who presented her group's findings in Hyderabad. "What I want is something that will fill in the defect and increase total contact area to better distribute the pressure. So I create the device for the foot as if it was a prosthetic socket, to capture the different shapes and bony prominences"

Each custom orthosis included a 4-mm Pedillin base layer supplemented with Poron in high-pressure areas, topped with a layer of EVA and another layer of Pedillin.

El-Hilaly and colleagues assessed static and dynamic plantar pressures in the 20 patients using a pressure mat under three conditions: barefoot, with the custom orthoses, and with flat insoles. They found that, during walking, both insoles decreased peak plantar pressures in the midfoot, heel, and midmetatarsal regions, but the custom insoles decreased pressures more than the flat insoles. During standing, they found significant reduction of peak plantar pressures only with the custom insoles.

The findings were also e-published in December by *The Foot*.

SOURCES:

Tang U, Zugner R, Tranberg R. Effectiveness of insoles in preventive treatment of diabetic patients. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

El-Hilaly R, El-Shazly O, Amer A. The role of a total contact insole in diminishing foot pressures following first ray amputation in diabetics. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

El-Hilaly R, El-Shazly O, Amer A. The role of a total contact insole in diminishing foot pressures following partial first ray amputation in diabetic patients. *Foot* 2012 Dec 19. [Epub ahead of print]

sports medicine

PROXIMAL ROCKER BAR ON SHOE CAN RELIEVE TENSION ON ACHILLES TENDON IN RUNNERS

A rocker bar proximally positioned on a running shoe can relieve tension on the Achilles tendon as well as reduce the force required of the calf muscles during walking and slow running, according to research from the Netherlands.

The findings could have implications for rehabilitation of runners with Achilles tendinosis, said Klaas Postema, MD, PhD, professor of rehabilitation medicine at the University of Groningen, who presented his group's results at the ISPO World Congress in Hyderabad, India.

"With every step, there's a lot of tension on the Achilles tendon. It's not surprising that it hurts," Postema said. "With a proximally placed rocker bar the ground reaction force moves proximally, and the lever arm is shorter, so the need for force from the calf muscles goes down."

Postema and colleagues analyzed 16 recreational runners, all heel strikers, while walking and slow running (7 km/h) wearing a sport shoe with and without a rocker bar. At both speeds, the rocker-bar condition was associated

with significant decreases in internal plantar flexion moment and ankle dorsiflexion motion during late stance. Spatiotemporal variables and hip and knee moments did not differ significantly between shoe conditions.

SOURCE:

Postema K, Sobhani S, Vd Heuvel E, et al. A proximally placed rocker bar and external ankle moments during walking and slow speed running. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

OSTEOARTHRITIS

KNEE BRACES AND WEDGED INSOLES BOTH ALTER GAIT IN PATIENTS WITH KNEE OA

A Taiwanese study offers more evidence that offloading knee braces and wedged foot orthoses are both associated with significant biomechanical improvements in patients with knee osteoarthritis (OA).

Investigators from National Taiwan University performed gait analysis on 15 patients with medial compartment knee OA and 15 matched controls. Knee OA patients were analyzed under two orthotic conditions, with a knee orthosis or with lateral wedged cork foot orthoses. Patients with severe pain were excluded.

Both orthotic conditions were associated with significant increases in gait speed,

decreases in gait cycle time, and a lateral shift of the center of pressure compared to shoes only. Both significantly decreased peak knee adduction moment, which is commonly used as a surrogate measure for knee loading, as well as knee valgus angle and knee valgus excursion. Both devices, in particular the knee brace, were associated with a trend toward decreased co-contraction of the quadriceps and hamstrings muscles on the lateral side during gait.

The knee brace was associated with significant decreases in knee flexion angle and knee flexion excursion compared to shoes only. The wedged foot orthoses were associated with

a slight increase in ankle abduction moment.

The findings are consistent with those of previous studies (see "OA knee braces face off against wedged insoles," November 2012, page 37).

"Orthotic interventions can improve gait deviations and kinematic and kinetic performance," said Chun-Te Lin, a doctoral student in the Rehabilitation Engineering Laboratory at National Taiwan University, who presented his group's findings at the ISPO World Congress in Hyderabad, India.

SOURCE:

Lin C, Chang L. The effects of foot orthoses and knee orthoses on gait pattern and muscular activation of patients with medial compartment knee osteoarthritis. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

cerebral palsy

DYNAMIC DEVICES FACILITATE COMPLIANCE, OUTCOMES IN CHILDREN WITH CEREBRAL PALSY

Brace wear time, not torque, is key

Dynamic orthoses offer an effective alternative to static devices for management of tip-toe gait and knee flexion contracture in children with cerebral palsy (CP), particularly because the dynamic devices are associated with greater compliance, according to separate studies from Sweden and France.

In 10 children with CP, researchers from the Medical University of Vienna found that wearing a dynamic ankle foot orthosis (AFO) 23 hours a day was associated with significant correction of tip-toe walking after three months. The AFO, which features a ring-shaped foot support, was designed to address intra-articular rotational misalignment at the ankle, according to Christian Grasl, Dipl Ing, a researcher in the Center for Medical Physics and Biomedical Engineering at the Medical University of Vienna, who presented his group's findings at the ISPO World Congress in Hyderabad.

Just one of the 10 children continued to walk with a primary forefoot strike after the three months of AFO wear. Mean ankle dorsiflexion and foot progression angle for the group improved, with no loss of ankle power.

Similar effects could probably be achieved with a less aggressive regimen, Grasl said, but the Vienna researchers believe the 23-hour number makes intuitive sense to children and parents.

"It may be that 17 or 18 hours is enough, but it's just easier to say 23 hours, which leaves about one hour for bathing and cleaning the device," he said.

In a second study from the Regional Institute for Physical Medicine and Rehabilitation in Nancy, France, researchers found that dynamic knee ankle foot orthoses (KAFOs) designed to provide a low-load prolonged stretch were more effective than static KAFOs for managing knee flexion contracture in children with CP.

Thirty children with knee flexion contracture of at least 10° were randomized to receive dynamic or static KAFOs. After eight months of night use, knee flexion contracture had been reduced by a mean of 12.5° with the dynamic KAFO compared to just 3.5° with the static KAFO. Device tolerance was good or very good in 72.5% of patients in the dynamic group but just 31.8% of the static group.

"The key for success is the wearing time of the brace, not the level of torque. The practitioner must explain this to the family," said Isabelle Heymann, a researcher at the Regional Institute for Physical Medicine and Rehabilitation, who presented her group's findings in Hyderabad.

A third study from the University of Gothenburg in Sweden found that gait abnormalities related to leg length discrepancies (LLD) in children with CP can be

addressed by adding an extra sole to the shoe of the shorter limb.

In eight children with a mean LLD of 1.73 cm, researchers added a split sole of 55-shore ethylene vinyl acetate (EVA) to the shoe of the shorter limb and compared spatiotemporal gait variables for that condition with two others, barefoot and unadjusted shoes only.

The extra-sole condition was the only one of the three in which percent of time in stance phase did not differ significantly between limbs, according to Roland Zugner, RPT, MSc, a doctoral student in the department of orthopedics at the University of Gothenburg, who presented the results in Hyderabad.

SOURCES:

Grasl C, Kranzl A, Csepan R. Outcome of 23H bracing for tip-toe walking children with cerebral palsy. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

Heymann I. Superior efficacy of low-load prolonged stretch dynamic orthosis in cerebral palsy. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.

Zugner R, Stefansdottir I, Nystrom-Eek M. Gait pattern in children with CP and leg length discrepancy, effects of an extra sole. Presented at International Society of Prosthetics and Orthotics 2013 World Congress, Hyderabad, India, February 2013.