Orthotic Management of Children with Down Syndrome

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What causes flat feet (pronation) in children with Down Syndrome?

Children with Down Syndrome are at a much higher risk for foot problems due to hypotonia (low tone) and ligamentous laxity. Both characteristics contribute to joint hypermobility. This means the bone of the feet are not properly stabilized and aligned for standing and walking. Without taut ligamentous support, the heel tilts inward toward the ground and the surrounding bones tend to follow. When the foot collapses to the ground, it gives the appearance that there is not an arch. The degree of collapse will vary from one person to the next. If it goes untreated, it may lead to ankle and joint deformity. Long-term use of this standing and walking pattern can lead to a sedentary lifestyle, pain and fatigue.

Why is pronation a problem?

When the child walks with a poor foot posture, they are weight bearing on the inside borders of their feet, ultimately walking with a wider base of support causing the feet to point outward. This inefficient walking pattern creates shorter step length, a slower walking pace and, over time, the calf muscles will shorten in length. This is referred to as a contracture. The child must use more energy to walk and fatigues more quickly. As the child grows, the increased weight on the ligaments will cause them to stretch even further. As the foot posture continues to collapse, it has a direct effect on all the joints above the foot, causing it to alter body mechanics and compromises how the child walks, runs and jumps.

What can be done about it?

There are many possible treatment strategies for flexible flat feet depending upon the individual's age, clinical observations and the severity of their needs. The treatment goal is to provide the right support to facilitate an efficient walking pattern while maintaining optimal alignment of the foot and ankle. Every patient presents in their own unique concerns, alignments, strengths and weaknesses; therefore, the orthosis must be customized to the individual's needs to achieve the best possible outcome. Establishing these goals and functional expectations are best done collaboratively with other medical providers that may include a physician or physical therapist.

How do we choose the right orthotic design?

The evolution of the orthotic industry is relatively slow as compared to its counterpart, prosthetics. It can be much more difficult to design around an existing limb with deformity to facilitate functional benefits than it is to replace the limb with bionic technology designed to mimic human locomotion. Over the last 10 years there have been significant developments with orthotic design methodology. At Orthotic Care Services, we've pushed the boundaries to find solutions that form, fit and function, better than they ever have before. In order to achieve this consistency of success, we had to take a close look at our internal processes and the consecutive steps that are taken at the point of contact with a patient.

- Proper assessment of the patient
- Gathering clinical data
- Establishing reasonable and achievable goals
- Obtaining an optimal negative mold/model of the limb
- Formulating an orthotic design (anticipation)
- Modification methods of the positive model
- Fabrication methods
- Material selections that include soft and rigid zones
- Establishing finished heights (trim-line)
- Fitting and its relationship with the shoe
- Most of all tuning its performance at the fitting.

We continue to look closer and closer to truly understand cause and effect when we implement orthotic care.

- How does low tone affect joint alignment at the foot and ankle?
- How does the human body change structurally when muscles become weak?
- Why do muscles become shorter in their length when alignment and gait are impaired?
- What forces are acting on the body that cause the foot and ankle to change in shape and collapse to the ground?

Consideration to each and every detail has translated to improved comfort, compliance and outcomes. Material science and fit strategies have been the driving force behind improving the functional performances and outcomes for our patients. The answers to these questions are complex but are better understood today than they were even yesterday.

How does the orthosis attach to the human body?

Understanding gait, muscle strength, muscle tightness, joint alignment and its effect on the human body have guided orthotic design. At Orthotic Care Services we are constantly reinventing the wheel, so to speak, as we seek to mimic nature. If you look close enough you'll notice how the many small details add up to make a big difference.

Mechanical fitting strategies describe how the orthoses attach to the body, dynamic: how they move like flesh and bone, structurally: how they interface with the ground below and how those forces, when designed just right, enhance mobility.

In years past, orthoses would be fit to the bottom of the foot or to the back of the leg. Today, our designs envelope the limb by wrapping around it circumferentially acting like connective tissue to maintain the orthopedic structural integrity underneath. This prevents the limb from moving inside so the orthosis becomes a part of the body as the device secures itself to the limb.

Optimally, we use materials that are hard over areas that are soft and soft materials over areas that are hard. This framework becomes stiff and soft at the right point during the walking and running cycle. What is the normal physiology of walking, running and jumping and how do we use material and components to create optimal performance? The solution is to utilize stiff and soft zones to create structural control where you need it and shock absorption during impact and where we anticipate movement and potential pressures. There is a new focus to have the orthosis interface with the body and with the ground to enhance the experience and functionality.

Patient Story: Meet JJ

I had the privilege of meeting JJ a few months ago and knew right away he was going to be a lot of fun to work with. JJ is an 18 year old, affectionate young man that presents today with a primary diagnosis of Down Syndrome.

It didn't take long to figure out that JJ was confident and mature enough to represent himself as he didn't waste any time greeting me with a handshake. He immediately opens your eyes and softens your heart. His spontaneous hugs and kisses reminds his personal care attendants (PCAs) that he appreciates their support and friendship.

He was well represented by two loving PCAs that report his dad knows another family who has received bracing from Orthotic Care Services. They report his current AFOs, which are from another provider, started leaving marks on his skin a few months ago and he has not worn them much since then. They report his balance and gait are improved in his AFOs as compared to without. According to his PCAs he has had many different types of over the years.

I was told JJ has an appetite to dine at classy restaurants, including The Capital Grille and Red Lobster. According to his family, he loves to be the center of attention so I would suspect a "Norm from Cheers" like presence when he arrives anywhere. In his spare time he enjoys video books and picture schedules.

Clinical Findings:

Foot Alignment:

Probably best described by the photos seen here:


Medically speaking, his foot alignment would be described as severe pes planovalgus. The heel tips inward, the arch collapses to the floor and the forefoot swings outward away from midline.

Skin integrity:

Heavy callusing on the inside of the foot (navicular) and back of the heel.

Visual Gait Assessment:

JJ walks with a very impaired gait due to his low tone (hypotonic) foot posture. There's evident lateral trunk shifting with each step, wide base of supports, short step lengths and an externally rotated foot projection angle. Because the steps are short in length, he initiates contact with his midfoot rather than his heel. As he transitions his body weight over the limb the foot collapses reducing his ability to achieve energy or power off of his toes. This reduced power creates a slow walking pace (cadence) and ultimately fatigue as JJ expends more energy to walk than you or me.

Range of Motion:

Ankle range of motion, or the lack of it, was the most significant clinical finding that influenced orthotic design for JJ. The saying, use it or lose, holds true with muscle length. When gait pattern and foot/ankle alignments are compromised, muscles become shorter. This is referred to as a contracture. The limitation in ankle dorsiflexion (the motion needed to foot up beyond 90 degrees) causes the foot to collapse. This is clinically significant because it's a mechanical obstruction that prevents the ankle from moving into this needed dorsiflexion position when we correct/neutralize the foot alignment.

In JJ's case, we were able to passively achieve a neutral foot alignment; however, doing so meant he wouldn't have the ability to use this ankle motion while wearing a brace. This was precisely why he was getting pressure in his previous design. The static foot alignment was well supported in the brace but as soon as he moved to take a step the foot was forced to collapse because the calf muscles were contracted. The foot and the brace were essentially fighting one another and usually the skin loses the battle. This is why you'll see strong callusing or blistering.

Your body needs approximately 10 degrees of ankle motion to walk, ascend and descend sloped surfaces such as stairs. JJ had less than zero and was measured at -2 degrees of dorsiflexion.

Goals:

The functional goals are driven by the information provided by the family, observations of skin, foot alignments, range of motion and visual gait assessment. Orthotically, we would like to fit a system that provides optimal dynamic alignments at the foot and ankle, assists with walking performance, restores ankle range of motion to +10 degrees of dorsiflexion and improves endurance.

Recommendation: Short Two Pull Solid Ankle AFO

The orthotic strategy was to capture a neutralized foot and ankle alignment using silicone like materials that interface with the limb while using a hard exoskeleton of sorts to maintain the boney alignments underneath. Because of the combined severity of the foot /ankle alignments and limitations in ankle joint range of motion, we're forced to utilize what is referred to as a solid ankle AFO design. Its definition is far from the truth. What is considered solid by description is in fact very dynamic. The design is enhanced by creating soft zones at the heel, arch and the outside of the foot that prevent it from functioning like a ski boot.

Outcome:

After 3 weeks of use, JJ was seen again at our office for a routine follow up to assess fit and function. Though it wouldn't be uncommon to make some tuning adjustments at this visit, JJ did NOT have any pressure related issues in brace. In fact, the calluses on his feet were clearing up. The PCAs reported 8-10 hours of use per day and improved balance for walking and while ascending stairs and no opposition to wearing.

Visual Gait Assessment in Brace:

What I found most significant while observing JJ walking were his feet pointing straight ahead. Range of motion was already improving at the ankle. Step lengths were longer and his gait was more fluid.

Future:

I would anticipate that JJ will continue to develop movement strategies while wearing the AFOs over the next couple of months. Even in this short time, he's demonstrating therapeutic benefits to restore range of motion along with standing and ambulatory balance.

It's too early to tell if we will be able to graduate JJ to a jointed design as we'll need to reassess his new baseline to make these decisions at a later date.

How do I set up an evaluation appointment?

Orthotic Care Services prefers to work cooperatively with the referral sources to establish a pathway of care. Most or our pediatric referrals come from a pediatric physical therapist or pediatrician. If you are interested in a free evaluation, please call any of our 3 conveniently located clinics in the Twin Cities set up an appointment.

Check out our website www.orthoticcareservices.com.