To Study the Effect of Ankle Foot Orthosis during Walking of Foot Drop Patients

Harish Kumar Banga  
PEC University of Technology, Chandigarh  
Production & Industrial Engineering Department

Dr Parveen Kalra  
PEC University of Technology, Chandigarh  
Production & Industrial Engineering Department

Dr Sandip Dhole  
PGIMER, Chandigarh  
Physical Rehabilitation & Medicine Department

ABSTRACT

There is significant difference in spatiotemporal parameter of gait of patients with foot drop and healthy individual. Foot drop is a gait abnormality in which the dropping of the forefoot happens due to weakness, irritation or damage to the common fibular nerve including the sciatic nerve, or paralysis of the muscles in the anterior portion of the lower leg. Our aim is to assess the effect of Ankle foot orthosis in these patients by doing gait analysis.

Keywords

Drop foot, ankle foot orthosis (AFO), gait analysis, human biomechanics

INTRODUCTION

Gait analysis is the study of walking - a detailed examination of how the skeleton and muscles work together when we walk. In the gait analysis laboratory, we study complex walking problems in adults and children. This is used in planning patient management and in evaluating outcomes of treatment. Anyone with a movement problem which affects their walking may benefit from gait analysis. It may be used to plan therapy, surgery, checks orthotic or prosthetic prescription, for research, or as a baseline record of the walking pattern. In order to interpret gait analysis data, joint angle definitions must be defined. This is important for routine clinical use of gait data for treatment decision-making and for the presentation of research data in publications. The joint angle definitions are system dependent and ultimately depend on the marker alignment and underlying mathematical models. Interpretation of joint kinematic and kinetic data involves a knowledge of marker placement and an appreciation of the joint models used. It must be clearly stated whether angles are relative (relating the position of one body segment to another) or absolute (segment orientation in terms of a laboratory coordinate system). Labels used in data output should reflect whether angles are relative or absolute. For example, referring to the thigh segment orientation in the sagittal plane as the "hip angle" is incorrect. Joint angle information should be obtained using three-dimensional techniques and relate to body segment axes, or coordinate systems, as determined by the appropriate anatomy. Ultimately, there is a need to work toward standardization of angle definitions independent of our body segment marker set placement and gait model (for example, the use of Euler angles for kinematics). This will improve the ability to communicate data between different laboratories.

Serdar Kesikburun and his colleagues assess the Effect of ankle foot orthosis on gait parameters and functional ambulation in patients with stroke and found that walking speed, cadence, and ankle dorsiflexion at initial contact and midswing were significantly increased while walking with AFO compared to walking barefoot.

Esquenazi A and his colleagues investigate the effect of an ankle-foot orthosis on temporal spatial parameters and asymmetry of gait in hemiparetic patients and found that the use of an AFO improved the symmetry of several of the temporal spatial parameters of gait, and consequently, the gait pattern of these hemiparetic patients was enhanced.
Franceschini M and his colleagues assessed effects of an ankle-foot orthosis on spatiotemporal parameters and energy cost of hemiparetic gait and found the orthosis significantly improved self-selected speed, stride cycle, stance and double support and reduced energy cost of walking without affecting cardiorespiratory response. Moreover, a significant correlation was found between the improvement of double support and the reduction of energy cost.

**Title and Authors**

**To study the effect of ankle foot orthosis during walking of foot drop patients**

Harish Kumar Banga and PEC University of Technology Chandigarh, harishbanga.phdprod13@pec.edu.in

Dr. Parveen Kalra and PEC University of Technology Chandigarh, parveenkalra@pec.ac.in

Dr Sandip Dhole and Physical Rehabilitation & Medicine Department, PGIMER Chandigarh, drsandipdhole@gmail.com

**METHOD**

A typical gait analysis laboratory has several cameras (video and/or infrared) placed around a walkway or a treadmill, which are linked to a computer. The patient has markers located at various points of reference of the body (e.g., iliac spines of the pelvis, ankle malleolus, and the condyles of the knee), or groups of markers applied to half of the body segments. The patient walks down the catwalk or the treadmill and the computer calculates the trajectory of each marker in three dimensions. A model is applied to calculate the movement of the underlying bones. This gives a complete breakdown of the movement of each joint. One common method is to use Helen Hayes Hospital market set, in which a total of 15 markers are attached on the lower-body. The 15 marker motions are analyzed analytically, and it provides angular motion of each joint.

To calculate the kinetics of gait patterns, most labs have floor-mounted load transducers, also known as force platforms, which measure the ground reaction forces and moments, including the magnitude, direction, and location (called the center of pressure). The spatial distribution of forces can be measured with pedobarography equipment. Adding this to the known dynamics of each body segment enables the solution of equations based on the Newton–Euler equations of motion permitting computations of the net forces and the net moments of force about each joint at every stage of the gait cycle. The computational method for this is known as inverse dynamics.

**Figure 1:** Acquisition of information on the position of the markers in 2D through the chambers of the left and right, this combination of information gives rise to a 3D image on the position of the markers
This use of kinetics, however, does not result in information for individual muscles but muscle groups, such as the extensor or flexors of the limb. To detect the activity and contribution of individual muscles to movement, it is necessary to investigate the electrical activity of muscles. Many labs also use surface electrodes attached to the skin to detect the electrical activity or electromyogram (EMG) of, for example, muscles of the leg. In this way it is possible to investigate the activation times of muscles and, to some degree, the magnitude of their activation—thereby assessing their contribution to gait. Deviations from normal kinematic, kinetic, or EMG patterns are used to diagnose specific pathologies, predict the outcome of treatments, or determine the effectiveness of training programs.

Foot drop:

Foot drop, sometimes called drop foot, is a general term for difficulty lifting the front part of the foot. If you have foot drop, you may drag the front of your foot on the ground when you walk. Foot drop isn't a disease. Rather, foot drop is a sign of an underlying neurological, muscular or anatomical problem. Sometimes foot drop is temporary. In other cases, foot drop is permanent. If you have foot drop, you may need to wear a brace on your ankle and foot to hold your foot in a normal position.

Symptoms:

Foot drop makes it difficult to lift the front part of your foot, so it might drag on the floor when you walk. To counter this, you might raise your thigh when you walk as if you were climbing stairs (steppage gait), to help your foot clear the floor. This odd gait might cause you to slap your foot down onto the floor with each step you take. In some cases, the skin on the top of your foot and toes may feel numb. Foot drop typically affects only one foot. Depending on the underlying cause, however, it's possible for both feet to be affected.

Causes :

Foot drop is caused by weakness or paralysis of the muscles involved in lifting the front part of the foot. The underlying causes of foot drop are varied and may include:

- Nerve injury. The most common cause of foot drop is compression of a nerve in your leg that controls the muscles involved in lifting the foot. This nerve can also be injured during hip or knee replacement surgery, which may cause foot drop. A nerve root injury ("pinched nerve") in the spine can also cause foot drop. People who have diabetes are more susceptible to nerve disorders, which are associated with foot drop.

- Muscle or nerve disorders. Various forms of muscular dystrophy, an inherited disease that causes progressive muscle weakness, may contribute to foot drop. Other disorders, such as polio or Charcot-Marie-Tooth disease, also can cause foot drop.

- Brain and spinal cord disorders. Disorders that affect the spinal cord or brain — such as amyotrophic lateral sclerosis (ALS), multiple sclerosis or stroke — may cause foot drop.

Ankle Foot Orthosis (AFO):

The AFO is used to treat various neuromuscular (nerve and muscle) diseases and disorders and to also provide functionality after an injury or a surgery. AFOs aim is to eliminate the problems related to foot-to-ground placement that affect foot clearance and heel contact. It is also prescribed to restore stability to the foot during the swing and stance phases of walking, and to compensate for thigh muscle weakness so that the knee does not buckle due to weakness. Our CPO orthotists evaluate your condition and then fit you with the appropriate ankle foot orthosis. Depending on your condition, you could be fitted with a Static AFO, Dynamic AFO, Foot Drop Splint, Hinged Ankle AFO, Flexible AFO, Tubular AFO, Gauntlet AFO or Fixed AFO. CPO provides you with customised and fabricated AFOs that suit your particular and specific needs.
Results & Discussion

Table 1: Anthropometric data of Foot Drop patients

<table>
<thead>
<tr>
<th>Patients</th>
<th>Age</th>
<th>Weight</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>36</td>
<td>49</td>
<td>162</td>
</tr>
<tr>
<td>2</td>
<td>49</td>
<td>97</td>
<td>172</td>
</tr>
<tr>
<td>3</td>
<td>54</td>
<td>84</td>
<td>168</td>
</tr>
<tr>
<td>4</td>
<td>56</td>
<td>66</td>
<td>166</td>
</tr>
<tr>
<td>5</td>
<td>52</td>
<td>64</td>
<td>164</td>
</tr>
</tbody>
</table>

Figure 2: Mean Velocity difference with and without AFO
Figure 3:- Stride Time difference with and without AFO

Figure 4:- Stride Length difference with and without AFO
**Figure 5:** Cadence difference with and without AFO

![Cadence difference with and without AFO](image1)

**Figure 6:** Swing Time difference with and without AFO

![Swing Time difference with and without AFO](image2)
Figure 7: Stance Time difference with and without AFO

Table 2: Gait Parameters of foot drop Patients with and without AFO

<table>
<thead>
<tr>
<th>Human gait parameters</th>
<th>Without AFO</th>
<th>With AFO</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity</td>
<td>0.8±07</td>
<td>0.98±0.08</td>
<td>0.0213</td>
</tr>
<tr>
<td>Stride Time</td>
<td>1.21±0.10</td>
<td>1.19±0.09</td>
<td>0.0196</td>
</tr>
<tr>
<td>Stance Time</td>
<td>0.79±0.38</td>
<td>0.76±0.03</td>
<td>0.0074</td>
</tr>
<tr>
<td>Swing Time</td>
<td>0.52±0.12</td>
<td>0.42±0.03</td>
<td>0.1812</td>
</tr>
<tr>
<td>Stride Length</td>
<td>1.06±0.09</td>
<td>1.17±0.10</td>
<td>0.0030</td>
</tr>
<tr>
<td>Cadence</td>
<td>99.20±5.93</td>
<td>102.60±6.58</td>
<td>0.0673</td>
</tr>
</tbody>
</table>
Conclusion:
To assess the effect of ankle foot orthosis on spatial temporal parameter of gait using 3 Dimensional instrumented gait analysis in foot drop patients. There is significant improvement in temporal parameters of gait with the use of ankle foot orthosis. 3 dimensional instrumented gait analysis can be useful tool to document objectively usefulness of ankle foot orthosis in foot drop patients.

REFERENCES