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Three Dimensional Gait Assessment During Walking of Healthy People and Drop Foot Patients

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ABSTRACT

The present study is focused on clinical gait analysis of normal human and drop foot patients, which can be utilised in customized design of ankle foot orthosis for drop foot patients. Gait analysis is the study of human movements using instumention for the measurement of various body movements. The individual's Gait analysis may helps patients by assessing their gait patterns and provide effective treatment accordingly. Foot drop is a kind of gait abnormaility which may happens due to weakness of ankle and toe dorsiflexion. There is significant difference in spatiotemporal parameter of gait of patients with foot drop and healthy individual. Clinical gait anaylsis asses the effect of Ankle foot orthosis in these patients.

Keywords: Ankle foot orthosis; AFO; Clinical gait analysis; Drop foot; Dorsiflexion; Planterflexion

1. INTRODUCTION

Gait analysis is the study of walking a described examination of how the skeleton and muscles work together during walk. In the walk analysis laboratory, the complex walking problems are studied in adults and children. This is used in planning patient management and in figuring out the worth, amount, or quality of results of treatment. Anyone with a movement problem which affects their walking may benefit from this walk analysis. It may be used to plan therapy, surgery, checks orthotic or (artificial leg, arm, etc.) prescription, for research, or as an (a measure of what occurs naturally/sports boundary line) record of the walking pattern[1-3].

The tenuous beginnings of gait analysis are traceable to early historic times and involve a progressive evolution that represents an amazing panorama of discovery and invention. Its evolution is important to understanding the growth of certain methods and theoretical assumptions.

Improvement of present day PC based frameworks happened autonomously amid the late 1970s and mid 1980s in doctor's facility based research labs.. Business advancement soon took after with the coming into perspective of business TV and later infrared camera frameworks in the mid-1980s[4-6].

Serdar Kesikburun and his colleagues assessed 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 mid swing were significantly increased while walking with AFO compared to walking barefoot[7].

Esquenazi A and his colleagues investigated the effect of an ankle-foot orthosis on temporal spatial parameters and asymmetry of gait in hemiparetic patients and using AFO, It was found that the symmetry of several of the temporal spatial parameters of gait has been improved, and consequently[8], there was enhancement in the gait pattern of these hemiparetic patients.

Franceschini M and his colleagues assessed the effects of an AFO on spatiotemporal parameters and energy cost of hemiparetic gait and found that there was significant improvementin self-selected speed, stance and double support, stride cycle , and reduced energy cost of walking without affecting cardiorespiratory response[9]. Moreover, a significant correlation among the improvement of double support and the fall of energy cost was found. The phases of walking can be understood by considering each foot movement during walking.. There are two phases, i.e: Stance phase and Swing phase as shown in Fig 1. Stance phase represent the the time during which the foot is on the ground and it is about 3/5th of the walking cycle. It also comprises both feet are on the ground during stance phase. Now, when one foot is in air and other foot is on the ground then the foot in air represents the swing phase of the gait cycle.

A precise way to understand the different phases of the gait cycle considering single foot can be represented through five substages as shown in Fig. 1. The substages has been described as follows:

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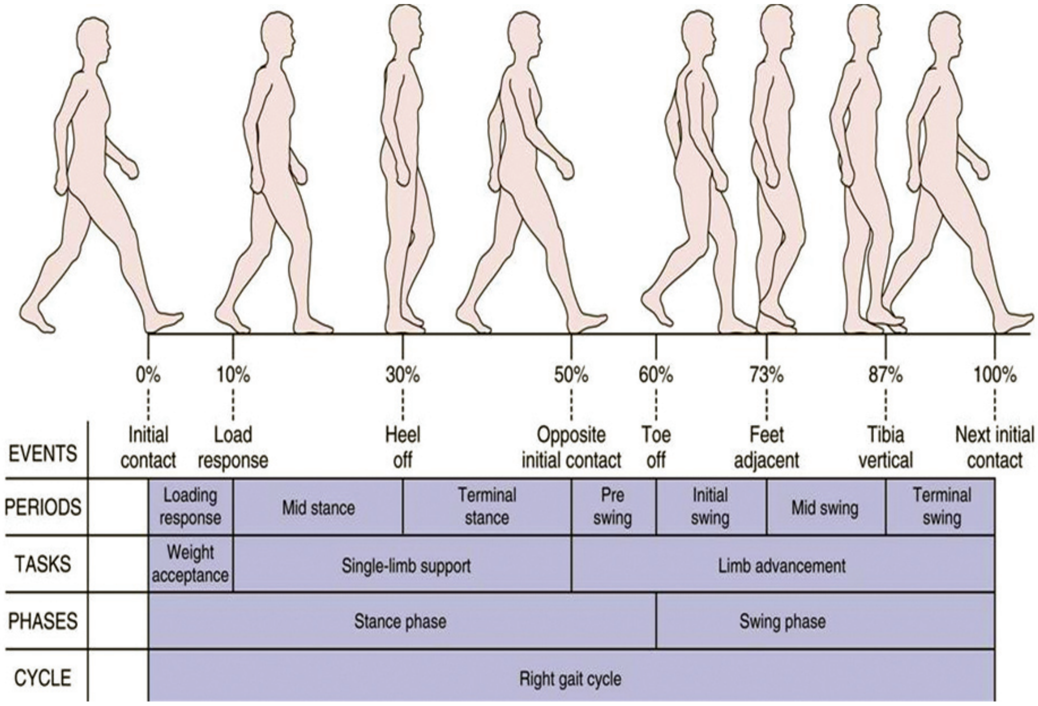

Figure 1. Phases human of gait.

1.1 Heel Strike

The heel strike stage fundamentally speaks to beginning contact and it happens when the heel first reach the ground and keeps going till the total foot is on the ground.

1.2 Early Flatfoot

The start of the 'early flatfoot' happens when entire foot is on the ground amid the development and it endures till focal point of gravity of the body ignores the highest point of the foot. The foot adjust to uneven terrains and go about as safeguard by engrossing the foot affect on ground.

1.3 Late Flatfoot

This stage is otherwise called Early heel rise stage and it happens when the body's focal point of gravity before the unbiased position The late flatfoot phase of walk cycle closes when the heel lifts off the ground. Amid the 'late flatfoot' stage , the foot is required to go from being an adaptable safeguard to being a hardened/not adaptable lever that can serve to push the body forward.

1.4 Heel Rise

This stage, as the name recommends, starts when the heelstatrs to leave the ground. The foot goes about as a solid adaptable lever and propel the body amid this stage. The powers that experience the foot amid this period of stride cycle are essential and are two-three time the body weight. The expansion in body weight constrain is because of the working of the foot as a lever arm Given these high strengths and considering (contemplating/when one ponders) that the normal human makes around 3000-5000 strides for each day (a dynamic individual ordinarily takes 10,000 steps/day), it is not shocking that the foot may grow long haul rehashing stress related issues, for example, foot bonegia, foot swellings, (backside/far from the head) bring down leg bonel muscle-to-bone interfacing band (unsafe, furious practices), peroneal muscle-to-bone associating banditis, and seasmoiditis.

1.5 Toe Off

The toe off phase of walk begins when the toes leave the ground. This stage speaks to the begin of the swing stage. The running is not quite the same as strolling as for buoy stage which speaks to the time when both of the feet are off the ground. In addition, running is identified with higher velocities, therefor the strengths that experience the foot can be (in a major/imperative manner) more prominent than amid strolling (for the most part four-five circumstances body weight amid running.

2. METHOD

A typical walk analysis laboratory has (more than two, but not a lot of) cameras (video and / or infrared) placed around a walkway or a treadmill, which are linked to a computer. The patient has markers located at different points of reference of the body (e.g., iliac spines of the hip, ankleankle, and the condyles of the knee), or groups of markers applied to half of the body pieces/parts. The patient walks down the catwalk or the treadmill and the computer calculates the arc-like path of each marker in three dimensions. A model is applied to calculate the movement of the hidden (under) bones. This gives a complete breakdown of the movement of each joint. One common method is to use Helen Hayes Hospital market set, 11 in which a total of 15 markers are attached on the lower body. The 15 marker movements are carefully studied (in a way when you carefully examine something), and it provides skinny (so you can see bones)/having angles movement of each joint.

Table 1. Anthropometric data of foot drop patients

Patients (No's.)	Age	Weight (Kg)	Height (cm)
1	36	49	162
2	49	97	172
3	54	84	168
4	56	66	166
5	52	64	164

To ascertain the (movement related)s of walk examples, most labs have floor mounted load transducers, otherwise called drive (raised, flat, supporting surfaces), which measure the ground reaction powers and minutes, including the significance, heading, and area (called the centre of weight). The (identified with space or existing in space) circulation of strengths can be measured with pedobarography gear. Adding this to the known examples of connections, development, or sound of each body part/segment empowers the arrangement of conditions in light of the Newton Euler conditions of development allowing calculations of the net powers and the netmoments of compel about each joint at each phase of the walk cycle. The computer based technique for this is known as converse examples of connections, development, or sound.

This utilisation of (movement related), be that as it may, does not bring about data for individual muscles but muscle gatherings, for example, the extensor or flexors of the appendage. To distinguish the action and (thing that is given/ work that is done) of individual muscles to development, it is important to (get some information about/attempt to discover reality about) the electrical action of muscles. Numerous labs likewise use surface terminals joined to the skin to recognise the electrical movement or electromyogram (EMG) of, for instance, muscles of the leg. Along these lines it is conceivable to (get some information about/attempt to discover reality about) the (incitement of activity/making dynamic and effective) times of muscles and, to some degree, the significance of their incitement of activity dynamic and compelling by in that way testing/assessing their work that is done to walk.

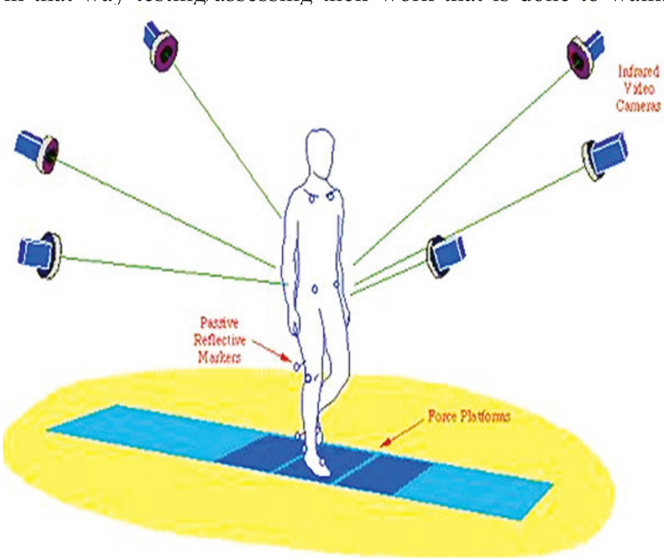

Figure 2. Clinical gait anaylsis system for disabled walk patients.

Astounding oversights from normally kinematic, development related, or EMG examples are utilised to its cause obviously specific ailments, (portray a conceivable future occasion) the consequence of medications, or choose/make sense of the effectiveness of preparing projects[12-15].

2.1 Foot drop

Foot drop, infrequently called drop foot, is a general term for trouble lifting the front some portion of the foot. On the off chance that you have foot drop, you may drag the front of your foot on the ground when you walk. Foot drop isn't an infection. Or maybe, foot drop is an indication of a covered up (under) nerve-based, strong or (identified with body structure) problem. Sometimes foot drop is going on for a short-time. In different cases, foot drop is perpetual. In the event that you have foot drop, you may need to wear a brace on your lower leg and foot to hold your foot in a healthy position[16-17].

Symptoms

Foot drop makes it very hard to lift the front some portion of your foot, so it may delay the floor when you walk. To fight against this, you may raise your thigh when you stroll as though you were climbing stairs (steppage stroll), to help your foot clear the floor. This odd walk may make you slap your foot down onto the floor with each progression you take. Now and again, the skin on the highest point of your foot and toes may feel numb. Foot drop as a rule influences just a single foot. Contingent upon the hidden (under) cause, be that as it may, it's workable for both feet to be influenced.

Causes

Foot drop is created by shortcoming or (condition of being not able move) of the muscles required in lifting the front some portion of the foot. The hidden (under) reasons for foot drop are fluctuated and may include:

- **Nerve injury**

  The most widely recognised reason for foot drop is press or constrain into a littler space of a nerve in your leg that controls the muscles required in lifting the foot. This nerve can likewise be harmed during hip or knee substitution surgery, which may cause foot drop. A nerve root harm ('pinchednerve') in the spine can likewise bring about foot drop. Individuals who have (malady where glucose swings fiercely) are all the more effectively ready to be hurt or affected by nerve ailments/ issues, which are identified with foot drop.

- **Muscle or nerve disorders.**

  Distinctive types of strong dystrophy, a conceived in ailment that causes dynamic muscle weakness, may provide for foot drop. Different infections/issues, for example, polio or Charcot-Marie-Tooth ailment, likewise can bring about foot drop.

- **Brain and spinal cord disorders.**

  Disorders/issues that influence the spinal string or mind-, for example, amyotrophic sidelong body-tissue solidifying (ALS), different sclerosis or stroke - may bring about foot drop.

2.2 Ankle Foot Orthosis

The Ankle Foot Orthosis (AFO) is utilised to treat diverse (identified with nerves and muscles) (nerve and muscle) sicknesses and ailments/issues and to likewise give capacity to get things done after a damage or a surgery. Main point is to take out the issues identified with foot-to-ground arrangement that influence foot clearance and heel contact. It is likewise recommended to reestablish (firm and consistent nature/enduring nature/quality) to the foot amid the swing and (method for standing/state of mind) stages of walking, and to compensate for thigh muscle shortcoming so that the knee does not clasp due to weakness. Our CPO orthotists (make sense of the value, sum, or nature of) your condition and then fit you with the fitting lower leg foot orthosis. Contingent upon your condition, you could befitted with a Static AFO, Pattern of conduct AFO, Foot Drop Splint, Hinged Ankle AFO, Flexible AFO, Tubular AFO, Glove/(image for a battle) AFO or Fixed AFO. CPO gives you with customised and made AFOs that suit your specific and particular needs[18-23].

3. RESULTS AND DISCUSSION

After clinical gait analysis of normal human and drop foot patients which is utilised to manufacturing of ankle foot orthosis used by drop foot patients. Which evaluate the difference of drop patients and normal person walking.

The Table 2 shows the difference between various human gait parameters of healthy and foot drop patients also Table 3 The P-Value of healthy and foot drop patients after 3D gait assessment. Figure 3 shows that Force values during walking of Healthy and Foot Drop Patients with Ankle Foot Orthosis. Which help to analysed how many force is required or achieved. In Fig. 4 to Fig. 9, respectively showing all human

Table 2. Comparison of human gait paraments between healthy and foot drop patients

Human gait parameters	Normal person	Drop foot patients
Stride time	1.1	1.31
Stance time	0.65	0.8
Swing time	0.44	0.51
Stride length	1.36	1.1
Step length	0.62	0.58
Mean velocity	1.2	0.8
Gait deviation index	≥100	70.84

Table 3. P-Value of foot drop Patients with and without AFO.

Human gait parameters	Without AFO	With AFO	P Value
Velocity	0.8±07	0.98±0.08	0.0213
Stride time	1.21±0.10	1.19±0.09	0.0196
Stance time	0.79±0.38	0.76±0.03	0.0074
Swing time	0.52±0.12	0.42±0.03	0.1812
Stride length	1.06±0.09	1.17±0.10	0.0030
Cadence	99.20±5.93	102.60±6.58	0.0673

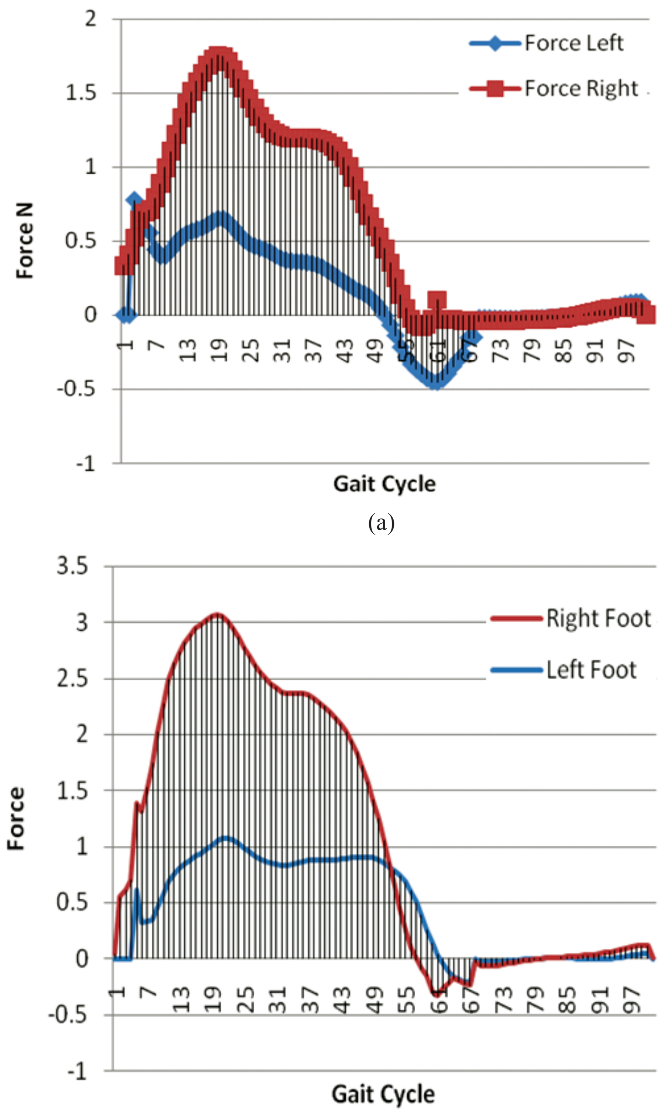

Figure 3. (a) Force of drop foot patients (b) with ankle foot orthosis.

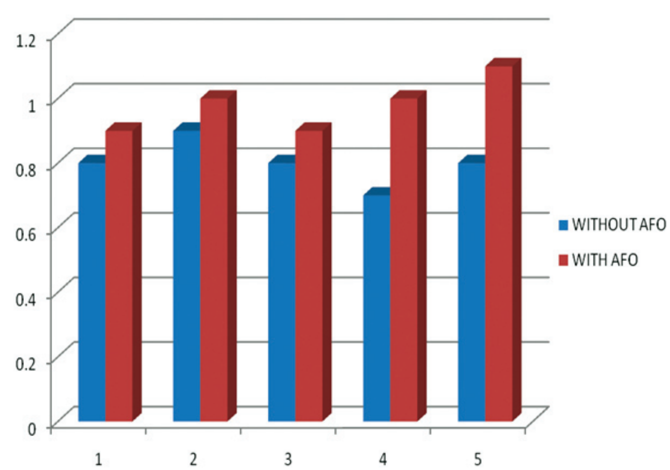

Figure 4. Mean velocity difference with and without AFO.

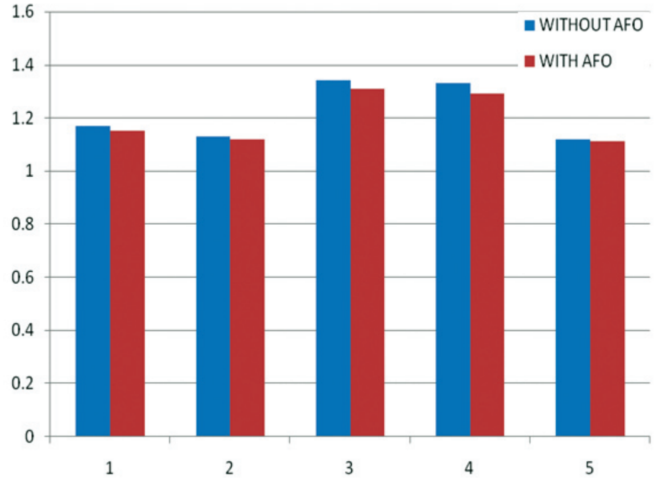

Figure 5. Stride time difference with and without AFO.

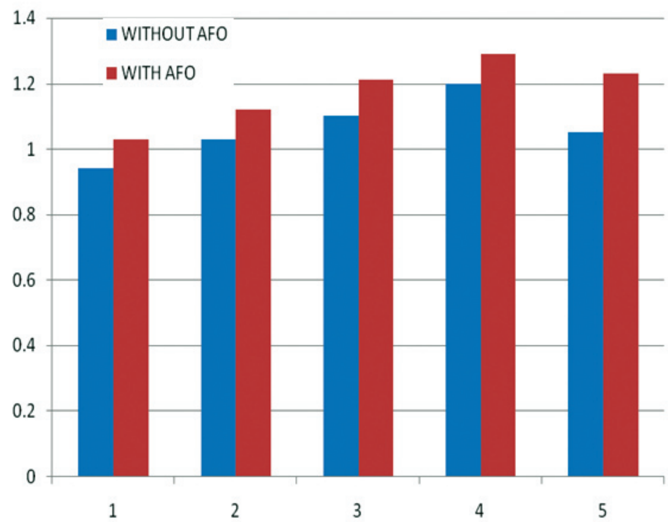

Figure 6. Stride length difference with and without AFO.

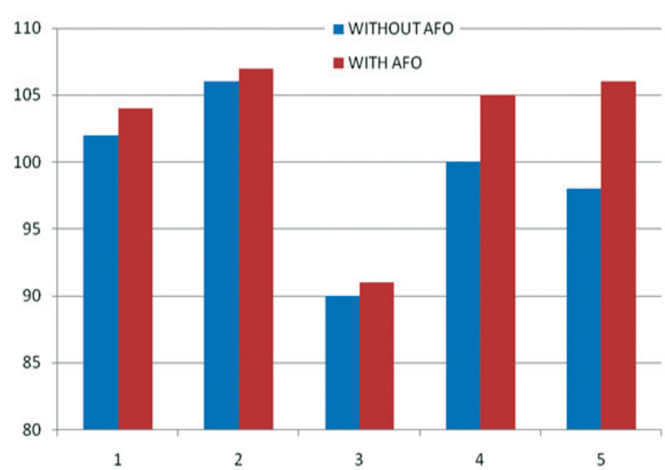

Figure 7. Cadence difference with and without AFO.

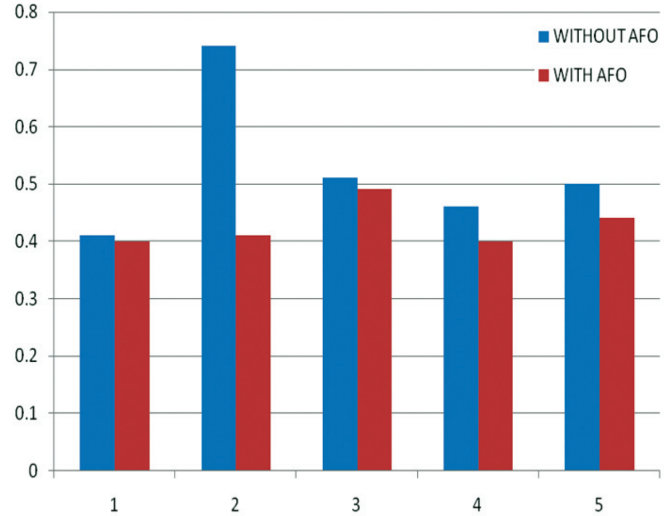

Figure 8. Swing time difference with and without AFO.

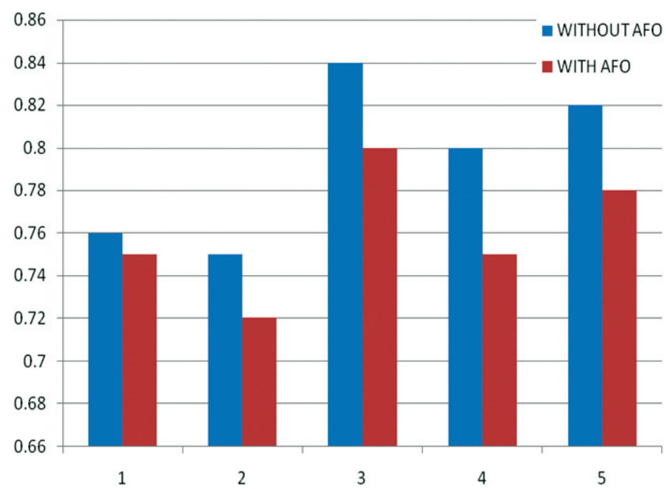

Figure 9. Stance time difference with and without AFO.

gait parameters between healthy and foot drop patients after 3D gait assessment during walking.

4. CONCLUSIONS

To assess the effect of ankle foot orthosis on spatial temporal parameter of gait using three dimensional instrumented gait analysis in foot drop patients. There is significant improvement in temporal parameters of gait with the use of ankle foot orthosis. Three dimensional instrumented gait analysis can be useful tool to document objectively usefulness of ankle foot orthosis in foot drop patients.

The capacity to walk upright is a key useful action which, when (did/done/finished) (in a way that is not the same as what's generally expected), hits/impacts contrarily/severely on exercises of daily living. The solution based (procedure of making sense of the value, sum, or nature of something) of walk (things that are unique in relation to what's normally expected), (did/done/finished) in conjunction with a careful history and physical examination, is an essential undertaking. These walk (things that are not quite the same as what's typically expected) result from different neuromusculoskeletal ailments/issues and can frequently be recognised amid the (looking at and testing so a choice can be made) (procedure of making sense of the value, sum, or nature of something). Making the correct (ID of an illness or issue, or its cause) is important in taking into consideration fitting mending/repairing and orthotic (achievement arranges/methods for achieving objectives). (now and again), to manage entangled spasticity or for choosing/making sense of surgical correction, a formal walk laboratory (process of figuring out the worth, amount, or quality of something) may be necessary. After clinical gait analysis of normal human and drop foot patients which is utilised to manufacturing of ankle foot orthosis by additive manufacturing used by drop foot patients. Which evaluate the difference of drop patients and normal person walking. Further work is using gait analysis value for customised design of ankle foot orthosis.

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