# Kinematic and Kinetic Analysis in Adult Subjects Suffering from Subble or Flexible Flat Foot Versus Normal

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## ABSTRACT

*The purpose of this study was to determine the Kinematic and kinetic analysis in adult subjects suffering from subble or flexible flat foot since their childhood but never treated during normal gait cycle versus normal. Thirty subjects contributed in this study divided into two groups, the first group is flexible flat foot while the second group is normal subjects, each group consisted of fifteen male subjects. Kinematic and kinetic analysis of gait for the two groups including spatial (distance) and temporal (time) variables done using three dimensional computerized gait analysis system. Time distance variables (stride length - stride time - speed of walking), kinematic (joint angles of pelvis, hip, knee and ankle) and kinetic variables (moments of hip, knee and ankle in sagital pane) of the patients of flexible flat foot compared with normal subjects matching in age and sex, weight, height and socio-economic level. The two group compared with each other by paired t test. The results of the study revealed that there is no significant difference between the spatial – temporal kinematic and kinetic parameters of gait cycle flexible flat foot or in normal subjects.*

## INTRODUCTION

Flat foot is often a complex disorder, with diverse symptoms and varying degrees of deformity and disability. There are several types of flatfoot, all of which have a partial or total loss of the arch[12].

Flexible flatfoot is one of the most common types of flatfoot. It typically begins in childhood or adolescence and continues into adulthood. It usually occurs in both feet and generally progresses in severity throughout the adult years. As the deformity worsens, the soft tissues (tendons and ligaments) of the arch may stretch or tear and can become inflamed[15].

The term "flexible" means that while the foot is flat when standing (weight-bearing), the arch returns when not standing. In the early stages of flexible flatfoot arthritis is not restricting motion of the arch and foot, but in the later stages arthritis may develop to such a point that the arch and foot become stiff fig. (1)[11].

Symptoms, which may occur in some persons with flexible flat foot, include:

- Pain in the heel, arch, ankle, or along the outside of the foot.
- Pain associated with shin splint.

General weakness or fatigue in the foot or leg[16].

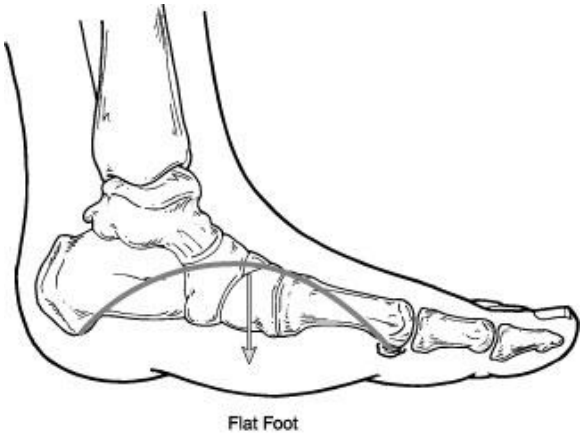


***Fig. (1): Flat foot.***

**Diagnosis of Flexible Flatfoot:**

X-rays are usually taken to determine the severity of the disorder[9].

**Treatment Options:**

Activity modifications. Cut down on activities that bring you pain and avoid prolonged walking and standing to give your arches a rest[17].

Weight loss. If you are overweight, try to lose weight. Putting too much weight on your arches may aggravate your symptoms[4].

Orthotic devices. Custom orthotic devices give more support to the arches[9].

Medications. Non-steroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, help reduce pain and inflammation[19].

Shoe modifications. Wearing shoes that support the arches is important for anyone who has flatfoot[14].

Surgery. In severe cases where pain is not adequately relieved by other treatments, surgery may be considered[8].

**Pediatric Flatfoot:**

Flatfoot is common in both children and adults. When this deformity occurs in children, it is referred to as a pediatric flatfoot, a term that actually includes several types of flatfoot Fig. (2)[3].

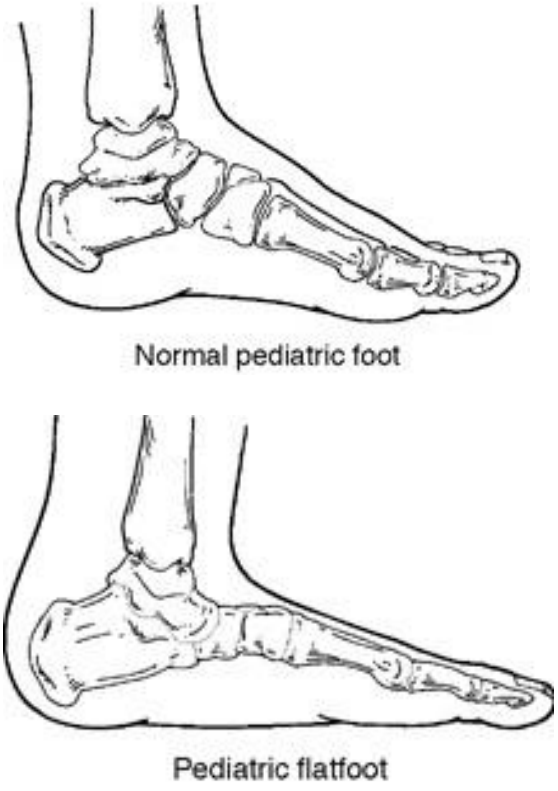


***Fig. (2): Normal and pediatric flat foot[3].***

Most children with flatfoot have no symptoms, but some children have one or more symptoms. When symptoms do occur, they vary according to the type of flatfoot. Some signs and symptoms may include the following:

- Pain, tenderness, or cramping in the foot, leg, and knee.
- Outward tilting of the heel.
- Awkwardness or changes in walking.
- Difficulty with shoes.
- Reduced energy when participating in physical activities.
- Voluntary withdrawal from physical activities.

Flatfoot can be apparent at birth or it may not show up until years later, depending on the type of flatfoot. Some forms of flatfoot occur in one foot only, while others may affect both feet[1].

**Types of Pediatric Flatfoot**

Various terms are used to describe the different types of flatfoot. For example, flatfoot is either asymptomatic (without symptoms) or symptomatic (with symptoms). As mentioned earlier, the majority of children with flatfoot have an asymptomatic condition fig. (3)[7].

Symptomatic flatfoot is further described as being either flexible or rigid. Flexible means that the foot is flat when standing (weight-bearing), but the arch returns when not standing. Rigid means the arch is always stiff and flat, whether standing on the foot or not. Several types of flatfoot are categorized as rigid[18].

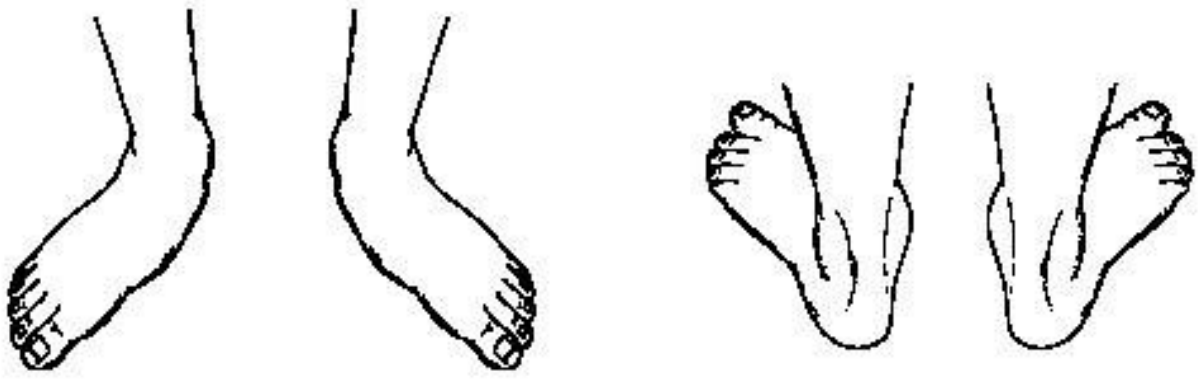

***Fig. (3): Types of pediatric flatfoot[18].***

Tarsal coalition. This is a congenital (existing at birth) condition. It involves an abnormal joining of two or more bones in the foot. Tarsal coalition may or may not produce pain. When pain occurs, it usually starts in preadolescence or adolescence[10].

Congenital vertical talus. Because of the foot's rigid "rocker bottom" appearance that occurs with congenital vertical talus, this condition is apparent in the newborn. Symptoms begin at walking age, since it is difficult for the child to bear weight and wear shoes. There are other types of pediatric flatfoot, such as those caused by injury or some diseases[2].

**Diagnosis**

The child's walk (gait) and range of motion of the foot should be evaluated. Because flatfoot is sometimes related to problems in the leg, the knee and hip should be examined. X-rays are often taken to determine the severity of the deformity[5].

**Treatment:**

Non-surgical Approaches

Deland, 2001[6] reported that; if a child's flatfoot is asymptomatic, treatment is often not required. Instead, the condition will be observed and re-evaluated periodically. Custom orthotic devices may be considered for some cases of asymptomatic flatfoot. In symptomatic pediatric flatfoot, treatment is required. One or more approaches, depending on the child's particular case. Some examples of non-surgical options include:

Activity modifications. The child needs to temporarily decrease activities that bring pain as well as avoid prolonged walking or standing.

Orthotic devices. Custom orthotic devices fit inside the shoe to support the structure of the foot and improve function.

Physical therapy. Stretching exercises provide provides relief in some cases of flatfoot.

Medications. Non-steroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, may be recommended to help reduce pain and inflammation.

Shoe modifications. The proper choice of shoes is important.

When is Surgery Needed?

In some cases, surgery is necessary to relieve the symptoms and improve foot function. A variety of techniques to treat the different types of pediatric flatfoot. The surgical procedure or combination of procedures selected for your child will depend on his or her particular type of flatfoot and degree of deformity[13].

**Material and methods:**

Patients population:

Thirty male adult subjects contributed in this study divided into two groups, normal and flexible flat foot, each group consisted of fifteen subjects. The study group consisted of fifteen adult male subjects suffering from flexible flat foot matching in age ,sex weight, height and socio-economic level with the control group. The control group consisted of fifteen normal male healthy subject.

The control group was selected on the basis that they have no past history of any musculoskeletal problems. The age of both study and control group was between 20 and 30 years.

The patient in the study and control group was diagnosed and referred to physiotherapy department by orthopedist from orthopedic outpatient clinic.

Equipment and methods:

Kinematic and kinetic analysis of gait including spatial (distance) and temporal (time) variables done using three dimensional computerized gait analysis system (vicon 370 with five cameras and two bertecs forceplate). data analysis was performed using SPSS.

Time distance variables including (stride length- stride time and speed of walking), kinematic variables including (pelvis tilting, excursion of hip, knee and ankle) and kinetic variables including (moments of hip, knee and ankle in sagital plane) of the patients of flexible flat foot compared with normal subjects (the control group).

The two group compared with each other using paried t test.

## RESULTS

The results of the study revealed that there is no significant difference between the spatial temporal, kinematic and kinetic

parameters of gait cycle in both normal and flexible flat foot subjects (table1).

Some patients with flexible flat foot participated in this study suffering from lumbo sacral pain, calf spasm, hip pain, pain in both knees, pain in the ankle and subtalar joint in addition to pain in the planter aspect sole of foot.

## DISCUSSION

Flexible flatfoot is one of the most common types of flatfoot. It typically begins in childhood or adolescence and continues into adulthood. It usually occurs in both feet and generally progresses in severity throughout the adult years. As the deformity worsens, the soft tissues (tendons and ligaments) of the arch may stretch or tear and can become inflamed[15].

The term "flexible" means that while the foot is flat when standing (weight-bearing), the arch returns when not standing. In the early stages of flexible flatfoot arthritis is not restricting motion of the arch and foot, but in the later stages arthritis may develop to such a point that the arch and foot become stiff[11].

Flexible flatfoot may be asymptomatic or may present symptoms in other patients. Symptoms, which may occur in some persons with flexible flat foot, include:

- Pain in the heel, arch, ankle, or along the outside of the foot.
- Pain associated with shin splint.
- General weakness or fatigue in the foot or leg[16].

This study proved that that there is no significant difference between normal and flexible flat foot subjects in relation to the biomechanics of foot including the kinematic and kinetic parameters of gait cycle.

Aggressive treatment may not be necessary during childhood for subble or flexible flat foot.

***Table (1): Spatio temporal, kinematic and kinetic parameters of gait cycle of adult flexible flat foot versus normal subjects (mean ± SD).***

| Variables | Group1 | Group 2 |
|---|---|---|
| Stride length | 1.12±0.11 | 1.11±0.12 |
| Stride time | 1.17±0.11 | 1.2±0.1 |
| Speed of walking | 0.96±0.15 | 0.99±0.12 |
| Tilting of pelvis | 2.22±0.8 | 2.01±0.9 |
| Hip flexor moment | 1.20±0.08 | 1.2±0.02 |
| Knee extensor moment | 0.31±0.08 | 0. 35±0.3 |
| Ankle planter flexor moment | 1.7±0.20 | 1.8±0.4 |
| Hip excursion | 37.5±4.5 | 39.1±4.5 |
| Knee excursion | 50.3±6 | 51.3±7 |
| Ankle excursion | 21.3±7 | 23.3±5 |

## Conclusion

The results of the study proved that there is no significant difference between the spatial temporal kinematic and kinetic parameters of gait cycle flexible flat foot or in normal subjects.

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**الملخص العربي**

## التحليل الحركي الوصفي والسببي للأشخاص البالغين الذين يعانون من القدم المسطحة المرنة مقارنة بالأصحاء

يهدف البحث إلى دراسة التحليل الحركي في كلا من الأشخاص البالغين الذين يعانون من القدم المسطحة المرنة والأشخاص الأصحاء أثناء دورة المشي . أجريت الدراسة على ثلاثين شخص وتم تقسيمهم إلى مجموعتين متساويتين تتكون كل مجموعة من خمسة عشر شخصا . المجموعة الأولى وهى مكونة من خمسة عشر شخصا يعانون من القدم المسطحة المرنة بينما تكونت المجموعة الثانية من خمسة عشر شخصا من الأصحاء الذين لا يعانون من أي مشاكل في الجهاز العضلي الهيكلي ومتقاربين مع المجموعة الأولى في نفس الفئة العمرية – الطول – الوزن- الجنس (ذكور) - المستوى الاجتماعي والمادي . تم دراسة التحليل الحركي لكلا المجموعتين داخل معمل التحليل الحركي أثناء دورة المشي وقد أظهرت النتائج عدم وجود اختلاف في مقاييس التحليل الحركي أثناء دورة المشي بين المجموعتين سواء في (طول الخطوة – زمن الخطوة – سرعة المشي – التغير الزاوي لمفاصل الحوض والفخذ والركبة والكاحل – هذا بالإضافة إلى مقدار العزوم حول مفاصل الطرف السفلى الفخذ والركبة والكاحل) .