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Original Research Article

STUDY OF VERTICAL GROUND REACTION FORCES AND GAIT PARAMETERS IN CONSERVATIVELY OR SURGICALLY TREATED CTEV CHILDREN

Dev Reshi Kumar Pandey[1], Ripudaman Sharma[2], Suhail Wani[3], Ritika Kansal[4], Amit Joon[5]

[1]Associate Professor, Department of Orthopedics, GS Medical College & Hospital Pilkhuwa, Hapur, Uttar Pradesh, India
[2]Assistant Professor, Department of Orthopedics, GS Medical College & Hospital Pilkhuwa, Hapur, Uttar Pradesh, India
[3]Senior Resident, Department of Orthopedics, GS Medical College & Hospital Pilkhuwa, Hapur, Uttar Pradesh, India
[4]Associate Professor, Department of Pathology, GS Medical College & Hospital Pilkhuwa, Hapur, Uttar Pradesh, India
[5]Associate Professor, Department of Community Medicine, GS Medical College & Hospital Pilkhuwa, Hapur, Uttar Pradesh, India

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Corresponding Author:
Dr. Suhail Wani
Email: shlwn@outlook.com

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Abstract

Background: Clubfoot with unknown etiology is a foot deformity. It can be unilateral or bilateral. None of the treatment method for Congenital talipes varus (CTEV) is ideal. It includes conservative and surgical method. Gait analysis is the evolving method to assess the functional outcome in treated clubfoot children. The objective of the study was to find out the efficacy of treatment in respect to the selected measures from vertical ground reaction force variables and gait parameters in treated CTEV children. **Materials and Methods:** Total 60 treated unilateral clubfoot children of 6 to 12 years of age group with conservatively treated (n=30) and surgically treated (n=30) were recruited to assess gait cycle properties, step time parameters and vertical ground reaction force variables. Comparison was done between these two treated groups. Age and sex matched healthy control (n=30) were also taken for comparison with these treated group. **Result:** No significant difference was found between surgically and conservatively treated clubfoot children. But there was significant difference, when comparison was made with control group. Step time parameters were decreased in clubfoot children. Forces over MLF, MLM and MLR are increased. This shows that the child puts most of the weight on lateral border of foot. **Conclusion:** The study confirms that even after treatment, gait parameters do not reach normal levels. Gait analysis can be used to quantify gait pattern characteristics and is helpful in evaluation and further development of treatment of patients.

INTRODUCTION

Clubfoot is a hard deformation described by reversal, adduction, and equinus that regularly require careful intercession.[1] Clubfoot, termed congenital talipes equino-varus, is a complex paediatric foot deformity with an incidence of about 1 in every 1000 births.[2] It is characterized by three-dimensional deformities such as forefoot adductus, midfoot cavus, hindfoot varus, and ankle equinus.[3] Several surgical techniques (soft tissue release, arthrodesis) have been used to correct clubfoot in the past few decades.[4-6] However, nonsurgical treatment strategies such as physiotherapy, casts, and braces have been considered the most effective methods and widely accepted by orthopaedic surgeons.

Surgically treated clubfoot may be associated with many complications, including scar contracture, neurovascular injury, wound infection, and limb length discrepancy. Although conservative treatment is generally considered a good choice, treatment of clubfoot in its advanced stages remains challenging for paediatric orthopaedic surgeons.

In our study residual in toeing, mild foot drop, weak plantar flexor power, a possible residual inversion deformity of the foot, increased frequency and decreased duration of cycle and asymmetry in gait were the main characteristics of gait of children with treated CTEV.

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In this study, the latest objective assessing of gait pattern characteristics by means of kinematics and dynamics in control, conservatively treated and surgically treated cases of CTEV had been compared.

MATERIALS AND METHODS

Present study was conducted on the patients of CTEV, in orthopaedic department of GSMCH, pilkhuwa. It was done over a period of year from Jan 2022 to Dec 2022. Children with age of 6 to 12 years, who had already taken conservative or surgical treatment and were not awaiting for further treatment and with plantigrade feet (pirani score<1) were included in this study. After taking ethical clearance, total 30 conservatively treated and 30 surgically treated club foot children were recruited and informed consent form was taken from their parents and guardians. All recruited children were with unilateral CTEV. 30 normal control children who were age and sex matched were also recruited from outpatient clinics. They had no any musculoskeletal or neurological abnormalities.

Ultraflex unit (Gait analysis system) was used for data collection. Ultraflex unit with 16 channels is a portable modular programmable system. It has computer dynography (CDG). The complete ultraflex gait analysis system consists many parts.

CDG shoes with sensors: CDG shoes with 8 Load sensors at sole in each, are designed to measure and record the normal forces under foot during walk. Cables attached to sole transfer the normal forces data to Ultraflex unit for recording.

Measurement unit: It is a portable measurement unit, used to record normal ground reaction forces during walk. All recorded data are to be stored in the memory card.

Ultraflex optical link cable: It is made up of glass fibre and used for high speed transfer.

Cords: Used to connect ultraflex measurement unit to the computer for data analysis.

Straps: Used to fix the cord with the body so that the patients have no problem in walking.

Methods of data collection

Ultraflex unit was set around the waist of each subject and a pair of CDG shoes of approximate size was put on foot. The subjects were then given 2 minutes of familiarization time. After this the patients were asked to walk straight for ten meters at their natural speed in corridor. Data was then taken for 20 seconds of gait cycle. The recorded data was then transferred to processor by link cables. Data analysis was done from fifth to fifteenth second of gait as it was considered to represent natural gait pattern. Gait parameters and vertical ground reaction forces assessment is done by measuring the following data -

Gait cycle properties: It includes gait cycle duration, frequency and symmetry.

Step time parameters: It includes single support time, double support time, stance time, step time and single swing time.

Vertical ground reaction forces variables and force graphics: It includes heel on, mid stance and toe off.

RESULTS

Gait cycle informatons including step time parameters and vertical ground reaction force variables of all 30 club foot treated patients are shown in [Table 1 and 2]. These information were collected by using ultraflax unit from histogram and force graphics. Although gait of patients of treated CTEV patients looks apparently similar to control subjects but significant changes in mean values were observed when conservatively and surgically treated CTEV patients were compared with age and sex matched healthy control. There were no significant changes in all parameters when comparison was made between conservatively and surgically treated CTEV patients.

Increased frequency and decreased cycle duration were observed in both conservatively and surgically treated CTEV patients. All the step time parameters were observed reduced in these patients even after treatment. It was seen that the center of gravity is also shifted towards affected side in unilateral CTEV patients and thus the symmetry is also disturbed. Gait analysis shows that center of pressure is shifted towards lateral side in the affected foot in club foot patients. Vertical ground reaction forces were mainly distributed over lateral border of foot. Increased forces over MLF, MLM and MLR shows that the child puts most of the weight on lateral border of foot.

Force graphics shows that patient faces difficulty to maintain balance and takes more time in stabilizing the affected foot on ground.

Table 1: Comparison of step time parameters of conservatively treated and surgically treated CTEV patients with control group.

Step Time Parameters	Control	Conservatively treated	Surgically treated
Single Support Time	.83±.11[b,c]	.30±.02[a]	.33±.08 [a]
Double Support Time	.45±.03[b,c]	.15±.03[a]	.17±.06 [a]
Stance Time	.99±.01[b,c]	.57±.10[a]	.60±.04 [a]
Step Time	.75±.01[b,c]	.45±.01[a]	.46±.07 [a]
Single swing	.86±.01[b,c]	.36±.01[a]	.39±.12 [a]

$p<0.001$ is significant using paired t test denoted as 'a' for control, 'b' for conservatively treated, 'c' for surgically treated

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Table 2: Comparison of VGRF of conservatively treated and surgically treated CTEV patients with control group.

VGRF	Control	Conservatively treated	Surgically treated
Heel	21.5±.89 [b,c]	13.4±.93[a]	14.3±2.2[a]
MLR	64.5±6.3 [b,c]	94.5±6.3[a]	92.8±6.0[a]
MMR	50.0±12.9 [b,c]	9.5±12.9[a]	11.5±4.5[a]
MLM	21.1±5.2 [b,c]	91.1±5.2[a]	88.9±5.0[a]
MMM	40.8±1.9 [b,c]	17.8±1.9[a]	18.9±2.5[a]
MLF	37.9±4.9 [b,c]	50.4±4.9[a]	48.0±4.6[a]
MMF	41.0±3.14 [b,c]	21.0±3.1[a]	22.5±3.4[a]
TOE	59.1±2.5 [b,c]	15.6±2.5[a]	17.0±2.9[a]

MMF-midsole medial front, MLF-midsole lateral front, MMM-midsole medial middle, MLM-midsole lateral middle, MMR-midsole medial rear, MLR-midsole lateral rear. $p<0.001$ is significant using paired t test denoted as 'a' for control, 'b' for conservatively treated, 'c' for surgically treated.

DISCUSSION

The current study analysed and evaluated the functional gait parameters. Study of Otis et al also assessed the data of clubfoot surgery with gait analysis utilising cadence parameters and EMG data.[7] One of the previous study suggested that in treated clubfoot patients centre of pressure is shifted towards lateral side of foot as compared with control.[8] This is in line with our study, the values of vertical ground forces, MLF, MLM & MLR were found to be significantly increased in conservatively and surgically treated patients, as compared with control. Cyclogram shows that centre of gravity is shifted towards affected side in unilateral club foot, thus showing the asymmetry in walking.

Davies et al discovered powerless lower leg plantar flexors with diminished scope of development of the lower leg, besides strange minutes around the knees and hips.[9] This shows that patient faces trouble in keeping up equilibrium and takes additional time in settling the influenced foot on ground. Term of mid position stage was expanded in both one-sided and respective club foot bunch when contrasted with controls. In our examination appropriation of ground response powers more than 8 sensors was recorded during stride. Powers were for the most part dispersed along the horizontal line of the foot. Davis et al,[10] tracked down that sidelong ground response powers in kids with clubfoot was more prominent than that of typical youngsters. Aronson and puskarich 8 discovered expanded pressure along the fifth metatarsal while Widhe and Berggren,[11] showed a shift towards the horizontal. Every one of these discoveries show a potential remaining reversal disfigurement of the foot, which causes parallel boundary strolling. Front ground response power was discovered to be feeble which suggests absence of push off that is frail plantar flexor action.

The current literature reveals that in clubfoot patients who are not awaiting any further treatment, gait parameters do not reach normal levels.

CONCLUSION

Thus this study recommends that there is not much difference in the results of the conservative and surgical methods of interventions, So the patients should first opt the conservative method and if the significant improvement is not seen with time then only he or she should go for surgical intervention. This study also suggests that Gait analysis can be used to quantify gait pattern characteristics and may be helpful in evaluation of patients needing further surgical intervention and development of treatment protocols of patients with clubfoot.

Power training of plantar flexors in the club foot patients to facilitate larger ankle movement thereby reducing the loads on the knee and hip joints.

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