

Effects of UCBL and Custom Made Semi-rigid Insole on Pedobarographic Parameters in Pediatric Flexible Flat Foot

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Introduction

Pediatric flexible flat foot (PFFF) is often associated with pain along the medial longitudinal arch and potential disability, and it can lead to severe pes plano valgus deformity in adults, thereby leading to the requirement of surgical treatments. Therefore, several conservative treatment methods, from intrinsic muscle exercises to orthosis, including UCBL and custom made semi-rigid insole. Pedobarography is a method that enables measurement of pressure between the foot and the floor during dynamic loading. Pedobarography analysis shows that the distribution of plantar pressure of the foot. The aim of this study is to investigate and compare the effect of UCBL and custom made semi-rigid insole on pedobarographic and radiologic parameters in PFFF.

Methods

We retrospectively recruited 143 children diagnosed with PFFF between the ages of 4 and 12 years during the period of June, 2014 through June, 2021. Of this group, 119 patients were excluded because of missing data, other medical and neurological conditions that may affect the flat foot, leaving 24 patients was available for analysis. A total of 48 cases were analyzed for the left and right feet of 24 participants. On the weight bearing foot lateral radiographs, calcaneal pitch angle and medial cuneiform

height were measured for analysis of PFFF. Participants measured pedobarography via EMED® n-50 system (Novel GmbH, Munich, Germany). Plantar pressure was determined using standard pedobarography diagnostic, computer recorded parameters: peak pressure (kPa) and maximal force (Ns) and contact area (cm²). The center of pressure excursion index (CPEI) (%) was calculated according to pedobarographic data. Pedobarography and X-ray were measured before wearing orthosis and 1-year after wearing orthosis. The Mann-Whitney U test was used to compare the difference (Δ) of radiographic and pedobarographic parameters between UCBL and custom made semi-rigid insole groups. Wilcoxon signed ranked test was used to compare the parameters measured before orthosis application and 1 year after orthosis application. Statistical analysis was performed using SPSS version 21.0 (IBM SPSS, Armonk, NY, USA), and p-values less than 0.05, were considered statistically significant.

Results

Table 1 showed the baseline characteristics of participants. The baseline radiographic and pedobarographic parameters showed no significant difference between UCBL group and custom made semi-rigid insole group. In this study, there was significant Δ CPEI between two groups. (Table 2) In custom made semi-rigid insole group, the contact area ratio of midfoot and toe, and CPEI at 1-year after wearing insole was significantly different compared with UCBL group. (Table 3) In custom made semi-rigid insole group, the medial cuneiform height and CPEI were significant improved 1 year after application of insole.

Conclusion

This result showed that custom made semi-rigid insole is more effective for the

improvement in the deviation of the center pressure curve and the medial longitudinal arch. The custom made semi-rigid insole might help relieve foot pain and improve the medial longitudinal arch in children with PFFF.

Table 1. Demographic data of the participants

Variables	All Patients (N=48)
Age, years	9.74±2.08
Male (%)	61.2%
Type of insole	
UCBL	22
Custom made semi-rigid insole	26
Side of analysis	
Right	24
Left	24
Calcaneal pitch angle (degree)	14.42±4.82
Medial Cuneiform height(mm)	19.63±4.10
Maximal force (total) (Ns)	412.35±83.71
Maximal force (hindfoot) (Ns)	269.74±55.96
Maximal force (midfoot) (Ns)	105.16±36.41
Maximal force (forefoot) (Ns)	293.13±79.33
Maximal force (toe) (Ns)	98.50±36.70
Peak pressure (total) (kPa)	430.33±125.59
Peak pressure (hindfoot) (kPa)	313.74±93.26
Peak pressure (midfoot) (kPa)	107.33±29.43
Peak pressure (forefoot) (kPa)	274.12±73.95
Peak pressure (toe) (kPa)	337.20±167.13

Table 2. Comparison of Radiographic and Pedobarographic Measurements between UCBL and Semi-rigid Insole Group

	UCBL group	Semi-rigid insole group	P-value
ΔCalcaneal pitch angle(degree)	1.99±3.16	2.11±2.69	0.87
Δmedial cuneiform height (mm)	2.67±3.24	2.89±3.96	0.71
ΔMaximal force ratio (hindfoot) (Ns)	-0.03±0.09	-0.03±0.10	0.28
ΔMaximal force ratio (midfoot) (Ns)	-0.01±0.03	-0.00±0.06	0.41
ΔMaximal force ratio (forefoot) (Ns)	0.06±0.12	0.07±0.09	0.64
ΔMaximal force ratio (toe) (Ns)	0.01±0.06	-0.02±0.08	0.16
ΔPeak pressure ratio (hindfoot) (kPa)	-0.10±0.21	-0.03±0.11	0.44
ΔPeak pressure ratio (midfoot) (kPa)	-0.01±0.08	-0.03±0.12	0.79
ΔPeak pressure ratio (forefoot) (kPa)	0.08±0.15	0.08±0.20	0.69
ΔPeak pressure ratio (toe) (kPa)	0.06±0.18	-0.06±0.24	0.10
ΔContact area ratio (hindfoot) (cm ²)	-0.00±0.15	-0.01±0.01	0.44
Δ Contact area ratio (midfoot) (cm ²)	0.00±0.03	0.01±0.02	0.20
Δ Contact area ratio (forefoot) (cm ²)	-0.01±0.02	0.01±0.05	0.02
Δ Contact area ratio (toe) (cm ²)	0.01±0.04	0.01±0.04	0.22
ΔCPEI (%)	0.03±0.08	-0.02±0.17	0.00*

Δ, Difference

*p<0.05

Table 3. Comparison of Radiographic and Pedobarographic Measurements at 1-year after orthosis application between UCBL and Semi-rigid Insole Group

	UCBL group	Semi-rigid insole group	P-value
Calcaneal pitch angle (degree)	17.04±1.06	15.21±4.26	0.40
medial cuneiform height (mm)	25.22±6.39	20.20±3.67	0.05
Maximal force ratio (hindfoot) (Ns)	0.62±0.07	0.65±0.09	0.48
Maximal force ratio (midfoot) (Ns)	0.29±0.09	0.26±0.12	0.19
Maximal force ratio (forefoot) (Ns)	0.76±0.07	0.79±0.06	0.17
Maximal force ratio (toe) (Ns)	0.23±0.07	0.26±0.07	0.23
Peak pressure ratio (hindfoot) (kPa)	0.62±0.21	0.74±0.20	0.07
Peak pressure ratio (midfoot) (kPa)	0.28±0.11	0.23±0.08	0.14
Peak pressure ratio (forefoot) (kPa)	0.68±0.24	0.77±0.19	0.28
Peak pressure ratio (toe) (kPa)	0.80±0.24	0.71±0.22	0.18
Contact area ratio (hindfoot) (cm ²)	0.24±0.03	0.24±0.02	0.99
Contact area ratio (midfoot) (cm²)	0.27±0.04	0.24±0.04	0.03*
Contact area ratio (forefoot) (cm ²)	0.38±0.02	0.38±0.02	0.62
Contact area ratio (toe) (cm²)	0.13±0.02	0.14±0.02	0.01*
CPEI (%)	0.19±0.09	0.15±0.16	0.02*

*p<0.05

Table 4. Comparison of Radiographic and Pedobarographic Measurements between before orthosis application and 1-year after orthosis application in Semi-rigid Insole Group

	Before orthosis application	1-year after orthosis application	P-value
Calcaneal pitch angle (degree)	13.71±4.55	15.21±4.26	0.059
medial cuneiform height(mm)	20.04±3.64	20.20±3.67	0.037*
Maximal force ratio (hindfoot) (Ns)	0.67±0.08	0.65±0.09	0.106
Maximal force ratio (midfoot) (Ns)	0.23±0.08	0.26±0.12	0.783
Maximal force ratio (forefoot) (Ns)	0.71±0.10	0.79±0.06	0.001*
Maximal force ratio (toe) (Ns)	0.27±0.11	0.26±0.07	0.200
Peak pressure ratio (hindfoot) (kPa)	0.77±0.17	0.74±0.20	0.274
Peak pressure ratio (midfoot) (kPa)	0.25±0.12	0.23±0.08	0.465
Peak pressure ratio (forefoot) (kPa)	0.73±0.20	0.77±0.19	0.072
Peak pressure ratio (toe) (kPa)	0.77±0.22	0.71±0.22	0.249
Contact area ratio (hindfoot) (cm ²)	0.25±0.03	0.24±0.02	0.062
Contact area ratio (midfoot) (cm ²)	0.22±0.05	0.24±0.04	0.067
Contact area ratio (forefoot) (cm ²)	0.37±0.05	0.38±0.02	0.570
Contact area ratio (toe) (cm ²)	0.14±0.03	0.14±0.02	0.548
CPEI (%)	0.16±0.06	0.15±0.16	0.002*