

Effects of Biomechanical Foot Orthoses on the Resting Calcaneal Stance Position Angle in Flatfoot Children

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Introduction

Flatfoot is a prevalent condition in pediatric rehabilitation departments, characterized by a loss of the foot's medial longitudinal arch, leading to pain and balance issues. While commonly diagnosed in early childhood, its incidence varies with age, with some studies suggesting arch formation by age 10. Persistence of flatfoot can cause secondary deformities and impact the quality of life. Various assessment methods exist, and risk factors include age, gender, BMI, joint hypermobility, neuromuscular disorders, hereditary conditions, injuries, and skeletal abnormalities. Treatment options encompass conservative and surgical interventions, with biomechanical foot orthoses (BFO) commonly used as a conservative approach. However, the quantitative effects of BFO in children with flatfoot remain underexplored.

Methods

This retrospective study collected data from 77 flatfoot patients at a rehabilitation department in Daegu Fatima Hospital. Inclusion/exclusion criteria were established. The study measured the resting calcaneal stance position (RCSP) angle as an indicator of flatfoot severity. Customized BFOs were prescribed based on the severity of flatfoot. Statistical analyses, including paired t-tests and independent t-tests, were conducted to assess changes in RCSP angles and compare variables among patient groups.

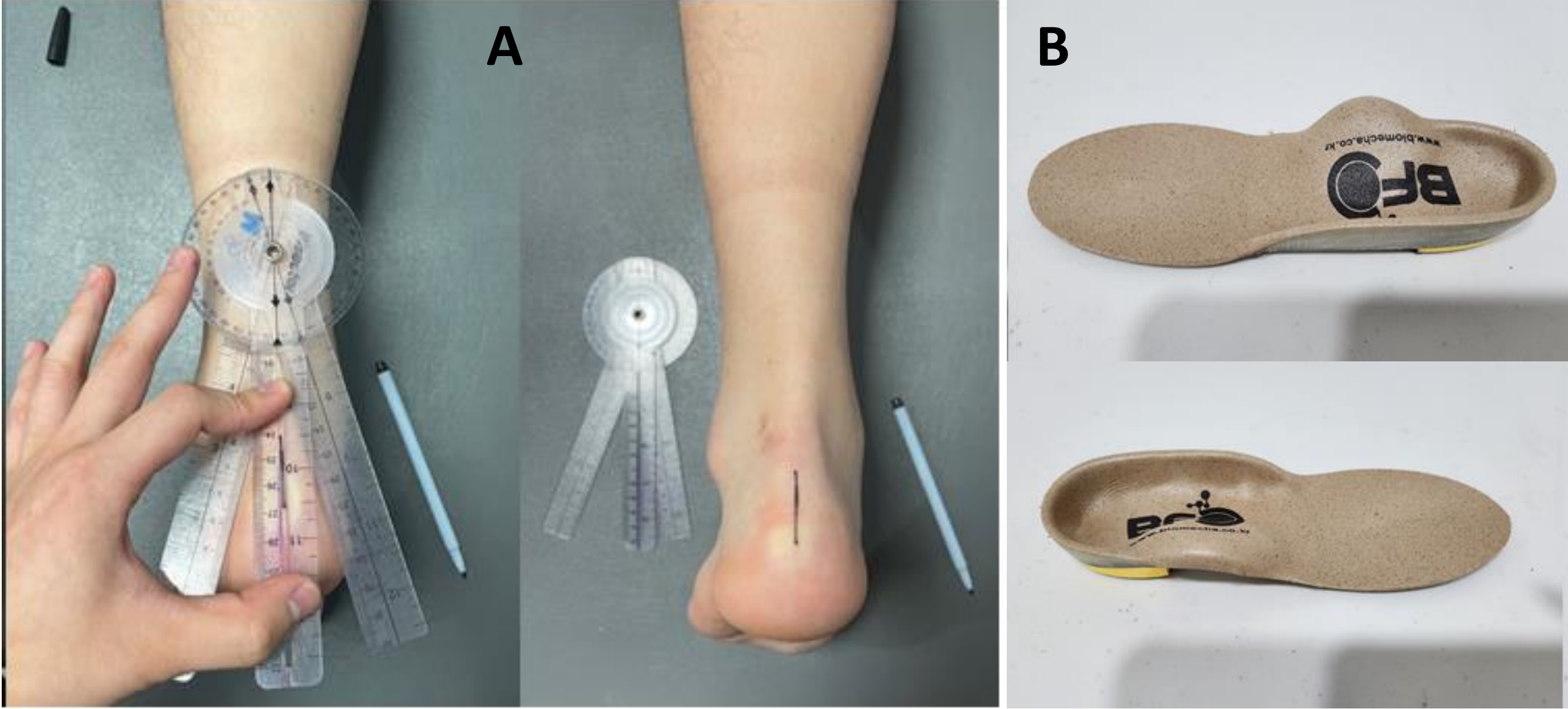


Figure 1. (A) Measuring the RCSP angle. (B) Customized BFO manufactured based on the inverted technique (GeoMedi, co., Uiwang, South Korea)

Sex	Age	BMI	BFO start (in months)	RCSP angle				RCSP angle difference	
				Rt. 1st	Lt. 1st	Rt. 2nd	Lt. 2 nd	Right	Left
Boys (N=50)	10.98 ±2.52	19.56 ±4.46	98.72 ±30.15	-8.96 ±9.52	-7.60 ±3.46	-5.56 ±2.70	-4.92 ±2.93	3.40 ±2.69	2.68 ±2.29
Girls (N=27)	11.19 ±2.48	18.46 ±3.31	102.37 ±32.65	-8.15 ±3.64	-7.85 ±3.86	-5.19 ±3.43	-4.89 ±3.19	2.96 ±2.55	2.96 ±2.92
Total (N=77)	11.05 ±2.49	19.17 ±4.10	100.00 ±30.89	-8.68 ±3.56	-7.69 ±3.58	-5.43 ±2.96	-4.91 ±3.00	3.25 ±2.64	2.78 ±2.51

Table 1. Characteristics of the normal group and flatfoot group

Group	Age	BMI	BFO start (in months)	RCSP angle				RCSP angle difference	
				Rt. 1st	Lt. 1st	Rt. 2nd	Lt. 2 nd	Right	Left
Severe group (N=34)	11.21 ±2.03	18.86 ±3.13	87.46 ±31.90	-11.82 ±2.25	-10.50 ±2.56	-7.18 ±2.97	-6.62 ±2.96	4.65 ±2.70	3.88 ±2.69
Mild to moderate group (N=43)	10.93 ±2.82	19.42 ±4.76	102.37 ±32.65	-6.19 ±2.15	-5.47 ±2.58	-4.05 ±2.12	-3.56 ±2.27	2.14 ±2.01	1.91 ±1.99
P-value	0.633	0.559	0.176	0.000	0.000	0.000	0.000	0.000	0.000

Table 2. In a comparison between groups divided by severity of flatfoot, the improvement in RCSP angle was found to be greater in the severe group.

Results

The study comprised 77 flatfoot patients (50 boys, 27 girls) with mean age 11.05 ± 2.49 years, BMI 19.17 ± 4.10, BFO prescription age 100 ± 30.89 months, and follow-up duration 27.79 ± 20.97 months, showing no gender-based differences.

Post BFO prescription, significant improvement in RCSP angles for both feet was noted ($p \leq 0.001$). Initial RCSP angles were -8.68 ± 3.56 and -7.69 ± 3.58 , while follow-up angles were -5.42 ± 2.96 and -4.90 ± 3.00 for the right and left foot respectively, with gender-based analysis demonstrating similar improvement ($p \leq 0.001$).

Patients categorized by flatfoot severity—severe (RCSP angle < -10 degrees in either foot) and moderate to mild—highlighted significantly greater RCSP angle improvement in severe cases ($p \leq 0.001$), despite no age, BMI, or BFO prescription age differences.

Comparing RCSP angle improvements (>4 degrees vs. ≤4 degrees) showed significant disparity ($p \leq 0.001$) while revealing no age, BFO prescription age, or BMI differences between groups.

Group	Age	BMI	BFO start (in months)
Improvement of more than 4 degrees (N=40)	11.55 ±2.48	19.20 ±3.56	100.43 ±33.32
Improvement of less than 4 degrees (N=37)	10.51 ±2.42	19.14 ±4.67	99.54 ±28.47
P-value	0.068	0.955	0.901

Table 3. Comparison of the mean values for age, BMI, and age at the time of first BFO prescription between the groups whose RCSP angle improved by more and less than 4 degrees using the independent t-test.

Conclusion

This study confirms the efficacy of BFOs in improving RCSP angles in children with flat feet over a follow-up period of more than 2 years, irrespective of age, gender, BMI, or initiation age of BFO use. Despite the study's limitations in terms of being retrospective and lacking a control group, these findings signify the potential benefits of BFOs in managing flatfoot. Further research with larger sample sizes and controlled studies is warranted to validate these observations and enhance our understanding of flatfoot management strategies.