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Foot Taping versus Medical Shoes on Kinematic Gait Parameters In Children With Down's Syndrome

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Abstract: Children with Down syndrome (DS) frequently have flatfoot deformity. The objective of this study was to assess the difference between taping and medical shoes as means of foot arches support. Thirty children with DS were randomly recruited and assigned to one of the next two groups; DS taping and DS shoe group. Kinematic gait parameters were measured before using assigned interventions and during application of interventions using footprint analysis. Results showed improved gait parameters(velocity, Base of Support, Stride length and Step length) in both groups during application of interventions compared to pre intervention measures. When both interventions were compared to each other no significant differences between groups were detected. Conclusion: both taping and medical shoe were equally effective in improving kinematic gait parameters in children with DS.

Key words: Down syndrome · Taping · Medical shoe · Flatfoot

INTRODUCTION

Down syndrome (DS) is a genetic disorder caused by an extra chromosome 21 present in all or some of the individual's cells [1-3]. Children with DS have qualitative differences in gait patterns. Fifty percent of all children with DS have gait problems [1].

Flat foot is a common deformity in children. It can be described as "generalized ligaments laxity in the foot in which the foot has an abnormally low or absent arch. Flat foot is associated with pronated foot [4, 5]. Flat foot deformity secondary to ligaments laxity is observed in more than 90% of persons with DS [3]. Wide-based gait and tendency to rotate foot and ankle externally also contribute to pronation and collapse of the midfoot [3, 4, 6]. Concolino *et al*., (2006) reported that in 50 children with DS showed several orthopedic anomalies including flat foot (60%) and pronated flat foot (16%) [4].

Temporal-distance (TD) measurement methods were applied in this study to measure kinematic gait parameters. Footprint analysis was documented widely as a feasible, valid and reliable clinical and research tool. The main outcome measures of this method are: Stride length, step width, step length, walking velocity and degree of toe out [7, 8. several studies believed that medical shoe is most appropriately used for flexible flat foot children [2] and found that medial support in a shoe may provide increased foot stability and reduce maximal pronation [12, 10].

Garcia-Rodriguez, (1999) found that corrective footwear confines the foot in a rigid mold that limits normal function of extrinsic and intrinsic muscles of the foot. Furthermore, insole arch supports remove the usual alternating stimuli that strengthen the foot muscles that maintain arches [11]. The immobilization of a joint with orthotics during gait results in increased energy cost, decreased cadence and reduced walking speed in normal individuals [12, 13].

The habit of walking barefoot during the first years of life in Indian children was reported as a possible reason for the proportional increase in the height of the medial longitudinal foot arch in comparison with Europeans [14]. Ankle taping was reported to correct mal alignment of the foot depending on mechanical and physiological effects by ability of taping to stiffen ankle joint and limits hyper mobility and improves gait pattern [15, 16].

Existing evidence supports that tape changes foot and leg posture through increasing navicular bone height, medial longitudinal arch height, calcaneal eversion and alteration of plantar pressure patterns [17]. Taping may

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enhance joint position sense and improve orientation of the plantar surface of the foot with respect to the leg [18].

Taping can be effective in supporting the longitudinal arch whilst not encompassing the whole foot and again is adapted in order to leave the weight bearing section of the heel and first metatarsal head free for barefoot and places the subtalar joint near neutral position [19].

Based on available literature it was the idea that we would test for evidence whether taping would be a feasible replacement of medical shoe in managing flat foot deformity in children with DS. To our best knowledge. It has not yet been identified which would be more efficient in improving kinematic gait parameters in children with DS, using medical shoes or foot taping, immediately following application of either interventions. The aim of this study was to compare immediate effects of taping and medical shoes on kinematic gait parameters in Saudi children with DS. It was hypothesized that there was no significant difference between taping and medical shoes in immediate improvement of kinematic gait parameters in children with DS.

MATERIALS AND METHODS

Subjects' Selection: This study included 30 children with DS, age ranged between 3:5 years (11 boys and 14 girls). Children were randomly recruited from children lists at "The Down Syndrome School in Riyadh", through selecting names from school lists allocating 4th child out of each set of 5 children starting by 3rd set of 5 in school's registry.

Children with DS were included in the study if they had flexible flat foot deformity, did not used any medical shoes orthosis before, had been walking for at least one year and had no other significant lower limb deformities other than flat foot. Children with DS were excluded from the study if they had over weight or obesity according to BMI, any significant skeletal disorder that might affect gait other than foot deformity.

When thirty children were already recruited, their names were randomly listed and assigned to taping or medical shoes groups by selecting odd numbers in the list to join first group and even numbers to join second group respectively (Fig. 1).

Parents got full explanation of study's aims and procedures, signed a questionnaire describing child's medical history and signed informed consent forms prior to enrollment of their children in this study. This study was approved by ethics committee of the Rehabilitation Department at College of Applied Medical Sciences in King Saud University.

Methods

Design: Comparative Study: For assessment of kinematic data using footprint method, absorbent paper walkway (8m x 1m) was set. Walkway was affixed with brown

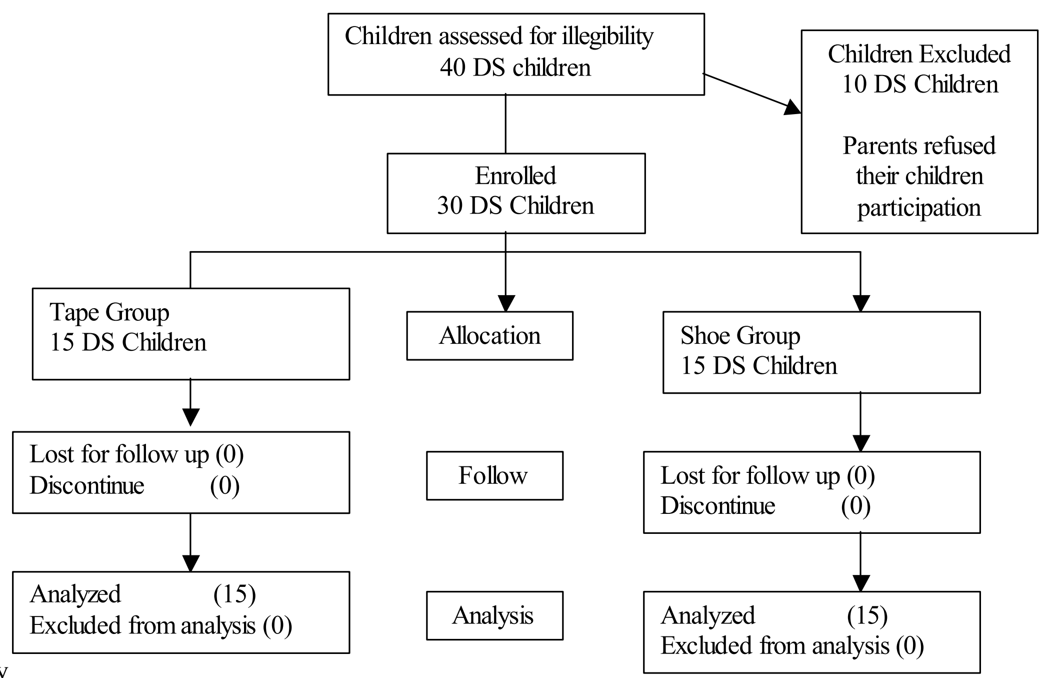


Fig. 1: Study

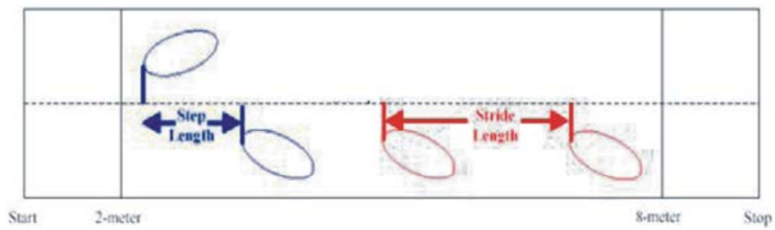


Fig. 2: Measurements of step length and stride length on foot print.

heavy-duty tape to prevent any slippage during data collection. Ink pad impregnated with non-toxic ink was used to provide footprints. Martin Stop watch (office depot, USA) was used to record time to calculate velocity (Velocity= Distance/ Time). One meter standard plastic ruler (rapid elect, Ltd, UK) was used to measure step length and stride length. SECA (medic scale, SECA corp. Ger.) was used to measure a height in centimeters and weight in kilograms for each child. Shoes of the same brand and model, with prefabricated shoe insert (Kiddythotics, Prolab, USA) for foot arches support, provided in different sizes to fit all children sizes in medial shoe group. Peha Haft tape (Heidenheim, Ger., size 4cm x 4m) was used for taping procedures.

Procedures: A well trained physiotherapist measured children heights and weights as well as the kinematic gait parameters. He was unaware with the treatment allocation groups (Taping or medical shoes). BMI was calculated. During assessment, every child removed his/her shoes and sat on a chair in the end of a walkway. The child was asked to walk at his/her comfortable speed across the paper looking straight ahead. The child walked once forward and backward the eight meters length of paper (no ink), to become familiar with the testing procedure, followed by a five-minute rest. Then two trials with non-toxic ink were performed separated by a five minute rest. The child was asked to walk normally at a self-selected velocity along the eight meters walkway to the chair at the end of paper. Then tape group children were taped and walked with taping along the walkway once more. Shoe group children walked wearing medical shoes along the walkway [7].

All measures were taken along six meters of the walkway starting by third step, to eliminate the effects of acceleration and deceleration at the beginning and end of walking respectively. Timer on the stopwatch was set from the third step to the line drawn at the far end of the walkway.

Spatial parameters were taken directly from average of two sets of footprints. A reference point was identified at the most posterior point of each foot print. Base of support (BOS) was measured as the perpendicular distance between reference point and midline. Step length measured as the distance on midline between reference points of two successive prints of opposite feet. Stride length measures as the distance on midline between reference points of two successive prints of the same foot (Fig. 2). Statistical analysis was conducted by using SPSS version (10.0) and the point of significance was set at $P< 0.05$.

RESULTS

Demographic data of children participating in this study are shown in Table (1). Paired t-test was carried out to compare before and during experiment mean differences in each tested parameter within each group.

In DS taping group significant increments were detected in step length, stride length, velocity and decrement in BOS in “during taping trial” as compared to “barefoot trial” i.e. pre taping trial. In DS shoe group, significant increments/ decrements were also detected in the same tested parameters in “shoe trial” as compared to “barefoot trial” (Table 2, Figs. 3-A and B).

Table 1: Demographic data of all participants

	DS Taping group		DS shoe Group			
	Mean	SD	Mean	SD	t-value	Sig.
Age (years)	3.67	+ 0.72	4.06	+ 0.88	-1.54	0.13
Weight (Kg)	15.61	+ 1.99	16.46	+ 2.74	-1.11	0.28
Height (cm)	98.93	+ 3.15	101.21	+ 6.92	-1.22	0.23
BMI (kg/m^2)	15.49	+ 1.47	16.01	+ 1.67	-1.03	0.31

$P<0.05$

Table 2: Comparison of means of kinematic gait parameters within groups between barefoot and during intervention

		Barefoot		Intervention Tape or Shoe			
		Mean	SD	Mean	SD	t-value	Sig.
DS Taping group	Velocity (cm/sec.)	67.28	10.97	76.29	9.01	-3.46	0.00*
	BOS (cm)	12.63	1.96	9.20	1.17	-8.74	0.00*
	Stride Length (cm)	45.50	7.15	52.47	7.81	-7.09	0.00*
	Step Length (cm)	25.63	4.62	30.73	5.51	-8.76	0.00*
DS Shoe group	Velocity (cm/sec.)	67.48	5.90	77.57	3.54	-8.35	0.00*
	BOS (cm)	11.80	1.06	9.10	1.31	-8088	0.00*
	Stride Length (cm)	44.83	6.05	50.43	6.49	-10.64	0.00*
	Step Length (cm)	26.53	3.72	30.83	4.28	-5.12	0.00*

P<0.05

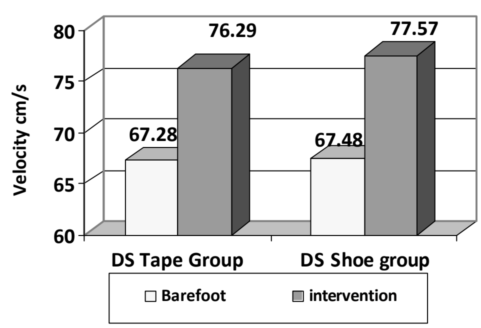
Table 3: Comparison of means of selected kinematic gait parameters between groups during both Barefoot and intervention trials

		DS taping group		DS shoe group		Independent *t*-test	
		Mean	SD	Mean	SD	t-value	Sig.
Velocity(cm/sec.)	Barefoot	67.28	10.97	67.48	5.91	-0.06	0.95
	Intervention	76.29	9.01	77.57	3.54	0.51	0.61
BOS(cm.)	Barefoot	12.63	1.69	11.80	1.06	-1.61	0.12
	Intervention	9.21	1.17	9.11	1.31	0.17	0.86
Stride length(cm)							
	Barefoot	45.51	7.15	44.83	6.05	0.23	0.82
	Intervention	52.46	7.80	50.43	6.49	-0.77	0.44
Step length(cm)	Barefoot	25.63	4.62	26.53	3.72	-0.51	0.62
	Intervention	30.73	5.51	30.83	4.28	0.05	0.95

Significant at P<0.05

Base of support (BOS), Standard deviation (SD)

3A



3B

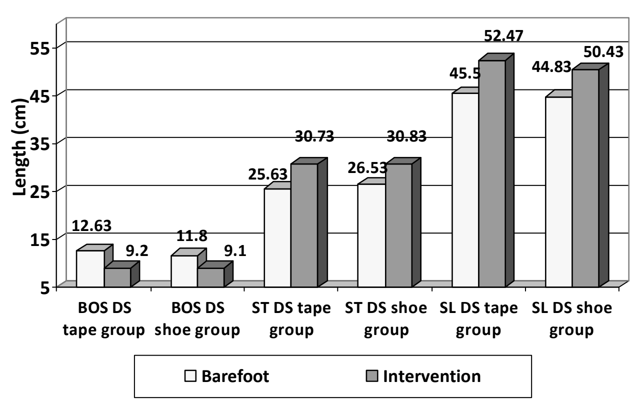
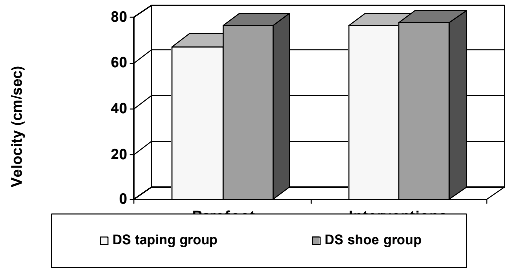


Fig. 3: A-Comparison between mean velocity at barefoot trial and intervention trial in both groups. B-Comparison between mean bases of support (BOS), step length(SL) and stride length(ST) at barefoot trial and intervention trial in both Down's syndrome (DS)groups.

4-A



4-B

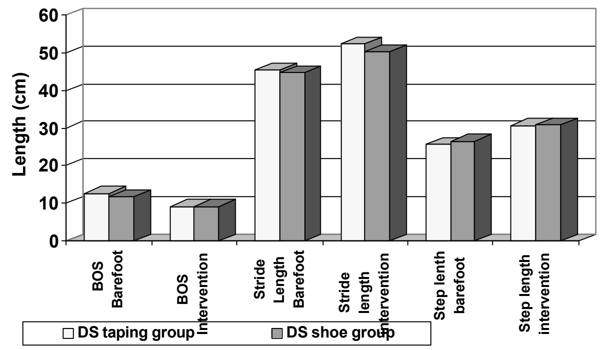


Fig. 4: A-Comparison of mean velocities between groups during barefoot and intervention trials. B-Comparison of mean Base of Support(BOS),step length and strides length, between Down's Syndrome (DS)groups during barefoot and intervention trials.

Independent *t* test was used to test differences between both groups walking barefooted, with tape/ wearing shoes for each gait variables. It was noticed that there were no significant differences between the two groups ($P < 0.05$) in mean values for walking BOS, velocity, step length or stride length, whether in barefoot comparisons or intervention. Comparisons of data are shown in Table (3) and Figs. (4-A and B).

DISCUSSION

Results of this study showed that medical shoe with medial arch support or, low-Dye taping were both efficient in immediate improvement of all selected kinematic gait parameters in children with DS. Arch supports reduce foot pronation and provide more stability of the foot via holding it into a more rigid posture. Besides, arch supports might provide an alternative somatosensory input from sole of the foot, which might aid foot stability and overall body balance, thus aids wider steps, strides, higher velocities and narrower BOS [20].

These results are supported by previous studies that explained effects of medical shoes and foot taping separately. A number of studies believe that the medical shoe is most appropriately used for the flexible flat foot children [2] and found that medial support in a shoe may provide increased stability to foot and leg and may reduce the maximal foot pronation [9]. Likewise, existing evidence suggested that taping reduces pronation, as indicated by shifts in midfoot pressure from medial to lateral, as well as changes in forefoot and hind foot forces [17,18, 21, 22]. Also, taping stiffen the ankle joint and limits the hypermobility and improve the gait pattern [15, 16].

Results showed the comparison between medical shoe and taping on walking velocity, BOS, step length and stride length. Immediate effects of both interventions were insignificantly different from each other. Despite being slightly different, the basic mechanism of both modalities is to support foot arches and reduce foot pronation, which explains the insignificant differences detected. Unfortunately, there were no previous direct comparisons between these interventions in children with DS, or even children with flatfoot deformity in general.

Since it was pointed out in previous literatures that prolonged shoe use in early years of life were more liable to foot deformities than barefoot walkers [10, 14], probably due to prolonged rigid support that might reduce normal muscle strength that supports foot arches. It was found that low-Dye taping might be used to replace medical shoe in correcting flatfoot. Taping would achieve similar outcomes related to mechanical foot support and provide bare weight bearing sections of the heel and forefoot [19].

Since the mechanical support provided by foot taping was reported to tend to reduction within short period of time [22], would it be sufficient to maintain the same gains in kinematic parameters measured in this study over a prolonged period of time is untested.

Considering reported drawbacks of prolonged use of medical shoe in children and possible drawbacks of prolonged use of low-Dye taping, it is suggested that prolonged effects of low-Dye taping on kinematic gait parameters in children with DS as well as the tolerance of the skin of children with DS to prolonged durations of taping should be assessed in future studies.

CONCLUSION

Both foot taping and medical shoe were found equally beneficial in improving walking velocity, BOS, step length and stride length in children with DS. Currently, our best clinical suggestion based on these results is the alternative use of both supportive methods, in a way to achieve benefits and avoid possible drawbacks of each.

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