Weight distributions on soles of feet in the primary and early permanent dentition with normal occlusion

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This study investigated the differences of weight distribution on the sole of the feet in the primary and the early permanent dentition by the modifying Morton staticometer. The distribution of body weight in the outer forward part on soles of feet in the permanent dentition group was significantly greater than that in the primary dentition group. The distribution of body weight in the heel on soles of feet in the permanent dentition group was significantly smaller than that in the primary dentition group. These results indicated that the weight was shifted from the heels to the forefeet from primary to permanent dentition
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INTRODUCTION

Body balance is essential for upright posture and independent walking. Humans are continuously faced with new postural control tasks to which they have to adapt and adjust.[1] In the last years, a number of researches investigated the various determinants that may influence body posture. Respiration, head and neck position, mood states have been assessed to have effects on posture.[2,3,4] Among those determinants, recent studies seem to demonstrate a role of dental occlusion on postural stabilization.[5,6]

Dental occlusion has long been and still is a very controversial field in dentistry.[6] The dentition develops in important ways during childhood and adolescence.[7] The influence on dental occlusion by the masticatory muscle system has been widely studied and discussed in the study of human posture.[6] However, there has been less attention paid to the change of postural stabilization from primary to permanent dentition.

Body posture and its modifications can be measured by different approaches.[8,9] Studies of the distribution of body weight on the sole of the foot have been conducted from various perspectives since the 1920s. It was suggested that the measurement of the distribution of body weight on the sole of the foot could be made more precisely than by other methods such as an analysis of the center of gravity.[9,10] The purpose of this study was to investigate the difference of weight distribution on the sole of the feet in the primary and the early permanent dentition.

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MATERIALS AND METHODS

Subjects

Two groups of healthy volunteers, with no history of vestibular, neurologic, or musculoskeletal diseases were used. Hundred twenty Japanese children (60 boys and 60 girls, age from 2 to 5 years, mean 4.1 years) were selected from local nursery school comprised the primary dentition group. Hundred twenty young Japanese adults (60 males and 60 females, age from 16 to 25 years, mean 18.3 years) were selected from local students comprised the permanent dentition group. All subjects were determined clinically to have normal angle Class I occlusions and gave informed consent but were unaware of the aim of the experiment.

Apparatus

The measurement of the distributed weight on the sole of the foot was done by modifying Morton staticometer. The sole of each foot was divided into three separate areas, the inner forward part (IF) that includes the big toe, the outer forward part (OF) that includes the other four toes, and the heel (H) that includes posterior par. (Figure 1).

The distributed weight was registered by using a power-transforming platform (TROCHE Co., Ltd., Japan) with a personal computer (5523JBW, IBM Co.,

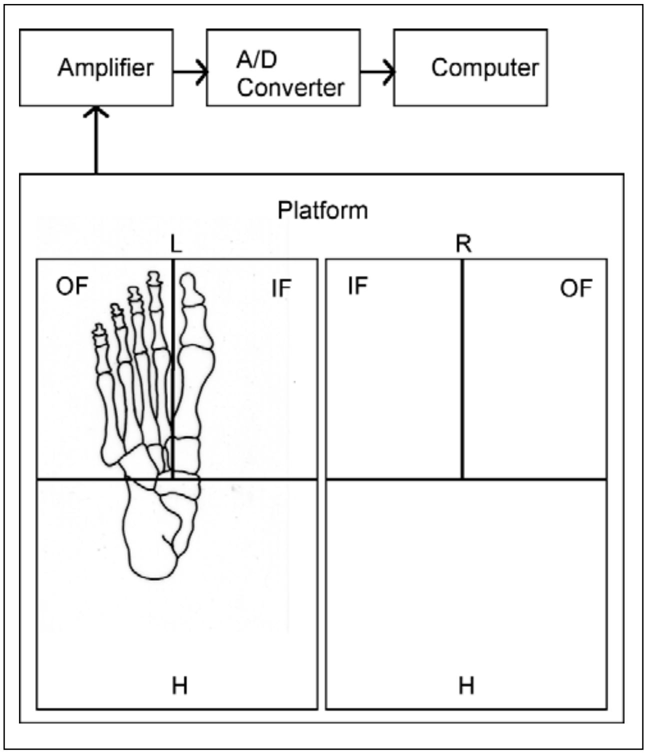

Figure 1. The system for measuring the distribution of weight on each foot in the six areas of the two platforms with foot position. (L: the left foot, R: the right foot, IF: the inner forward part, OF: the outer forward part, H: the heel)

Japan). Output values of the 6 separate areas were recorded simultaneously at completion of the upright posture and then converted into digital signals by an A/D converter. They were interpreted by a computer with reading accuracy of 100 g. The total of 6 values was designated as the body weight of subjects. For the convenience of statistical analyses, the 6 values were converted into percentages by dividing them by the body weight.

Procedure

Subjects were individually tested. While being measured, subjects were asked to stand as still as possible, barefoot, on the platforms. They stood in a comfortable position, with arms relaxed at their sides and feet parallel. The feet were set so that the division lines between the IF and the OF of both feet would coincide with the subject's left and right anterior superior iliac spines. During the test, the subjects were instructed to close the mouth and get the teeth together in his habitual position. They were asked to look at a mark on the wall at eye level while standing for a period of ten seconds and not allowed to move their feet from the initial position.

Statistical Analysis

The significance of differences were tested by analysis of variance (ANOVA) with Student's *t*-test. Probabilities of less than 0.05 were regarded as significant.

RESULTS

Mean percents of the distribution of body weight

The distribution of body weight in the OF on soles of feet in the permanent dentition group was significantly greater than that in the primary dentition group ($p<0.01$ in left foot, $p<0.001$ in right foot). The distribution of body weight in the H on soles of feet in the permanent dentition group was significantly smaller than that in the primary dentition group ($p<0.001$). There were no significant differences in the distribution of body weight in the IF on soles of feet between the primary dentition group and the permanent dentition group (Table 1, Figure 2).

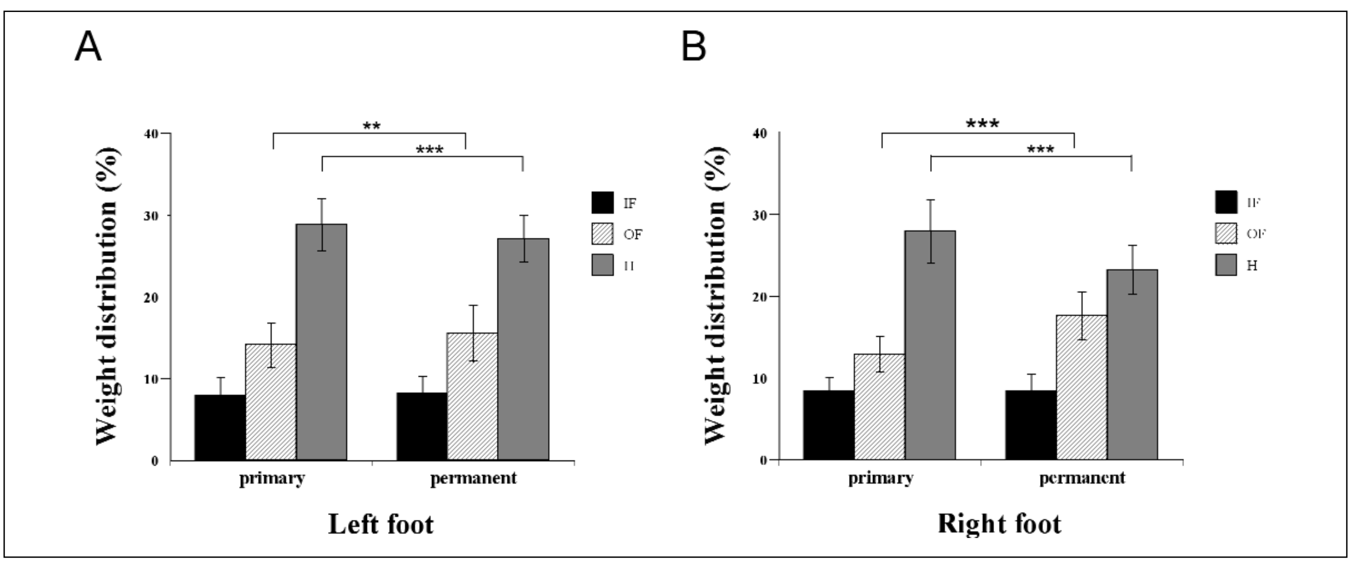

Figure 2. Mean percents of the distribution of body weight on soles of feet in the primary and early permanent dentition. (Primary: Primary dentition group, Permenent: Permanent dentition group, IF: the inner forward part, OF: the outer forward part, H: the heel, ** : p<0.01, *** : p<0.001)

Table 1. Mean percents of the distribution of body weight

		Left			Right		
Subjects	n	IF	OF	H	IF	OF	H
Primary	120	7.9Å}2.2	14.1±2.7	28.8±3.2	8.4±1.6	12.9±2.2	27.9±3.9
Permanent	120	8.2±2.1	15.5±3.4	27.1±2.8	8.3±2.2	17.6±2.9	23.2±3.0

Primary; Primary dentition group, Permanent, Permanent dentition group
IF; inner forward part, OF; outer forward part, H; heel

Table 2. Comparison of the ratio of the distributed weights in six areas.

		Left					Right				
Subjects	n	IF		OF		H	IF		OF		H
Primary	120	1.0	:	1.8	:	3.6	1.0	:	1.5	:	3.3
Permanent	120	1.0	:	1.9	:	3.3	1.0	:	2.1	:	2.8

Primary; Primary dentition group, Permanent, Permanent dentition group
IF; inner forward part, OF; outer forward part, H; heel

The ratio of the distribution of the body weight

The ratios of the distribution of the body weight are shown in Table 2. In the permanent dentition group, subjects had a ratio close to 1:2:3 for weight recorder for IF: OF: H. In the primary dentition group, subjects had a bigger value than 3 for the posterior part.

DISCUSSION

Balance is a somewhat ambiguous term, used to describe the ability to maintain or move within a weight-bearing posture without falling. Balance, whether in its static or dynamic form, is a derivative of postural stability.[11] Posture is not a static equilibrium. It is an active dynamic phenomenon. This may be attributed to the complexity of coordinating the neural, sensory, and musculoskeletal systems involved in maintaining postural stability.[12] At first sight, posture may seem to have a rather remote relationship to the dentition but it is the purpose of this essay to show a very definite connection, not only with its development and plan, but also with the other structures in the head and neck which are associated with the dentition and influence its form and function.[13]

A good balance of masticatory and head and neck muscles seems to be an important factor of postural stability.[3] The occlusion of the dentition is extremely important in masticatory function. Alterations of the body muscular equilibrium could influence mandibular position and facial morphology.[14] On the other hand, changes in mandibular posture could influence neck muscles and posture.[15] The posture of the body as a whole might thus be modified by stomatognathic alterations. It is suggested that harmonious conditions of the stomatognathic system affect not only stomatognathic function but also body posture.[16,17]

Generally younger subjects had a ratio close to 1:2:3 for weights recorded for IF: OF: H during a standing posture.[9,10] In this study, we found the early permanent dentition group subjects had ratios close to 1:2:3. For the primary dentition group subjects, the value of the H was greater than 3. The distribution of body weight in the OF on soles of feet in the permanent dentition group was significantly greater than that in the primary dentition group. The distribution of body weight in the H on soles of feet in the permanent dentition group was significantly smaller than that in the primary dentition group. These results indicated that the weight is shifted from the heels to the outer forefeet and from primary to permanent dentition.

The primary dentition is in a state of dynamic equilibrium. This equilibrium may result in a special facial morphology. It was proposed that this stage is a transition period in the development of posture control.[18] At this time, the function of sensory organization for balance control was poorer for the children than the young adults.[19] Also, in contrast to adults, the appearance of sway at high frequencies in children is not necessarily associated with any pathology.[20]

Recently many postural diseases have been classified among occlusal-functional alterations, mostly on a clinical basis. It was showed that subjects with a Class II malocclusion exhibit an anteriorly displaced posture, whereas subjects with a Class III malocclusion exhibit a posteriorly displaced posture.[16] The morphological and functional characteristics in patients with mandibular lateral displacement may play a compensatory role in posture control.[21] Approximately two-thirds of orthodontic anomalies are caused by improper growth and development in the period of the primary and mixed dentition.[22] Investigation on the distribution of body weight on the sole of the foot among children and young adults can be used to differentiation between physiological and pathological results in balance control as well as for monitoring therapy progress.

CONCLUSION

The weight distributions on soles of feet were different in the primary and early permanent dentition subjects. The weight was shifted from the heels to the forefeet from primary to permanent dentition.

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