

## Toothbrushing behavior in children: a study of pressure and stroke frequency

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### Abstract

*The pattern, the applied pressure, and the stroke frequency of toothbrushing during a specific test period were studied in 7- and 11-year-old children by means of a strain gauge connected to a toothbrush and an oscillograph. The younger age group consisted of 19 children and the older of 24 children. The majority of the children of both age groups spontaneously used the horizontal scrub technique. The hand motions of the younger children varied from long to short strokes, whereas the majority of the older children applied the short stroke technique. The toothbrushing behavior of the younger children was irregular, that of the older children more regular. The 11-year-old children showed significantly higher accumulated pressure and stroke frequency values than the younger ones. The findings indicated an age-related factor between the development of motor skills and the ability to brush.*

**T**he study of the toothbrushing behavior in children at different ages has grown during the last decades. Several studies<sup>3</sup> have reported the use of the horizontal scrub technique to be the method of choice by young children, and also their inability to apply other toothbrushing methods. Mescher<sup>4</sup> et al. described the difficulties 6- and 8-year-old children had in performing sulcular brushing and found that hand-function was age-related. The brushing performance of children under age seven was also observed to be briefer, more haphazard and erratic than those aged seven.<sup>1</sup>

Studies on the force and stroke frequency applied by children during toothbrushing are scarce. McClure<sup>2</sup> observed the pressure young children exerted on the gingiva when brushing their teeth, but this pressure was not recorded.

Several investigations of toothbrushing forces in adults showed significant variations in magnitude, varying from 203 g to 1533.3 g depending on the hardness of the brush, the method and the design of the investigation, and whether the brush was manual or powered.<sup>5,6,7,8</sup> Fraleigh et al.<sup>7</sup> measured the

toothbrushing force in a group of children aged four to fifteen years and reported that they recorded a mean of 123.6 g when using a powered toothbrush.

Oral hygiene instruction in younger age groups requires knowledge of their level of motor skill development. The purpose of this study was to compare toothbrushing patterns in terms of the pressure and stroke frequency in children either seven or eleven years of age.

### Methods and Materials

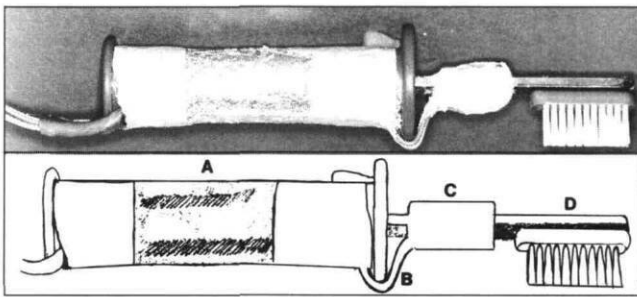
Forty-seven children, 22 seven year olds (mean age 7.03) and 25 eleven year olds (mean age 11.64), were recalled for routine prophylactic treatment in a School Dental Clinic and in the Department of Pedodontics, Faculty of Odontology in Göteborg. The children were of Swedish origin and came from a mixed socio-economic background.

The children's parents were informed that the toothbrushing pattern of the children would be investigated with a specially designed toothbrush connected to an oscillograph.

In cooperation with the Departments of Physiology and Technology, University of Göteborg, a measuring bridge with strain gauges (micro-measurements 120 ohms) was coupled to the upper part of an instrument, to which a toothbrush-head was attached, for recording the pressure and stroke frequency during the test period. The measuring bridge was isolated from the saliva with silicone (Figure 1). An amplifier was directly connected to the oscillograph in order to reinforce the signals from the measuring bridge.

The recording device was calibrated according to the manufacturer's manual before the test was started (Mingograph 800®).

The toothbrush head was a Jordan Junior® toothbrush, multitufted straight cut, with triple rows and medium nylon bristle. It had been specifically prepared for the measuring device and had 31 bristles



**Figure 1.** Standardized toothbrush, a. The rubber handle, b. The connection to the amplifier and the oscillograph, c. The measuring bridge with strain gauges isolated with silicone, d. The brass extension with a replaceable toothbrush head.

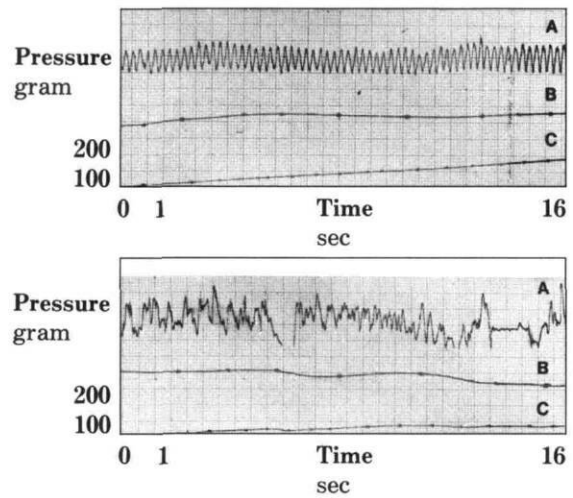
with a height of 11 mm. The toothbrush head, attached by small screws, was changed for each child.

The oral examination revealed complete dentitions in all the children. The children were given no formal toothbrushing instructions prior to the test. Each child was separately introduced to the toothbrush and the oscillograph and asked to demonstrate his/her routine toothbrushing technique. Before the start of the recording, the children, standing in front of a mirror, were instructed to brush the buccal side of the maxillary primary molars or the bicuspids and first permanent molar, depending on the development stage of the dentition.

The toothbrushing method, use of right or left hand, and the side of the maxilla brushed were recorded. The horizontal scrub method was divided into short and long strokes by visual observation and later the distance between the amplitudes on the curves were measured. The brushing technique was recorded as irregular when it could not be defined. Calibration of interobserver reliability concerning the brushing technique was made by the two observers. There was a good reliability between the observers.

The test period for each child lasted 16 seconds. The length of this period was chosen to correspond to the integrator of the oscillograph, recording the accumulated pressure (Figure 2).

Three 7 year olds and one 11 year old were not in-



**Figure 2.** (A. Top). Regular pattern of toothbrushing in an 11-year-old child, b. indicates medium pressure and c. is the integrator curve indicating the accumulated pressure. (Bottom). Irregular pattern of toothbrushing in a 7-year-old child.

cluded in the evaluation of the findings because they used extensive pressure against the cheek during the test period. Right- and lefthanded children were pooled together for the analysis of the data.

The Student's t-test was applied for the statistical analysis of data for 43 children. The pressure and stroke frequency were compared between the two age groups as well as the hand and side of the mouth brushed. An evaluation of the general toothbrushing pattern was made according to the curves registered by the oscillograph (Figure 2).

## Results

The toothbrushing technique of the 7- and 11-year-old children is shown in Table 1. The majority of the children of both age groups used the horizontal scrub method. The 7-year-old children preferred the long stroke, 68.4%, and the 11-year-old children the short stroke, 83.3% (Table 1).

The curves obtained showed an irregular stroke pattern in 57.8% of the younger children, but 75% of the older children had a regular pattern (Fig-

Table 1. Toothbrushing technique.	Age	n	short stroke	Horizontal scrub		Irregular technique
				long stroke	short and long stroke	
	7	19	3 (15.8%)	13 (68.4%)	—	3 (15.8%)
	11	24	20 (83.3%)	2 (8.3%)	1 (4.2%)	1 (4.2%)

Table 2. Accumulated pressure and stroke frequency in 7- and 11-year-old children.	Age	sex	n	pressure/gram		Stroke frequency	
				$\bar{x}$	SE	$\bar{x}$	SE
	7	boys	7	185.714	51.216	52.714	4.833
		girls	12	190.000	29.387 n.s.	52.000	4.166 n.s.
	11	boys	12	280.000	41.878	66.076	3.913
		girls	11	289.090	35.814 n.s.	72.727	4.520 n.s.
	7	boys and girls	19	188.421	25.606	52.263	3.094
	11	boys and girls	24	284.166	27.425**	69.124	2.979***

\*\* p © 0.01, \*\*\* p © 0.001

ure 2). The toothbrushing pressure applied in both age groups is shown in Table 2. The difference in accumulated pressure between the two age groups was significant ( $p < 0.01$ ). The 7 year olds applied 33.7% less pressure than their older peers. Statistical differences were not found when comparing the pressure applied by boys and girls within each age group. The stroke frequency showed a similar pattern as the accumulated pressure during brushing (Table 2). The difference between the two age groups was highly significant ( $p < 0.001$ ). The 7-year-old children used 24.3% less strokes than the older children. There was no difference in stroke frequency when comparing boys and girls within both age groups.

The results of pressure and stroke frequency compared with hand and side of the mouth brushed also were not significant.

## Discussion

These two age groups of children were selected for this study because of their known differences in mental and somatic development. Parents often are unaware of these differences and it is not uncommon for younger children to be responsible for their own toothbrushing without parental help or supervision.

The majority of the children in this study spontaneously used variations of the horizontal scrub technique. These observations confirm previous studies.<sup>1,2,3</sup> The younger age group tended more frequently to use the long horizontal scrub technique, whereas the short horizontal scrub technique was predominant in the older group. These findings are similar to those of Rugg-Gunn and MacGregor.<sup>3</sup>

The development of motor skills related to toothbrushing behavior in children seems to be age-related. The horizontal scrub technique is a suitable way of brushing considering the development of motor skills. McDonnell and Domalakes<sup>9</sup> reported in their study that after instruction in the roll technique of younger schoolchildren, they reverted to teaching a simple scrub technique.

The pattern of toothbrushing was evaluated in the curves registered by the oscillograph. As expected, most of the older children showed a more uniform pattern with regard to stroke frequency and the height of amplitude of the curves.

The 11-year-old children showed higher values in stroke frequency and accumulated pressure during the test period than the younger ones. However, individual variations were observed in both age groups. These findings may explain the greater dexterity of the older children when brushing their teeth, and it is probably related to previously described differences in the general pattern of toothbrushing. The results from our study also correspond to the conclusions drawn by Taylor et al. using their hand func-

tion tests in different age groups.<sup>10</sup> The values of accumulated pressure in both age groups are difficult to compare with those of previous studies in adults,<sup>5,6,7,8</sup> due to the variations in recording techniques.

Differences between the parameters studied were not observed between boys and girls in the two age groups. The size of the sample and the small number of boys in the younger age group did not allow us to draw any conclusions concerning differences in the motor skills between boys and girls.

The experimental condition did not seem to provoke visible anxiety or discomfort in either age group. However, the toothbrushing behavior of some of the younger children might have been influenced by the oscillograph and the experimental toothbrush.

## Conclusions

This study indicates that differences in the pattern of toothbrushing exist in different age groups. Oral hygiene instruction should be adjusted to a child's development stage and motor skill. Variations in the ability of toothbrushing must be considered — especially with younger children. Basic knowledge of the pattern of toothbrushing at different ages in normal children is important, but it becomes imperative when trying to teach handicapped persons with impaired handfunctions oral hygiene procedures.

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