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Evidence of Handedness and Related Dental Hygiene on Oral Health

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ABSTRACT

Purpose: Handedness is the inclination of a person to use one hand more comfortably than the other. Handedness is an important factor affecting performance in various tasks, one of which is oral health care. The aim of this research was to find out the effects of handedness and dental education on tooth brushing and oral health.

Methods: This research was conducted on 200 cases (100 males, 100 females), with an average age 22.5 years (range between 20-25). The dental health status of the participants was recorded under the proposed term DMRT where "R" stands for a general term "restored", instead of "filled".

Results: The results showed that; right-handers brushed their left bimaxillary quadrants better; on the contrary left-handers and ambidextrous cases brushed their right bimaxillary quadrants better. This result was found related to the location of DMRT.

Conclusion: Statistics conducted on the participants' parents' education and profession revealed that the parents' dental hygiene education was not sufficient to provide caries free oral health status for their children. Therefore, it is recommended to receive dental care instructions from a pediatric dentist, especially on brushing the side of hand dominance. As far as forensic analysis is concerned, dental caries, which appear to be of common occurrence, can be helpful at determining the handedness of a victim or a suspect, for precise deduction.

Keywords: Handedness, Evidence, Dental hygiene, Dentists pediatric, Oral health

INTRODUCTION

Handedness is the inclination of a person to use one hand more comfortably than the other, which can be technically assessed with the "Edinburgh Handedness Inventory" (EHI) test [1]. The selection criteria of this test were revised over time and the number of criteria was decreased and changed [2]. The latest revised version of the EHI test, allows the assessment of handedness quickly and with precision, this test encompassed two activities as writing and throwing and usage of two objects as tooth brush and spoon [3]. The issue of handedness is one of the personal identity indicators, which are important in diverse fields such as; forensic sciences, anthropology, sports, arts and dentistry. Concerning the first two branches the dominant hand side can be deduced from the evidences as; a forensic pathologist can determine the manner of death from the evidence of handedness and direction of the incision in a homicide case [4], likewise an anthropologist can diagnose handedness from structural formations of a skeleton such as; asymmetric muscle attachments on upper limb bones [5], greater total length of long bones or greater bicondylar width which correlates with the dominant side [6]. A research on sports examined the hand grip strength due to handedness on 268 female and 1,234 male university athletes who were tested with a digital hand grip dynamometer. The right-hand grip strength test results were not significant for left and right hander, but left hand grip strength test showed significant results for left and right hander where there was a correlation between hand strength and hand dominance [7]. Concerning artistic capabilities, a recent research where the same criteria

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with the EHI test for assessment of handedness was used showed that there was a correlation between left handedness and artistic competency [8].

Since tooth brushing was used as a measure for determining handedness, from the point of dentistry, therefore, handedness implies importance for tooth brushing, which is one of the main principles for protecting oral health. The utilization of the toothbrush object has remained in the entire above mentioned test lists, which was in the 6th row of the original list, then it is ranked 4th in the revised list and 3rd at the latest list of revision.

It is stated that for preventing oral diseases, education of patients on proper oral hygiene and risk increasing factors by health professionals is required [9]. This training should be initiated, especially by pediatric dentists, at an early age. The term "Pediatric" used here is (US) spelling, but pediatrics (UK) [10]. To improve the oral health status of a community, establishment of extensive collaborative oral health programs among; families, schools and societies had been suggested [11]. The aim of this research was to find out the effects of handedness on oral health regarding tooth brushing and to find out what kind of an education method can be effectively employed to help patients to overcome the difficulties in tooth brushing arising from handedness.

MATERIALS AND METHODS

In this study, oral health status of 200 subject (100 males, 100 females) with an average age of 22.51 years (male 22.55, female 22.46) were recorded through an interview and clinical examinations by the second author who is a qualified dental professional in the field of prosthodontics. During the questionnaire, the handedness of each case for tooth brushing as: right or left handed and ambidextrous were assigned, plus the subjects' mothers and father's education levels and professions were recorded. The dental health status of the participants was registered under a nomenclature abbreviation DMRT for decayed, missing and restored permanent teeth coined and proposed by the second author - instead of DMFT for decayed, missing and filled permanent teeth – since the contemporary tooth filling methods vary excessively as distinct restorations. In this recording third molars were excluded due to its extreme variability.

In this research, the odds ratio (OR) was used to measure the association between handedness and DMRT in a young adult group, to compare the risk factors for oral health. Application of the OR is commonly preferred for decision making in health studies, which reveals direct information for clinicians by finding out treatment practices that has the best OR regarding patient benefit and provides effect-size statistics [12].

RESULTS

The results showed that right handers brushed their left bimaxillary quadrants better, analogously left handers and ambidextrous cases brushed their right bimaxillary quadrants better than the left bimaxillary quadrants. Frequency of DMRT due to handedness and right/left bimaxillary upper and lower quadrants was shown with OR as; for right handed cases 2.5% more DMRT was formed on the right bimaxillary quadrant than on the left side, for left handed cases 16.6% more DMRT was formed on the left side than on the right side and for ambidextrous cases 6.1% more DMRT was formed on the left side than on the right side.

When Odds Ratio is 1 it denotes, that there is no difference between the given parties, however in the case when Odds Ratio is greater than 1, to find the percentage of the difference, the decimal is multiplied by 100 **(Table 1)**. The frequency of DMRT due to sex along with right and left handedness revealed that DMRT was not significant for sexes, however for the ambidextrous cases DMRT was 1.66 times more for females than males **(Table 2)**. The frequency of DMRT due to sex and handedness according to all teeth revealed that first and second molar teeth, M1 and M2, respectively were more prone to decay for both sexes. Additionally, right handed cases tended to have more DMRT at the right mandibular M1 and M2, conversely left and ambidextrous handed cases tended to have more DMRT at the left mandibular M1 and M2 **(Table 3)**.

Table 1. The frequency of DMRT due to quadrants and handedness.

Handedness*	Bimaxillary Quadrants**	DMRT	N of Intact Tooth	N of Total Tooth	Odds Ratios
Right	Right	509	1941	2450	1.025
	Left	499	1951	2450	
	Total	1038	3918	4900	
Left	Left	43	167	210	1.166
	Right	38	172	210	
	Total	81	339	420	
Ambidextrous	Left	20	120	140	1.061

	Right	19	121	140	
	Total	39	241	280	

***Handedness**: Preference for using either the right or left hand more comfortably than the other*
****Bimaxillary Quadrants:** Right or left both maxillary and mandibular quarters of the dental arches*

Table 2. The frequency of DMRT due to sex and handedness.

Sex	Handedness for Tooth Brushing	N of Cases	N of DMRT	N of Intact	N of Tooth	% of DMRT within Sex and Handedness
Male	Right handed	88	499	1965	2464	20.3
	Left handed	9	50	202	252	19.8
	Ambidextrous	3	8	76	84	9.5
	Total	100	557	2243	2800	19.9
Female	Right handed	87	509	1927	2436	20.9
	Left handed	6	31	137	168	18.5
	Ambidextrous	7	31	165	196	15.8
	Total	100	571	2229	2800	20.4
Total	Right handed	175	1008	3892	4900	20.6
	Left handed	15	81	339	420	19.3
	Ambidextrous	10	39	241	280	13.9
	Total	200	1128	4472	5600	20.1

Table 3. The frequency of DMRT due to sex and handedness according to all teeth.

Quadrants* and Tooth**	Male				Female				Total			
	Handedness				Handedness				Handedness			
	Right	Left	Both	Total	Right	Left	Both	Total	Right	Left	Both	Total
UR M2	42	4	0	46	47	2	4	53	89	6	4	99
UR M1	50	5	1	56	51	3	4	58	101	8	5	114
UR P2	13	1	0	14	15	0	1	16	28	1	1	30
UR P1	7	2	0	9	11	0	0	11	18	2	0	20
UR C	4	0	0	4	2	0	0	2	6	0	0	6
UR I2	5	0	0	5	5	0	0	5	10	0	0	10
UR I1	6	2	0	8	3	0	0	3	9	2	0	11
UL I1	6	1	0	7	3	0	0	3	9	1	0	10
UL I2	7	1	0	8	9	0	0	9	16	1	0	17
UL C	3	0	0	3	3	0	0	3	6	0	0	6
UL P1	8	2	0	10	12	0	0	12	20	2	0	22

UL P2	8	1	0	9	12	1	1	14	20	2	1	23
UL M1	45	3	2	50	42	4	3	49	87	7	5	99
UL M2	44	3	1	48	45	3	2	50	89	6	3	98
LR M2	52	4	0	56	50	3	4	57	102	7	4	113
LR M1	61	5	1	67	65	4	4	73	126	9	5	140
LR P2	8	0	0	8	8	1	0	9	16	1	0	17
LR P1	1	0	0	1	2	0	0	2	3	0	0	3
LR C	0	1	0	1	0	0	0	0	0	1	0	1
LR I2	0	0	0	0	0	0	0	0	0	0	0	0
LR I1	0	0	0	0	1	1	0	2	1	1	0	2
LL I1	1	0	0	1	0	0	0	0	1	0	0	1
LL I2	0	0	0	0	0	0	0	0	0	0	0	0
LL C	0	0	0	0	0	0	0	0	0	0	0	0
LL P1	3	0	0	3	1	0	0	1	4	0	0	4
LL P2	12	2	0	14	11	1	1	13	23	3	1	27
LL M1	61	8	1	70	58	4	4	66	119	12	5	136
LL M2	52	5	2	59	53	4	3	60	105	9	5	119

Quadrants*: *Upper Right (UR), Upper Left (UL), Lower Right (LR), Lower Left (LL)*
Tooth**: *Central Incisor (I1), Lateral Incisor (I2), Canine (C), First Premolar (P1), Second Premolar (P2), First Molar (M1), Second Molar (M2)*

The relation of DMRT with parents' education and profession does not show statistical significance **(Tables 4 and 5)**. The mean DMRT, due to its relation with parents' education and subjects' handedness showed that, the education level of the parents was not significant. In addition, no left-handed or ambidextrous cases were found in the groups of parent's having low levels of education; possibly due to parents' attempts at adapting their children to right handedness **(Table 6)**.

Table 4. The mean DMRT due to parents' education.

Mother's Education	Father's Education										Total	
	Illiterate		Primary school		Middle school		High school		University			
	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT
Illiterate	3	6.0			1	0	1	8.0			5	5.2
Primary school			12	4.2	11	5.2	11	5.6	17	7.0	51	5.7
Middle school					4	5.5	5	5.0	6	5.7	15	5.4
High School			1	10.0			14	5.1	37	5.5	52	5.5
University			1	8.0	1	2.0	2	12.0	73	5.6	77	5.8
Total	3	6.0	14	4.9	17	4.8	33	5.8	133	5.8	200	5.6

Table 5. The mean DMRT due to parents' profession.

Mother's Profession	Father's Profession								Total	
	Independent		Health Professional		Teacher		Other			
	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT	Cases	Mean DMRT
Independent	33	5.6	4	3	12	6.5	61	5	110	5.3
Health Professional			5	4.8			3	4	8	4.5
Teacher	2	6	4	4.8	23	6	26	6.7	55	6.2
Other	3	6.3	1	1	8	5.6	15	6.5	27	6
Total	38	5.7	14	4	43	6.1	105	5.6	200	5.6

Table 6. The mean DMRT due to its relation with parents' education and subjects' handedness.

Hand*	Education		Father's Education					Total
			Illiterate	Primary school	Middle school	High School	University	
Right handed	Mother's Education	Illiterate	6.0			8	7.2	5.2
		Primary school		0.2	5	5.1	5.7	5.6
		Middle			7	5	5.6	5.7
		High School		0.1		6.2	5.7	5.8
		University		0.1	2	12	7.2	5.9
		Total	6.0	0.2	4.8	6.1	5.9	5.8
Left handed	Mother's Education	Primary school			7.5	9		8
		High School				1	5.9	3.3
		University					5.9	5.2
		Total			7.5	3.7	5.5	5.4
Ambidextrous	Mother's Education	Primary school			3.5	7	4	4.5
		Middle			1			1
		High School				2	4.3	3.8
		University					5	5
		Total			2.7	4.5	4.4	3.9
Total	Mother's Education	Illiterate	6.0			8		5.2
		Primary school		0.2		5.6	7	5.6
		Middle			5.2	5	5.7	5.4
		High School		0.1	5.5	5.1	5.5	5.5
		University		0.1		12	5.6	5.8
		Total	6.0	0.2	4.8	5.8	5.8	5.6

Hand*: *Subjects' handedness, hand use for tooth brushing*

In categorical data analysis; according to the Gamma, Somers' d and McNemar-Bowker tests, the number of subjects DMRT according to their parent's education level was found statistically significant, due to non-homogeneous distribution of the data (p-value=0.00<0.05).

When the average DMRT according to parents' educational level was compared, the result was not statistically significant, however in case the educational level of mothers and fathers were equal (interaction), significant differences were found (p<0.05).The Spearman Correlation coefficient was found as 0.521, which shows that the effect of educational status of the family on DMRT was found as 52%.

DISCUSSION

To create a caries free dentition; oral health education together with regular, effective and frequent tooth brushing practice is essential. Over the years, there has been numerous research published on the methods, frequency and duration of tooth brushing activity, concerning the age range of pre-school children to adults [13-18]. Among them, tooth brushing at least twice a day, for 2 min, with circling and vertical sweeping type cleaning movements, not exceeding 300 g of gentle force was accepted appropriate for tooth brushing, however it is stated that despite of oral health prophylactic programs, the dental education given still needs to be developed [19,20]. To reduce the childhood caries, parent focused community-based efforts, dental check-up and brushing children's teeth 2 times a day by their parents were recommended [21,22].

In this research, the oral health status and caries prevalence of the participants disclosed the fact that the least number of caries was seen in the lower anterior region. This shows that dental hygiene was done naturally with the mechanical contribution of the tongue to tooth cleaning and function of the salivary ducts to this area. Maximum number of caries was inspected on the first molar teeth (M1) and subsidiary on second molar teeth (M2) on all quadrants for both sexes. With respect to M1, M2 erupts 6 years later, which means these teeth should be less affected by caries promoting factors compared to M1. In this research the high incidence of caries in M2 suggests that, brushing was not effective in this posterior region. One of the factors that contributed to the high incidence of caries in M2 was handedness and the resulting inability to reach to M2 region. Especially, right hander cannot perform tooth brushing activity precisely on the mandibular right side, whereas left and ambidextrous handed cases likewise cannot brush the mandibular left side properly. Here it was found that ambidextrous cases most act like the left handers **(Table 3)**.

A research performed to evaluate pre and post brushing plaque on the dentition of 25 adults with 3 types of toothbrushes revealed that, irrespective of the design of the toothbrush, the right handed participants could not clean the right side of their dental arch as sufficiently compared to the left side [23]. In this research it is found that there was no case present with the left handed or ambidextrous feature among the illiterate and primary school graduate parents group. The reason behind the absence of left handed and ambidextrous people in the illiterate group and the primary school graduates group might be, the parents' attempts at adapting the children to right handedness at a young age **(Table 6)**. It is found that the right-handers cannot properly clean their teeth localized at the right-hand side (DMRT was 2.5% more), similarly left-handers and ambidextrous cases cannot properly clean their teeth localized at the left side (DMRT was 16.6% and 6.1% more, respectively) which proves that the mean DMRT was found higher on the dominant hand side. Therefore, a proper dental brushing requires special care on the same sides of handedness.

In this research, it has been found that, even in the case when both the mother and the father were university graduates or health professionals the mean DMRT values showed that it was not enough alone to preserve the dental health of the child **(Tables 4-6)**. Therefore, as soon as the child's teeth erupt in the oral cavity, the first dental examination of the child and the dental health education of the parents must be realized by a pediatric dentist. At this stage, brushing the primary teeth with a finger brush, gauze or tooth wipes by the parents is necessary. Then from 0 to 3 years of age, a very thin layer of organic swallowable toothpaste should be spread on the brush for tooth brushing. This amount may be increased to the size of a lentil at age 3-6 and to a bean size after age 6. Dental floss can be started after 2.5-3 years of age, by the parents, when the primary molars are completely erupted; especially to clean the interdental areas. Tooth brushing should be done by the parents until the child matures enough to manage his/her own dental care. Even when the children themselves are capable of brushing their teeth, the control of the families by visual contact should continue for many years.

This research emphasizes that; the pediatric dentist should give importance to handedness of the patient. Instructions must be given on; attentive prolonged tooth brushing for the teeth that are located at the dominant side, especially on the mandibular quadrant, with tilting the head towards the non-dominant direction to provide more comfortable brushing action for the dominant hand.

CONCLUSION

The following results are derived from this research:

1. As a nomenclature recommendation, it is suggested to use the abbreviation of DMRT instead of DMFT, due to the fact that the term "restoration" is more accurate for contemporary fillings.
2. The frequency of DMRT due to sex and handedness according to all teeth revealed that molar teeth, especially the mandibular molar teeth located at the

same side of hand dominance are more prone to decay for both sexes. The ambidextrous handed cases mostly behave as the left handers.

3. When tooth brushing, special care to brushing the mandibular molar teeth located at the same side of hand dominance which is more prone to dental caries, should be given.

4. This research shows that, dental health information provided to children by their parents has been found lacking and insufficient. To secure a child's dental health, proper education provided by a pediatric dentist is essential. A pediatric dentist's instructions become extremely important in instructing the child to brush his/her dominant hand side and especially the mandibular molar teeth of the dominant hand side; longer and with special care, preferably while tilting his head to the non-dominant side as much as it provides ease for the dominant hand.

5. Further research is required to assess the difference of performance regarding various tasks, in people who are naturally right handed and people who are adapted to right handedness.

6. The specific result of this research is related with forensic cases, for determining the handedness of a victim or a suspect, dental caries can be evaluated as evidence.

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