Original Article

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Importance of patient's position during oral prophylaxis: A simulated study in phantom head.

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Objective: To study the relationship between amount and direction of water spraying from ultrasonic scaler tip and the position of phantom head while performing upper anterior teeth cleaning.

Materials and methods: Three black-dyed papers were placed around phantom head holding a velmix-cast securing plastic upper anterior teeth. Two types of ultrasonic scalers, magnetostrictive and piezoelectric, were activated on the upper anterior teeth in the phantom head which was adjusted at different angulations to the horizontal plane. Statistical difference was calculated to compare between the amount of water spreading from two scaler types and between the amounts of water spreading from ultrasonic scaler among different phantom head angulations. The direction of water spreading was explained by descriptive statistics using mean.

Results: The highest amount of water spreading from both scalers was measured at twelve o' clock in every phantom head angulation except at 0^{o} using Piezoelectric. The highest amount of water spreading was recorded when the phantom head was tilted by -10^{o} from the horizontal plane and was significantly different from 0^{o} and -20^{o} ($p < .05$). The magnetostrictive scalers produced significantly more water spreading than the piezoelectric scalers in every position of the phantom head. There was a statistically significant difference between the amount of spreading water produced by the magnetostrictive scalers and piezoelectric scalers ($p < .05$) when the phantom head is positioned parallel to the floor (0^{o}).

Conclusion: Angulation of the phantom head to the horizontal plane has an effect on the direction of water spreading around the phantom head. Piezoelectric scaler did produce less amount of water spreading than magnetostrictive one.

Keywords: angulation, phantom head, water spreading, ultrasonic scalers

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Introduction

Most dental procedures produce aerosol and splatter during the operation resulting in the multiplication of the amount of bacteria in the dental office environment compared to prior to the treatment.[1] Aerosols are very small liquid or solid particles (diameter is less than 50 microns) which can suspend in the air for long period of time before dropping down to the floor.[2] Splatters are large particles (diameter is more than 50 microns) which spread from the operating area and project down to the floor in short period of time.[3] These particles are composed of water, various organic particles and fluids.[4,5] These contaminated aerosols and splatters could be carriers of various viruses and tuberculosis which might compromise health of dental personnel and patients.[5,6]

Power-driven instrument (ultrasonic scaler) was introduced to facilitate the removal of dental deposits and calculus. This instrument does not only increase the efficacy of calculus removal but

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also decrease the operator's fatigue. Two types of widely used ultrasonic scaler; magnetostrictive and piezoelectric, have their own characteristics in vibrating frequency and the vibrating pattern of scaler tip[7] which might affect the amount and direction of water spreading pattern.

Accordingly, the main drawback of using power-driven machine is the spreading of aerosols and splatters which are harmful to health. Previous studies indicated that ultrasonic scaler did spread water particles which were contaminated with blood and bacteria.[8,9,10] The study of Harrel *et al* demonstrated that infection dissemination could be initiated during dental procedure. They showed that contaminated water from ultrasonic scaler widely spread out and contacted with dentist and dental assistant during periodontal cleaning.[4]

Since previous studies concentrated on the measurement of bacteria and blood components in the aerosols or the determination which dental procedure produced the most airborne contamination,[1,8,10,11,12] our study was set to investigate whether the angle of head position to the horizontal plane affects the amount and direction of water overspreading from two types of ultrasonic scalers; magnetostrictive and piezoelectric, in simulated upper anterior teeth cleaning procedure.

Materials and methods

A velmix cast holding plastic upper anterior teeth (tooth 13-23) was secured in phantom head then assembling water spreading-measuring board with the phantom head. (figure 1) Both ultrasonic scalers; Magnetostrictive (Densply® Cavitron BOBCAT Pro) and Piezoelectric (Newtron P5, Satelec Acteon), were set at the maximum speed and water coolant. The long axis of scaler's working tip was positioned parallel to the tooth labial surface. Operate the machine for the total of nine seconds per tooth (three seconds at the three designated point on the tooth; each tooth was marked with permanent black ink at the mesiolabial point angle, mid labial and distolabial point angle). (figure 2) The phantom head was set to three different angulations (0º, -10º, -20º) to the horizontal plane. The operation was done for five times for each phantom head position. Thus, the total of 15 experiments for each type of ultrasonic scaler were performed.

Statistical Analysis

The data was expressed as mean ± Standard Deviation. Student t-test was used to compare the amount of water spreading between two scaler types. The direction of water spreading was reported in descriptive statistics. The comparison of the amount of water spreading between different angulations of phantom head was performed by one-way ANOVA and subsequently followed by LSD test. The criterion for statistical significance was set at $p<0.05$.

Results

The average amount of water on water spreading-measuring board from magnetostrictive and piezoelectric scaler was shown in table 1 and 2.

Both ultrasonic scalers produced the most water-spreading when the phantom head was positioned at -10º to the horizontal plane. The least water-spreading was observed at 0º for piezoelectric and at -20º for magnetostrictive. There was significant difference of the amount of water spreading on the board between each pair of phantom head angulation ($p<0.05$).

The comparison between the amount of water-spreading of each angulation for magnetostrictive and piezoelectric devices was shown in table 3 and 4 respectively.

Difference was observed between each pair of phantom head angulation in each scaler ($p<0.05$) except between 0° and -20° in magnetostrictive scaler.

Using student t-test, there was a statistical difference between water-spreading from magnetostrictive and piezoelectric when the phantom head was set at 0° ($p<0.05$). (table 5)

The water-spreading direction was descriptively analyzed. For almost all phantom head position, the most contaminated position was at 12:00 o'clock position. Only at 0° position of piezoelectric where the most water-spreading position was at 15:00 o'clock position.

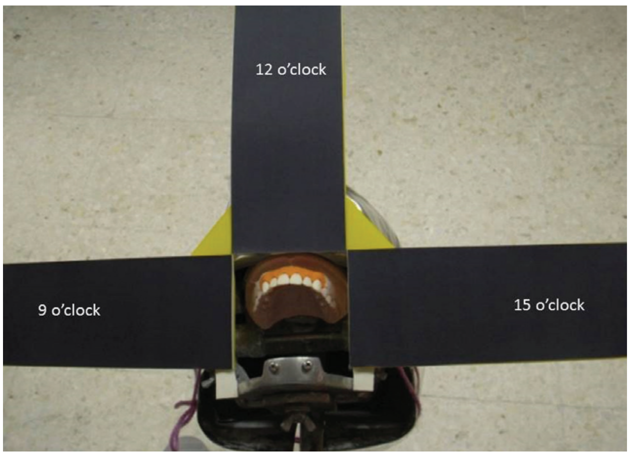

Figure 1 Experimental upper dental cast and measuring board were secured in phantom head

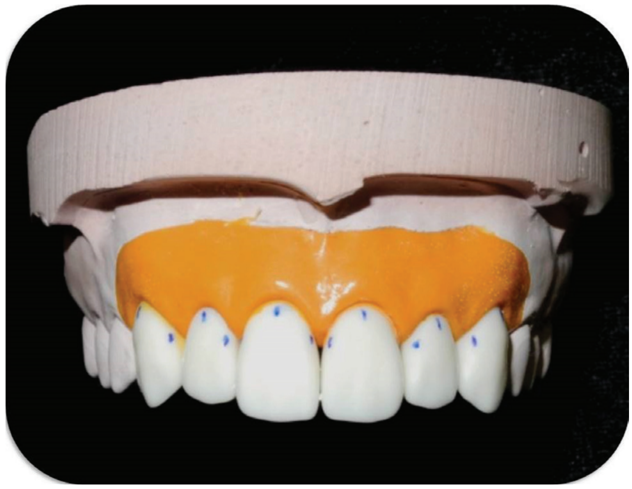

Figure 2 Color marks on the experiment teeth.

Table 1 Mean water spreading (droplets) on measuring board producing from Piezoelectric scaler.

Phantom head's angulation	Mean water spreading (droplets)			Total	P value
	9 o'clock	12 o'clock	15 o'clock		
0°	2.60	16.40	92.93	111.93±14.66	0.000
-10°	10.27	116.53	90.20	217.00±24.99	0.007
-20°	2.13	108.73	48.73	159.60±27.48	0.000

$P < 0.05$

Table 2 Mean water spreading (droplets) on measuring board producing from Magnetostrictive scaler.

Phantom head's angulation	Mean water spreading (droplets)			Total	P value
	9 o'clock	12 o'clock	15 o'clock		
0°	38.73	108.33	59.07	206.13±16.93	0.003
-10°	45.53	128.00	85.27	258.80±36.22	0.295
-20°	39.00	118.80	30.00	187.80±22.48	0.001

$P < 0.05$

Table 3 Level of significant difference of mean water spreading (droplets) on measuring board producing from Piezoelectric scaler between each two different phantom head's angulation.

Phantom head's angulation		P value
0°	-10°	0.000
0°	-20°	0.007
-10°	-20°	0.002

$P < 0.05$

Table 4 Level of significant difference of mean water spreading (droplets) on measuring board producing from Magnetostrictive scaler between each two different phantom head's angulation.

Phantom head's angulation		P value
0°	-10°	0.008
0°	-20°	0.295
-10°	-20°	0.001

$P < 0.05$

Table 5 Mean ± SD of water spreading (droplets) on measuring board from different phantom head's angulation and comparison between mean water spreading (droplets) on measuring board producing from Magnetostrictive and Piezoelectric scaler.

Type of scaler	Phantom head's angulation		
	0°	-10°	-20°
Piezoelectric scaler	111.93 ± 14.66	217.00 ± 24.99	159.60 ± 27.48
Magnetostrictive scaler	206.13 ± 16.93	258.80 ± 36.22	187.80 ± 22.48
P value	0.000	0.066	0.114

$p < 0.05$

Discussion

The amount of water-spreading from working area

It was demonstrated from our study that the angulation of phantom head to the horizontal plane and the type of ultrasonic scaler affected the amount of water spreading from the working area. The piezoelectric scaler did produce less water spreading than magnetostrictive one. Upon observing the stained spots on the board, it was obvious that the size of water droplets produced by piezoelectric was smaller than that of magnetostrictive. This might take into consideration whether the piezoelectric scaler produced more water-spreading droplets than that reported in this study. The postulation could be that the droplets from the piezoelectric might be too small to be detected by bare eyes or they might drop down on another area apart from our study's concern. As the projection of the aerosol and splatter is in the projectile pattern[13], the water droplets might project over the water-spreading measuring board and dropped down beyond the extension of the board.

According to the result, it might be impossible to work with the magnetostrictive to get the least water-spreading since the phantom head had to be position at -20º in order to get the least contamination. On the contrary, in normal daily life, we achieved the least water-spreading with the piezoelectric device since the least water-spreading occurred when the phantom head was set parallel to the floor (0º), the position which was set for usual practice.

Direction of water-spreading

This study revealed that the least water-spreading area was the 9 o'clock direction (the usual working position for dentist) when long axis of phantom head lied parallel to the horizontal plane (long axis of anterior teeth made 0º angulation with horizontal plane) which is comparable to the supine position in clinical situation. The most water-spreading area is at 15 o'clock direction, the usual sitting position for the dental assistant. At tilted head position (-10ºand -20º), the 12 o'clock position is the most popular dropping destination for aerosol and splatter from upper anterior teeth cleaning. It is to be concerned since 12 o'clock position is also a usual sitting position for dentist.

The results of this study showed that splatter and aerosol occurring during the dental procedure did spray not only to the dentist but also to the dental assistant. The results emphasized the importance of the use of large-bore high volume evacuator in order to reduce the amount of water-spreading which was consistent with the ADA recommendation.[14] Protective eyewear, face shield, long-sleeve gown, gloves, face mask/shield are mandatory gadgets to be worn during working with ultrasonic scaler.[14,15,16] The recommendation to use antiseptic mouthwash rinse patient's mouth before the cleansing procedure using ultrasonic scaler might be one of an effective strategy to control cross contamination since it would reduce the bacterial counts in the spraying water.[17] In addition, innovation in manufacturing protective gears or methods in limiting the spreading of splatters and aerosols would be an interesting frontier.

Conclusion

Patient's head angulation to the horizontal plane does affect the amount and direction of spraying water from the ultrasonic scaler's tip. Dental personnel's awareness on adjustment of patient's position and on the use of appropriate protective gears will reduce the risk of self and cross contamination during the use of ultrasonic scaler.

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