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The Effectiveness of the X-Dent Box (Dust Collector Box) In Collecting Trimming Dust From Different Types of Dental Prostheses Materials in University Sains Islam Malaysia (Usim) Dental Laboratory

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Abstract:

Trimming and polishing dental prostheses is a regular procedure conducted in dental laboratory. The dust that produced during trimming process has high hazard risk especially when it is exposed to dental technician in a long duration. X-Dent Box is invented as a protective equipment to reduce indoor air pollution by collecting the dust from exposing in dental laboratory thus protecting them. The aim of this study is to compare the effectiveness of the X- Dent Box in collecting dust from different type of dental prostheses materials during trimming process. Trimming procedure was performed for 4 minutes on five different types of common dental prostheses materials used in dental laboratory which are Plaster of Paris (PoP), dental stone (DS), resin special tray (RST), cold cure acrylic (ACC) and heat cure acrylic (HCA). The procedure is repeated 3 times for each sample using X-Dent Box and without X-Dent Box being attached to the vacuum. The collected dust in the vacuum bag and X-Dent Box was measured by weight. Data was then analysed. All types of dental prosthesis materials showed more than 60% (n:5) of dust been collected using X-Dent Box. The percentage of dust collected using X-Dent Box is between 65-90% as compared to without the box which only 20%-50%. The dust material that is most effective to the least effective collected by X-Dent box is PoP=CCA (90%) > HCA (85%) > DS (73%) > TRS (65%). There is no significant difference of dust collected with X-Dent Box ($p= 0.056$) compared to without the usage of X-Dent Box and on the effectiveness of X-Dent Box usage in comparing between different type of materials ($p=0.406$).

Keywords: Dental technician, dental prostheses, trimming dust, hazard, dental laboratory

1.Introduction

Dental technician is at risk of developing occupational respiratory disease due to exposure to various potentially toxic substances in their working environment (Tan et al, 2016). The exposure to the dusts generated from common and daily procedures conducted by dental technicians in the dental laboratory, such as trimming and polishing acrylic dentures and orthodontics appliances is unavoidable (Anthony et al, 2011). Inevitably, the floating dusts in the dental laboratory created a dirty and dusty workplace which takes hours that the dust can float in the dental laboratory environment before it starts to deposit as sediment on the floor. Because of that, the hazardous dust is inhaled by the dental technician mostly during the dust floating period.

Apart from that, it has been worse reported that the dental technicians may be exposed to potentially harmful and hazardous workplace due to exposure towards materials that is evaporated or leach a toxic vapor during material mixing and trimming was conducted (Anthony et al,2011; Taira et al,2009; Hu et al, 2006). Since 1939, few cases of silicosis among technician have been reported (Selden et al 1996). A number of studies have reported respiratory problems and lung diseases, mainly pneumoconiosis, within dental technicians (De Vuyst et al., 1986; Kotloff et al., 1993; Selden et al., 1996; Nayebzadeh et al., 1999; MMWR, 2004). Kotloff et al. (1993) and Rom et al. (1984) and the term dental technician's pneumoconiosis, or DTP,

is used to describe this condition. The air in the dental laboratory is also polluted due to the floating concentration of silica to be up to 0.051 mg/m³. There are also case reports indicated that dust produced through grinding metallic dental materials have caused pneumoconiosis (Kim et al, 2002).

The prevalence of dental technician pneumoconiosis reported in literatures range from 4.5% to 46%. Other than that, Choudat et al found that the prevalence of dental technician pneumoconiosis was significantly higher (22.2%) in dental technician with exposure more than 30 years as compare to those expose less than 30 years. It is also reported that 42% of dental technicians has foreign bodies in their eyes after 1 month working (Torbica et al, 2006).

The diagnosis of pneumoconiosis had improved patient's compliance to wear personal protective equipment when processing dental materials. A study has reported that, this is an occupational hazard and preventive measures should be reinforced to avoid future incidence (Tan et al, 2016). A full protection to dental technician is very important in order to reduce the risk to this hazardous pollution which can jeopardize their health. Currently, the common personal protective equipment used in laboratory in daily routine is masks, goggles, gowns and gloves. Still, the dental technicians are exposed to hazardous floating dusts during trimming and polishing procedures as due to improper use of standard personal protective equipment such as not appropriate thickness of mask were used in the dental laboratory.

Thus, Faculty of Dentistry USIM invented the X-Dent Box as an alternative way to collect the floating dust particles during routine procedure in dental laboratory. This equipment is invented to reduce the capacity of dust particles to float in laboratory but will directly suctioned the dust straight into the vacuum bag connected on the dental technician's workbench. As a result, it is capable to protect dental technician from inhaling the floating dust and thus protect them from long term effect of respiratory disease which is detrimental to health. The X-Dent Box has successfully reduced the indoor air pollution ($\pm 63.4\%$) and reduces the noise ($\pm 16.9\%$) from the handpiece during trimming and polishing process (Mohamed et al, 2017). This study will further try to investigate the effectiveness of X-Dent Box as the dust collector box to collect dust that form during trimming process from different type of dental materials that commonly used in the dental laboratory.

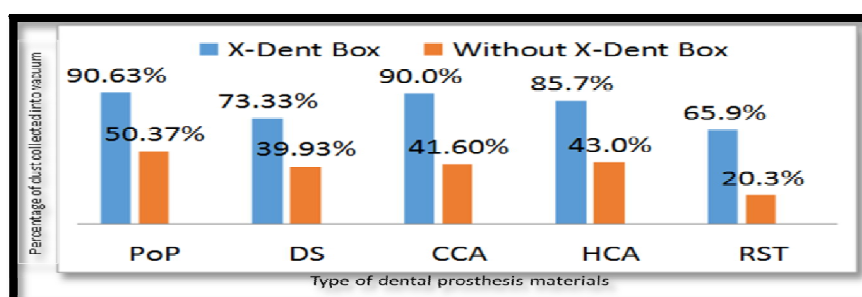
2. Methodology

Five types of commonly used and involved dental materials during the construction of dental prostheses were chosen. The materials were Plaster of Paris (PoP) and dental stone (DS) that are used the materials for study models and based, resin special tray (RST) material for special tray and cold cure acrylic (CCA) and heat cure acrylic (HCA) that are used for denture and wax rim base plate. All the materials were pre-formed in cuboid shape (standard size) with weight at 10g. The weight of vacuum bag from the vacuum suction that attached directly to workbench was measured before the trimming was done. The weight of the material sample was also measured pre-operatively before trimming. Trimming procedure was performed using the same straight hand piece and acrylic and stone bur for 4 minutes on those five different types of dental prostheses materials. The maximum time for trimming process was 4 minutes as that is the maximum duration of working time for the hand piece before it produced an increased of heat from trimming and bur rotation.

The collected dust in the vacuum bag and dust that left in the X-Dent Box was measured by weight using digital weighing scale (Electronic Bench Balance, 5KG/1G OZ LB 5000g). Then, the weight of the material sample was measured post operatively in order to compare the weight of each sample trimmed to the amount of material dust collected in the vacuum bag. The procedure was repeated 3 times for each sample of materials using X-Dent Box and without the use of X-Dent Box that being attached to the vacuum (Midea Vacuum Cleaner MVC-SC861R, with power usage of 600W) under the workbench.

The average weights from 3 measurements of each sample materials were calculated and the average weight was used for data analysis. The data was analyzed using Mann Whitney test (SPSS Version 21.0) to compare the weight of dust collected with X-Dent Box and without X-Dent Box and Kruskal Wallis test (SPSS Version 21.0) to compare the weight of dust collected from five dental prosthesis materials using X-Dent Box.

3. Results



Graph 1: Percentage of Weight of Dust Collected In Vacuum Bag with X-Dent Box and Without X-Dent Box Using Different Types Of Materials

The percentage of weight of dust collected using X-Dent Box and without X-Dent Box from five samples (Graph 1.0). The result portrays that all types of dental prosthesis materials showed more than 60% (n:5) of dust been collected using X-

Dent Box. The percentage of dust collected using X-Dent Box is between 65-90% as compared to without the box which only 20%-50%. The highest percentage of dust collected when using X-Dent Box was Plaster of Paris (PoP) and Cold Cure Acrylic (CCA) which is 90% and it is followed by heat cure acrylic (HCA) by 85.7%, dental stone (DS) by 73.3% and Resin Special Tray (TRS) by 65.9%. It is showed that different material which produced different shape and size of dust particle has different effectiveness of the dust being trapped and collected when using the X-Dent Box. Different shape of particle will contain different molecular weight thus has different duration of the dust to float freely in the air. The lighter molecular weight of the dust particles will take longer duration of time that it can expose floating into the air environment before it can settle down into sediment on the floor (Graham, 1979; Tsuda et al,2013). Therefore, it can be inhaled more by the dental technicians during that time (Tsuda et al, 2013; Foster et al, 2001).

However, there is no significant difference when the weight of the dust collected during trimming process with the use of X-Dent Box is compared to the weight of dust collected without the use of X-Dent Box ($p=0.056$) as shown in Table 1.0 of Mann Whitney Test. There is also no significant difference (Table 1.1) when the dust collected from all types of dental prosthesis materials is compared when using X-Dent Box ($p=0.406$).

Variable	Median (IQR)Median (IQR)		p- value
	X-Dent Box (n = 5)	Without X-Dent Box (n= 5)	
Weight of dust collected	2.00 (3.35)	1.00 (0.95)	0.056

Table 1: Comparison of Weight of Dust Collected In With X-Dent Box and Without X-Dent Box

	Weight of dust collected using X-Dent Box
Chi Square	4
Df	4
Asymp. Sign.	0.406

Table 2 : Comparison of Weight Of Dust Collected In Five Dental Prostheses Materials Using X-Dent Box and Without X-Dent Box

4. Discussion

It was found that by using X-Dent Box, it was successful in collecting dust from different types of dental prosthesis materials during trimming procedure between 65% to 90% as compared without the box (20% to 50%). In general, the result of this study showed that by using X-Dent Box during trimming procedure in laboratory it helps to reduce the floating dust particle from directly expose to the dental laboratory environment. The reduction or elimination of exposure by collective or individual protective measures are the best modalities of prevention (Leon et al,1999). Without adequate ventilation the levels of dust can be very high, exceeding recommended limits by up to 32 times (Selden et al., 1995). Even though, there is no significant difference between weights of dust collected using X-Dent Box and without X-Dent Box from different types of dental prosthesis material, X-Dent Box has shown that it is able to trap and collect more dust which then being suctioned directly into vacuum during trimming procedure. As a result, it proved that X-Dent Box can be the collective protective measures to prevent the hazardous dust from directly being inhaled by the dental technicians.

Mohamed et al in 2017 has reported that X-Dent Box has effectively reduced by more than 70% of the indoor air quality (IAQ) index. The study used only the dust formed from trimming process of the dental stone to prove the effectiveness of X-Dent Box to trap the dust produced during trimming process. In this study, the result has supported the previous study by showing the effectiveness of X-Dent box to collect the dust particles by different type of common dental prosthesis materials. Studies had been shown that the size of dust particles that produced during trimming, cutting and polishing process during the construction of dental prosthesis is less than $5\mu\text{m}$ (Ireland et al, 2003; Masayuki et al, 2009; Ilic et al, 2015) and can be to the size of $60\mu\text{m}$ to $150\mu\text{m}$ (Craig et al, 2000; Taira et al,2009). In dental laboratory, dust particles from methyl methacrylate that mostly consist in denture base material and special trays material is the major particle of exposure into the air of dental technician's work place (Hong et al, 2011). These particle size can be remained in the air for as much as 30 minutes to a few hours after the dental procedure and can easily reach the respiratory system which can further reach into the deeper gas exchange area in the lung (Ireland et al 2003 & 2011; Taira et al, 2009; Ilic et al,2015). By the use of X-Dent box, this study has been proved that the dust particle within the size of less than $5\mu\text{m}$ been successfully collected by the use of X-Dent Box from 65% to 90% thus can protect the dental technician from the inhalation of those dust particles.

Without the use of X-Dent Box, dental technician is highly advice to wear the personal protective equipment which is face mask and eye glasses protection to protect them from hazardous dust inhalation (Miller et al,2014, ADA Council of Dental Practice,1996). Studies has proved that dental technicians have risk to expose or infected by respiratory system diseases such asthma or upper respiratory tract infection within more than 3-6 months of working (Hu et al,2006, Kim et al,2002). This study found that without the use of X-Dent box only 20-50% of dust particles can be collected by the vacuum as compared 65-90% if X-Dent Box is used. Therefore, by using X-Dent box it can be conclude that the risk of dental technician being infected with respiratory disease infection can be reduce by more than 70% and also protect their eyes as X-Dent Box has top cover that can prevent splashing of the bigger size of particles or fragment directly to eyes. As a result, dental technicians do not have to wear eye glasses protection and thicker face mask as protection thus improve their efficiency due to better vision to working area.

5. Conclusion

As a conclusion, this study has shown that X-Dent Box can be useful as protective equipment for the dental technician and students from directly being exposed to floating dust during trimming procedure of different types of dental material prosthesis.

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