

Undergraduate Prosthodontics Students' Knowledge of Working With Methyl Methacrylate at Shahid Sadoughi Medical University in 2014

Mohammad Hossain Lotfikamran,¹ Sara Gholamhosseini,^{2,*} and Abbas Fallah Tafti³

¹Department of Prosthodontics, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, IR Iran

²School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, IR Iran

³Department of Prosthodontics, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Tehran, IR Iran

*Corresponding author: Sara Gholamhosseini, Dental Student, School of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, IR Iran. Tel: +98-3536255881, Fax: +98-3516250344, E-mail: atihosseini475@yahoo.com

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Abstract

Background: The toxicity of the methyl methacrylate monomer is an ongoing concern in dentistry. Therefore, those who are involved with this substance need to be cognizant of how to work with it.

Objectives: This study aimed to evaluate the level of working knowledge about methyl methacrylate among undergraduate prosthodontics students at Shahid Sadoughi university in 2014.

Materials and Methods: In this descriptive cross-sectional study, the knowledge level of 54 undergraduate prosthodontics students, who had passed the last 2 years of their education, was assessed via a 13-question survey related to methyl methacrylate. Each correct answer was assigned 2 points, and the total sum of right answers was used to measure the knowledge level of each participant. In order to analyze the study data, SPSS16 was used to apply an ANOVA test, t-test, and Pearson correlation coefficient.

Results: The mean level of individuals' knowledge in regard to working with methyl methacrylate was 14.74 ± 5.03 , with a domain variance of 0 to 22. A significant relationship was observed between age-related knowledge level mean and education level ($P = 0.001$), though no relationship was confirmed in regard to knowledge mean and gender ($P < 0.286$). Moreover, there was a reverse insignificant relationship between the students' total average and their knowledge level ($P = 0.715$).

Conclusions: The study results demonstrated that undergraduate prosthodontics students in their last two years of study had an average knowledge of working with methyl methacrylate. Therefore, health education should focus more on working with dentistry substances, in order to enhance the knowledge level of the targeted students.

Keywords: Knowledge, Methyl Methacrylate, Students

1. Background

Methyl methacrylate monomer (MMA), a transparent, colorless liquid with a strong smell, is polymerized by heat, light, or oxygen (1). MMA has a wide range of applications in dentistry, medicine, and industry (2). It is one of the basic constituent elements of numerous dentistry restorative materials and prosthesis resin. Furthermore, it is utilized as a bone cement in neurosurgery and orthopedic surgery, to fill the gap in the bones (3). Concerns have been raised about the toxicity of MMA since the early 1940s (4). As a matter of fact, researchers have reported that MMA plays a significant role in the production of free radicals (5). These radicals involve compounds detrimental to the tissues which can mediate the inflammation mechanism. Thus, their presence in each milieu, particularly in the oral milieu, can accelerate inflammatory reactions (5, 6).

Methyl methacrylate causes the peroxidation of lipids as well as the inhibition of antioxidant enzyme activities. In general, acrylic resins entail benzoyl peroxides, and when exposed to temperatures above 60°C, peroxide molecules of electrically neutral regions are formed involving unpaired electrons (7). These areas can be a source of free radicals. Since MMA is evaporated and the vapor pressure at 25° equals 40 mL of mercury, the risk of contamination with this substance is very high (8).

Due to their work in dental laboratories, dental technicians are regularly exposed to MMA. Constant contact with and inhalation of MMA vapors can lead to such adverse side effects as skin irritation (allergy), gastrointestinal disorders, liver toxicity, hemorrhage, and necrosis of the lung tissue (9). Other effects include eye irritation, stomatitis, asthma, and disorders of the central nervous system and reproductive systems (10). It should be mentioned that

MMA has not been introduced as a human carcinogen (11). The results of a study conducted in 2009 demonstrated that the use of clinical gloves alone does not protect dentists and technicians against the toxicity of MMA (12). Previous studies have recommended avoiding direct contact with this substance, as well as utilizing adequate ventilation in order to reduce the risk of such complications (2).

2. Objectives

Given the problems that MMA can be threatening for human health, this study was conducted to evaluate undergraduate prosthodontics students' (school of dentistry, Shahid Sadoughi Medical University, 2014) knowledge of the safety principles with respect to working with methyl methacrylate monomer in dental laboratories.

3. Materials and Methods

This descriptive cross-sectional study was conducted on 61 junior and senior undergraduate prosthodontics students at the Yazd school of dentistry, all of whom participated in the study voluntarily. The required information was collected by a two-part questionnaire: the first part gathered subjects' demographic information, while the second section contained 13 questions (drawn from some dentistry texts) to assess the students' knowledge about working with methyl methacrylate monomer. These questions were about MMA's pathways of absorption, its effects on the body, methods for measuring MMA vapor concentration, and methods for prevention of the side effect incidence. The questionnaire's validity was substantiated by a team of specialists in prosthodontics. Moreover, to assess the questionnaire's reliability, we conducted a pilot study on 10 students. Cronbach's alpha was calculated to give a benchmark level of 0.73. The students were given questionnaires individually, and the answers were obtained simultaneously as well.

In this study, data on the MMA-related questions were coded and valued according to the key answers to each question. The level of knowledge on each question was scored from zero to two. Accordingly, the total knowledge level ranged from 0 - 26. A low knowledge level was reported for scores of 1 - 8.99, moderate knowledge for scores of 9 - 16.99, and good knowledge level for scores of 17 - 26. The collected data was analyzed using SPSS (Version 16) via a t-test, ANOVA, and Pearson correlation coefficient. The significance level was considered relevant at 0.05.

4. Results

Sixty-one students took part the survey, among whom seven participants were excluded because their questionnaires were incomplete. The remaining 54 study participants consisted of 30 women (55.6%) and 24 men (44.4%), with a mean age of 22.52 ± 3.44 and the age range of 20 - 44 years. The total average score of these participants was 16.86 ± 1.01 (12 did not announce their average scores). The mean knowledge level of the subjects with respect to working with methyl methacrylate was 14.74 ± 5.03 , with a domain variance from zero to 22. To examine the relationship between subjects' knowledge level and age and sex, a t-test was used. The mean knowledge score significantly increased with age ($P = 0.001$). Females revealed more knowledge than males, though this difference was not statistically significant ($P = 0.286$) (Table 1).

Table 1. Comparing Participants' Knowledge Levels According to Age, Gender, and Education Level

| Variable | Number | Mean \pm SD | P Value |
|------------------------|--------|---------------|---------|
| Age, y | | | |
| 20 - 22 | 24 | 13.06 (5.38) | 0.001 |
| 23 - 44 | 30 | 17.38 (2.95) | 0.001 |
| Gender | | | |
| Male | 33 | 13.91 (5.85) | 0.286 |
| Female | 21 | 15.40 (4.25) | 0.286 |
| Education Level | | | |
| Term 5 | 21 | 11.23 (5.14) | 0.001 |
| Term 6 | 15 | 15.80 (4.41) | 0.001 |
| Term 7 | 8 | 17.50 (2.23) | 0.001 |
| Term 8 | 10 | 18.50 (2) | 0.001 |

ANOVA test results indicated a significant difference between the mean scores of students' knowledge level and the students' educational level, such that knowledge level increased in line with their education levels ($P = 0.001$) (Table 1). Moreover, the binary comparisons were performed using LSD, proposing that 5th-semester students showed significantly less knowledge than students in their 6th, 7th, and 8th semesters ($P < 0.05$). However, no significant knowledge differences were observed among students in semesters 6 - 8 ($P > 0.05$). Based on the Pearson correlation test, an insignificant inverse relationship was observed between students' total average score and their knowledge level ($P = 0.715$, $r = 0.058$).

5. Discussion

Some concerns have been raised regarding the potential toxicity of the methyl methacrylate monomer applied in dentistry, both for patients and dental staff. MMA, at least in vitro, appears to be toxic to cells and may cause irritation or allergic reactions in mucous membranes. In dental laboratories in which dental technicians are in regular contact with and may inhale MMA, complications may appear such as irritation and skin reactions, stomatitis, itchy feelings from fingertips, neuropathy, liver toxicity, hemorrhage, and necrosis of lung tissue (9). In this study, the majority of those students surveyed seem to be cognizant of the problems originating from this substance to the body (11). However, even though MMA does not appear to be carcinogenic to humans under normal conditions, in this study only one subject identified it as a non-carcinogenic substance.

Normally, the human respiratory volume is 15 liters per minute, and thus, 50% of the methyl methacrylate inhaled by breathing is absorbed by the lungs (13). MMA storage of more than one gram per kilogram of body weight will cause acute toxicity in the human body (14), a fact that 9.3% of subjects were aware of. The average allowable concentration of methyl methacrylate vapor is 204.70 mg/m (or 50 ppm). Exposure to strong odors can also cause skin and respiratory diseases (14). In this study, 13% of respondents were cognizant of this issue. Nadi and Asari put a great emphasis on measuring the levels of methyl methacrylate in the laboratory atmosphere, both in terms of the short-term exposures as well as exposure throughout the working shift (15).

The normal methods of analyzing the quality and quantity of acrylic compounds include gas chromatography, mass spectrometry, nuclear magnetic resonance, and infrared spectroscopy. Liquid gas chromatography is more technical than spectrophotometric methods, and seems to be more applicable (16). Thirty three percent of the subjects identified the correct answer, whereas more than half of them (57.4%) did not know the answer. Similarly, in the present study, 16.7% of respondents knew that the absorbed methyl methacrylate is excreted in the urine in the form of methanol (17). The study results introduced by Zaker-Jafari also revealed that the average amount of methanol in periodontics technicians' urine at the end of a working day was significantly greater than at the onset of their work. They also noted that the vapor concentration and duration of exposure to methyl methacrylate produced an important effect on methanol concentration in urine (13).

Regarding the toxicity of methanol and methyl methacrylate on vital organs such as the liver and kidneys,

it is necessitated to use appropriate protection methods, among which using masks and gloves can be considered the easiest initial procedures. Proper air conditioning in the working environment is a good second step, as it decreases the contact with methyl methacrylate vapor considerably (2). Koizumi and Ikeda proposed that absorbent materials can also have a significant influence on the concentration of methyl methacrylate vapor in a work environment. Therefore, the absorber tube can be effective in ensuring workplace safety (18). To reduce the risks of complications, dentistry staff should avoid direct contact with MMA (2). Fortunately, 90.7% of the study participants were cognizant of ways to prevent the adverse effects of MMA.

In addition to clinic staff, patients with a dental prosthesis are also faced with the effects of MMA. The maximum amount of methyl methacrylate monomer from a complete prosthesis with an acrylic base is release within 24 hours of delivery to the patient (19). 61.1% of the subjects in this study were aware of this problem. To reduce the amount of methyl methacrylate released from a dental prosthesis, it should be placed in water flow (1). Moreover, the patient is recommended to extract the dental prosthesis every night and put it in water (19-21). In the present study, 16.7% of the participants knew that applying this method can reduce the amount of methyl methacrylate released from the complete prosthesis in the patients' mouth. It is worth mentioning that the remaining monomer depends on not only the type of polymerization but also the amount of the liquid used in the mixture proportion, and on the burning method. The acrylic resin consisting of the lowest level of monomer releases the least amount of methyl methacrylate monomer. But resins with more resident monomer may release no more methyl methacrylate (22). 59.3% of participants knew about this issue.

In general, the level of knowledge was low in 5th semester students, medium in 6th semester students, and high in 7th and 8th semester students. This progress can be attributed to the presentation of proper courses as well as a good foundational education. Given these results, it is recommended to put more emphasis on health principles when working with dentistry materials.

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Footnotes

Authors' Contribution: Study concept and design: Mohammad Hossain Lotfikamran; acquisition of data: Sara Gholamhosseini; analysis and interpretation of data: Sara Gholamhosseini; drafting of the manuscript: Sara Gholamhosseini; critical revision of the manuscript for important intellectual content: Abbas Fallah Tafti; administrative, technical, and material support: Mohammad Hossain Lotfikamran; and study supervision: Mohammad Hossain Lotfikamran.

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