

## Letter to the Editor

# Simple and effective method to protect from toxic fumes of methyl methacrylate (bone cement) in operation theatre

Sir,

Methyl methacrylate (MMA) is a monomer of acrylic resin widely used in a variety of medical, dental, and industrial applications. Its extensive use in surgery, particularly for arthroplasties, has often raised concerns regarding potential human toxicity for orthopaedic surgeons, surgical nurses, and other operating-room staff who are occupationally exposed to the compound.<sup>1,2</sup>

Bone cement, when mixed before application, gives off a very pungent smell and cloud of fumes that operating theatre personnel near the operating table may inhale. This inhalation over time can lead to the nervous system side-effects (causing symptoms similar to drunkenness) with headache, drowsiness, nausea, weakness, fatigue, irritability, dizziness, and loss of appetite. Most people will not experience these nervous system side-effects without first experiencing local irritation to the skin, eyes, nose, or throat. MMA vapour at a level of 125 ppm may cause teary eyes, sore throat, coughing, and irritation of the nose. In animal studies, prolonged exposure to 400 ppm damaged the endothelium of the trachea. It is not known whether this occurs in humans.<sup>3</sup>

Most of the orthopedic surgeons do not use vacuum mixing of bone cement. In this article we present a simple and effective method to avoid inhaling toxic fumes generated while mixing bone cement before application.

### **What is our method?**

We routinely use bone cement in arthroplasty and for management of benign tumor like giant cell tumor. Second generation cementing technique manually mixing is done bone cement before application. We have noticed cloud of fumes filling whole operation theatre potentially affecting theatre personals. So we have adopted this method to avoid inhaling these toxic fumes. While mixing the bone cement we keep two working suction tubes on the mouth of bowl in which bone cement is being mixed. All toxic fumes generated out of MMA are sucked out of the operation theater. This method effectively eliminates the pungent smell and avoids inhaling the same (Figure 1).

MMA is a known irritant, inflammable and volatile shown to be possibly be toxic to the tracheal mucosa with reduced gastric motor activity, nausea and vomiting. It is shown to be a respiratory and skin sensitizer shown to

cause tears, conjunctival irritation and occasionally, corneal ulceration in operating room personnel, especially those wearing contact lenses.



**Figure 1: Method of keeping two working suction ends while mixing polymethyl methacrylate, toxic fumes are sucked out which significantly reduce the inhalation of fumes.**

Acute effects of methyl methacrylate are irritation to the skin, eyes, and mucous membranes in humans. An allergic response to dermal exposure may develop.<sup>4,6</sup> Respiratory symptoms reported in humans include chest tightness, dyspnoea, coughing, wheezing, and reduced peak flow.<sup>7</sup> Neurological symptoms, including headache, lethargy, lightheadedness, and sensation of heaviness in arms and legs, have occurred in humans following acute exposure to methyl methacrylate.<sup>7</sup> In mice and rats acutely exposed to high concentrations of methyl methacrylate by inhalation, degenerative olfactory changes in the nasal passages and lung damage have been observed. Tests involving acute exposure of rats, mice, rabbits, and guinea pigs have demonstrated methyl methacrylate to have low to moderate acute toxicity by inhalation or oral exposure.<sup>8</sup> Chronic effects (noncancer) includes respiratory and nasal symptoms and reduced lung function has been reported in chronically exposed workers.<sup>7</sup> In one study, occupational exposure to high doses of methyl methacrylate was associated with cardiovascular disorders in humans.<sup>4</sup> Chronic inhalation of methyl methacrylate by rats has resulted in respiratory effects (e.g., inflammation of the nasal cavity, degeneration/loss of olfactory epithelium in nasal turbinates, and lung congestion). Chronic inhalation of high levels of methyl methacrylate has resulted in degenerative and necrotic changes in the liver, kidney, brain, spleen, and bone marrow, decreased body weight

gain, listlessness, prostration, and ocular and nasal discharge in animals.<sup>5,7</sup>

Chemical structure of MMA is similar to that of a known carcinogen Dimethylnitrosamine. Epidemiological and experimental studies are inconclusive in relation to MMA being carcinogenic, however possibly a cause of sensitisation. Data on the effects of a single exposure to MMA is unavailable but studies indicate that in end user occupations like that of the operating nurse, where exposure is characterised by recurrent transient high peak levels, sensitisation that may occur is unknown as a kidney/liver toxin in humans; the important role these organs play in the body indicates the need for special consideration in individuals with impaired function of these organs.

Various recommendations in the operation theatre includes the theatre must be properly ventilated with frequent air changes. The liquid component and its vapours must not be exposed to a naked flame. Avoid direct contact with MMA. The wearing of a second/third pair of surgical gloves delays the spread and absorption of MMA proportional to the number of layers. Removal of the outer gloves directly after insertion of the cement and the donning of fresh pair/pairs is required. Exercise care when mixing the liquid (monomer) and powder (polymer) components to prevent inhalation exposure to the concentrated vapour. Splash proof safety goggles and face masks should be worn when mixing. Soft contact lens should not be worn when scrubbing for surgery that requires the mixing of bone cement. Mixing in an open mixing system should be carried out away from the face, the inhalation of the monomer vapour should be avoided and preferably a charcoal face mask should be worn if a vacuum mixing system is not available. If the liquid component comes into direct contact with the eyes, wash with copious amounts of water, report and seek medical advice. Numerous research studies have shown that the occupational hazards of MMA and the risk of contact between nursing staff and the cement are reduced by the use of effective vacuum cement mixing systems. Charcoal filtration at pressures <0.2 bars absolute pressure per minute to extract the potential hazardous vapours of MMA.<sup>2,12</sup> Cement should be stored as per manufacturer's recommendations, with the avoidance of direct sunlight. Pre-chilling the monomer at four degrees celsius eliminates the risk of monomer boiling at levels of 0.005 bar of pressure. However, the advice of the cement manufacturer should be sought before prechilling cement. Manufacturers reiterate many of these recommendations in the use of MMA. They remind surgeons to be thoroughly familiar with its component properties, handling characteristics and application to arthroplasty. Occupational health guidelines for MMA recommend medical surveillance of employees with COAD, skin, kidney and liver disease, as exposures to MMA vapour may exacerbate symptoms. The periodic examination of any employee developing the above listed symptoms is also recommended.<sup>3</sup>

In Indian scenario, most of hospitals do not have above facilities like vacuum mixing, laminar flow operation theatre, charcoal face mask etc. Suction apparatus is readily available in all operation theatres. In our method we use two working suction tubes on the mouth of bowl while mixing bone cement. We have noticed significant reduction in inhaled pungent smell of bone cement. We feel this method is effective in reduction of inhalation of fumes. Limitation of our method is lac of quantitative measurement of reduction in MMA fumes which is inhaled.

## CONCLUSION

Use of suction apparatus while manually mixing MMA before application is a simple, effective and reproducible method of avoiding inhalation of toxic fumes generated while mixing MMA. We recommend adopting this technique in all instances to mix MMA where facility of vacuum mixing is not available.

**Mohan Kumar E. G., Yathisha Kumar G. M.\*,  
Mohammed Noorudheen, Ajay Kumar**

Department of Orthopedic Surgery, K.I.M.S. Al Shifa  
Hospital, Perinthalmanna, Kerala, India

**\*Correspondence to**  
Dr. Yathisha Kumar G. M.,  
E-mail: yathishishere@gmail.com

## REFERENCES

1. Schummer W, Schlonski O, Breuer M. Bone cement embolism attached to central venous catheter. *Br J Anaesth.* 2014;112(4):672-4.
2. Leggat PA, Smith DR, Kedjarune U. Surgical applications of methyl methacrylate: a review of toxicity. *Arch Environ Occup Health.* 2009;64(3):207-12.
3. Caroline G. Methyl methacrylate: how safe is our OR environment? *J Nursing Res.* 2001;1:32-3.
4. U.S. Environmental Protection Agency. Health and Environmental Effects Profile for Methyl Methacrylate. EPA/600/x-85/364. Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, Office of Research and Development, Cincinnati, OH. 1985.
5. Calabrese EJ, Kenyon EM. *Air Toxics and Risk Assessment.* Chelsea, MI: Lewis Publishers; 1991.
6. Sittig M. *Handbook of Toxic and Hazardous Chemicals and Carcinogens.* 2nd edition. Park Ridge, NJ: Noyes Publications; 1985.
7. U.S. Environmental Protection Agency. Toxicological Review of Methyl Methacrylate (CAS No. 80-62-6) in Support of Summary Information on the Integrated Risk Information System (IRIS). National Center for Environmental Assessment, Office of Research and Development, Research Triangle Park, NC. 1998.

8. U.S. Department of Health and Human Services. Registry of Toxic Effects of Chemical Substances (RTECS, online database). National Toxicology Information Program, National Library of Medicine, Bethesda, MD; 1993.

**Cite this article as:** Mohan Kumar EG, Yathisha Kumar GM, Noorudheen M, Kumar A. Simple and effective method to protect from toxic fumes of methyl methacrylate (bone cement) in operation theatre. *Int J Res Orthop* 2020;6:230-2.