A possible mechanism for the toxicity of methacrylate monomers is elucidated in a recent publication from NIOM*. The resin matrix of dental restorative materials consists of combinations of methacrylate monomers like bisphenol A-glycidyl dimethacrylate (BisGMA), triethylene glycol dimethacrylate (TEGDMA), and glycerol dimethacrylate (GDMA) in composite fillings while 2-hydroxyethyl methacrylate (HEMA) is a major constituent in most dental adhesives. The polymerization process is never complete, and leakage of unreacted methacrylate monomers occurs during clinical service. Methacrylate monomers are associated with toxicity in many in vitro studies, however, mainly HEMA and TEGDMA have been studied in detail. The main mechanism is taught to be the monomers ability to deplete an important antioxidant in the cell called glutathione (GSH) and thereby cause toxicity. However, this theory has been questioned and other mechanisms have been proposed. Methacrylate monomers differ in their structure, size, and hydrophilicity thus, it is plausible that they can have different mechanism of toxicity. In the current study, the toxicity of five frequently used methacrylates (HEMA, TEGDMA, BisGMA, GDMA, MMA) are compared. We have found that the different metacrylate monomers differ in their ability to deplete the cellular antioxidant GSH, and that this binding does not fully corresponds to their toxicity. This was most apparent for the methacrylate BisGMA, which was toxic at low doses (figure 1), where GSH depletion was not observed. We concluded in this study that other, not yet known mechanisms can be involved in the observed toxicity of BisGMA.

It is important to elucidate possible mechanism of toxicity of these methacrylate monomers to contribute to safer materials in the future. Currently, NIOM has two Master students that study the mechanisms behind GDMA and BisGMA toxicity in more detail.

Clinical implication: The results may be indicative for explaining why patients may react to resin based materials and to which component(s) that are likely to cause an effect.

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FLOW CYTOMETRY

Flow cytometry is a technology that simultaneously measures and then analyzes multiple characteristics of single particles, usually cells, as they flow in a fluid stream through a beam of light. The technology is based upon detection of fluorescence and light scatter from a high number (usually several thousand) of single cells in suspension (figure 1). Cells can be labeled with fluorescent molecules (fluorochromes) that bind to specific components in the cells, such as DNA and protein. The cells are sent through an intense laser light causing light emission from the fluorochrome. This light is collected by a special type of optics that focuses the light in a fluorescence detector (photomultiplier). The photomultiplier converts light to electronic spikes that is proportional to the amount of fluorescent compound in the cell.

Flow cytometers have a wide range of applications. They are used in routine clinical laboratories and in many research laboratories.

NIOM has flow cytometers with the ability to analyze cells with the use of UV, 488 nm and 640 nm lasers. One example of measuring DNA in cells is seen in figure 2. A cell line (BEAS 2b) was exposed to 2-hydroxyethyl methacrylate (HEMA) for 24 hours, and differences in growth pattern are recorded. Other examples are measuring glutathione and reactive oxygen content in cells.

![Flow chamber](image1)

**Figure 1: Flow chamber**

![Cell cycle analysis](image2)

**Figure 2: Distribution of cells in cell cycle. A; control cells and B; HEMA exposed cells**

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The Nordic Institute of Dental Materials (NIOM) is responsible for promoting a continuing Nordic collaboration in the field of dental biomaterials. NIOM maintains a distinct Nordic profile through broad contacts with the Nordic dental educational institutions and research centres. The Institute undertakes research, materials testing, standardisation and research-based consulting directed towards health authorities and dental health services in the Nordic countries. Our research and consulting are required to be scientifically founded and applicable to clinical dentistry.