Polymethylmethacrylate (PMMA)

Methacrylate is a valuable tool to the neurosurgeon, even though it is currently being replaced by custom bone. During cranioplasty in the absence of custom bone, which is preformed based on the patients imaging, one has to make a cast to cover the cranial defect with or without the use of a mould. A good artificial skull outline is necessary for prevention of implant extrusion and acceptable cosmetic outcome ¹⁾.

Has a good degree of compatibility with human tissue

This compatibility was discovered by the English ophthalmologist Sir Harold Ridley in WWII RAF pilots, whose eyes had been riddled with PMMA splinters coming from the side windows of their Supermarine Spitfire fighters – the plastic scarcely caused any rejection, compared to glass splinters coming from aircraft such as the Hawker Hurricane.

In orthopedic surgery, PMMA bone cement is used to affix implants and to remodel lost bone. It is supplied as a powder with liquid methyl methacrylate (MMA). Although PMMA is biologically compatible, MMA is considered to be an irritant and a possible carcinogen. PMMA has also been linked to cardiopulmonary events in the operating room due to hypotension.

Bone cement acts like a grout and not so much like a glue in arthroplasty. Although sticky, it does not bond to either the bone or the implant, it primarily fills the spaces between the prosthesis and the bone preventing motion. A disadvantage of this bone cement is that it heats up to 82.5 °C (180.5 °F) while setting that may cause thermal necrosis of neighboring tissue.

A careful balance of initiators and monomers is needed to reduce the rate of polymerization, and thus the heat generated. A major consideration when using PMMA cement is the effect of stress shielding. Since PMMA has a Young's modulus between 1.8 and 3.1 GPa, which is greater than that of natural bone (around 14 GPa for human cortical bone), the stresses are loaded into the cement and so the bone no longer receives the mechanical signals to continue bone remodeling and so resorption will occur.

Dentures are often made of PMMA, and can be color-matched to the patient's teeth & gum tissue. PMMA is also used in the production of ocular prostheses, such as the osteo-odonto-keratoprosthesis. In cosmetic surgery, tiny PMMA microspheres suspended in some biological fluid are injected under the skin to reduce wrinkles or scars permanently.

Emerging biotechnology and Biomedical research uses PMMA to create microfluidic lab-on-a-chip devices, which require 100 micrometre-wide geometries for routing liquids. These small geometries are amenable to using PMMA in a biochip fabrication process and offers moderate biocompatibility.

Bioprocess chromatography columns use cast acrylic tubes as an alternative to glass and stainless steel. These are pressure rated and satisfy stringent requirements of materials for biocompatibility, toxicity and extractables.

see vertebroplasty.

Polymethylmethacrylate cranioplasty

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Bot GM, Ismail NJ, Usman B, Shilong DJ, Obande JO, Aliu S, Sale D, Shehu BB. Using the head as a mould for cranioplasty with methylmethacrylate. J Neurosci Rural Pract. 2013 Oct;4(4):471-4. doi: 10.4103/0976-3147.120207. PubMed PMID: 24347964; PubMed Central PMCID: PMC3858776.

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