Complications of Polymethyl Methacrylate Use in Esthetic Procedures: A Review

Complicações do uso de polimetilmetacrilato em procedimentos estéticos: Uma revisão

Henrique Cian da Cruz[1] Luana Tavares Neves[1] Júlia Tirloni Ramires[1] Natália Camila Correia Mendes[1] Giovana Beraldo Borges de Melo[1] Luísa Benincá Trentini[1] Ellen Fonseca Fumagale[1] Audrei Pavanello[1]

[1] Department of Medicine, Universidade Cesumar, Maringá, PR, Brazil

Rev Bras Cir Plást 2025;40:s00451810589.

Address for correspondence Henrique Cian da Cruz, Department of Medicine, Universidade Cesumar, Maringá, PR, Brazil (e-mail: henriquecian@hotmail.com).

Abstract

The search for alternatives to counteract the signs of aging has been increasing. One of these alternatives is polymethyl methacrylate (PMMA), a synthetic polymer and permanent dermal filler that is a low-cost and minimally-antigenic material which yields good esthetic outcomes. However, due to the potential complications, PMMA injections can be disastrous. Since the literature on the topic is scarce and healthcare professionals must be aware of these complications, the present study aimed to establish the relationship between PMMA use in esthetic procedures and its consequences. We conducted a review on the PubMed, Virtual Health Library, and SciELO databases, searching for articles published in any language from 2003 to 2023. The review included 27 studies. Early PMMA complications include pain, erythema, edema, allergies, hematomas, nodules, and tissue necrosis, which results from vascular obstruction and may lead to loss of tissue. In addition, there are reports of blindness and fat embolism resulting from improper PMMA application. Late complications can arise years after injection, and they include chronic inflammation, persistent granulomas, ulceration, allergic reactions, filler migration, infections, severe hypercalcemia, and renal failure. The use of PMMA in esthetic procedures can lead to severe complications, ranging from acute inflammations to permanent and fatal deformities, due to improper administration, lack of regulation, and the pursuit of quick outcomes. Therefore, it is essential to implement stringent regulatory and educational measures to protect the health and safety of the patients.

Keywords

- cosmetic techniques
- dermal fillers
- imprudence
- polymethyl methacrylate
- postoperative complications

Study conducted at Universidade Cesumar, Maringá, PR, , Brazil.

received
July 9, 2024
accepted
May 20, 2025

DOI https://doi.org/10.1055/s-0045-1810589.
ISSN 2177-1235.

Thieme Revinter Publicações Ltda., Rua Rego Freitas, 175, loja 1, República, São Paulo, SP, CEP 01220-010, Brazil

Resumo

A busca por alternativas para contornar as marcas do envelhecimento é crescente, e uma delas é o polimetilmetacrilato (PMMA), um polímero sintético e preenchedor dérmico permanente. É um material barato, pouco antigênico, e que leva a bom resultado estético. Entretanto, tendo em vista suas possíveis complicações, o preenchimento com PMMA pode ser desastroso. Assim, levando em conta a falta de estudos que sintetizem esse tema e a necessidade de os profissionais da saúde saberem dessas complicações, esta pesquisa buscou estabelecer a relação entre o uso do PMMA em procedimentos estéticos e as suas consequências. Para tanto, fez-se uma revisão nas bases de dados PubMed, Biblioteca Virtual em Saúde e SciELO buscando por artigos publicados em qualquer idioma entre 2003 e 2023. Ao todo, 27 estudos compuseram a revisão. As complicações precoces do uso de PMMA incluem dor, eritema, edema, alergias, hematomas, nódulos e necrose tecidual, que ocorre devido à obstrução vascular e pode resultar em perda de tecido. Também são relatados casos de cegueira e embolia gordurosa decorrentes da aplicação inadequada. As complicações tardias do uso de PMMA podem surgir anos após a injeção, e incluem inflamação crônica, granulomas persistentes, ulceração, reações alérgicas, migração do preenchimento, infecções, hipercalcemia grave e insuficiência renal. O uso de PMMA em procedimentos estéticos pode levar a complicações graves, desde inflamações agudas até deformidades permanentes e fatais, devido à imprudência na administração, à falta de regulamentação e à busca por resultados rápidos. Portanto, é essencial implementar medidas rigorosas de regulamentação e educação para proteger a saúde e a segurança dos pacientes.

Palavras-chave

- complicações pós-operatórias
- imprudência
- polimetilmetacrilato
- preenchedores dérmicos
- técnicas cosméticas

Introduction

Aging decreases the production of dermal collagen by fibroblasts. The reduced amount of dermal collagen results in loss of skin elasticity and sustainability.[1] This phenomenon increases the demand for esthetic procedures to deal with the aging process.[2] Currently, body filling and sculpting often use injections and prosthetics. Dentists, doctors, biomedical professionals, and pharmacists can perform these procedures, and each profession has inherent practical limitations.[1,3] Esthetic improvement employs several substances and materials and, among them, polymethyl methacrylate (PMMA) has shown success in these procedures.[2,4–6]

Polymethyl methacrylate is a polymer developed in 1902 as a bone cement;[6] however, its current applicability is broad. In medicine, PMMA is used in neurosurgery, orthopedic, dental, plastic, ophthalmic, and renal surgeries for functional and esthetic improvement.[6–9] Several attributes make PMMA a versatile and efficient material, including good biocompatibility and hemocompatibility, low weight and density, favorable esthetics (as it closely matches tissue color), simple technological use and synthesis, affordable price, mechanical stability, and good moldability.[4,7,10,11] Nevertheless, PMMA has several relevant negative points, including the potential for necrotic damage to local tissue due to exothermic reactions, low antimicrobial activity (that is, it may be more susceptible to infections than autologous tissue), high hydrophilicity, and low impact, flexural resistance, and porosity, which may interfere with vascularization.[4,7,12]

Many countries discuss the use of PMMA in esthetic procedures. Several studies[2,12–15] have reported that these interventions may not be effective and PMMA postoperative complications can hinder the patient's self-esteem and even their life.

The use of PMMA in esthetic procedures remains unsafe due to its potentially severe complications, especially in body regions highly valued by patients or posing a life risk, such as the lips, facial grooves, cheeks, chin, forehead, buttocks, and neck. Therefore, PMMA application is quite dangerous, especially considering the lack of treatment for its removal.[1,16,17] A recent Brazilian study,[18] for example, found that among 23 patients who experienced adverse reactions to esthetic fillers, PMMA was the most frequently used material.

The Brazilian Health Regulatory Agency (Agência Nacional de Vigilância Sanitária, ANVISA, in Portuguese) authorizes PMMA as a restorative treatment in two situations: facial and body volumetric correction due to disease sequelae and correction of lipodystrophy resulting from antiretrovirals for HIV/AIDS treatment, and PMMA indication includes corrective purposes alone, not esthetic purposes. Moreover, only qualified medical or dental professionals have permission to perform PMMA applications.[19] However, the Brazilian Federal Council of Medicine requested ANVISA to ban PMMA use in Brazil, with the support of powerful entities, such as the Brazilian Society of Plastic Surgery (Sociedade Brasileira de Cirurgia Plástica, SBCP, in Portuguese). The Brazilian Society of Dermatology (Sociedade Brasileira de Dermatologia, SBD, in Portuguese) contraindicates PMMA for

esthetic purposes but considers it a valuable material to treat antiretroviral-related lipodystrophy in HIV patients.[20] It is worth highlighting that not all antiretrovirals cause lipodystrophy to the same extent. This aspect must be taken into consideration when selecting treatments to avoid the future need for corrective esthetic procedures.[21]

A review of the scientific literature reveals the current lack of a specific antidote for PMMA in cases of complications from its application. Although the antidote concept does not apply to PMMA, effective complication management relies on early identification of symptoms and treatment according to severity. The standard therapeutic approach combines corticosteroid therapy with surgical removal of PMMA.

Therefore, professionals need to be aware of the potential outcomes of esthetic procedures. Considering the lack of studies summarizing these complications, it is imperative to have an approach that establishes and deepens the connection between PMMA use for esthetic purposes and its postoperative complications, bringing to light its "state of the art".

Objectives

The present study aimed to investigate the relationship between PMMA use for esthetic purposes and its complications. The specific objectives were to elucidate the current PMMA use in medicine, highlighting its applicability in the esthetic field, to describe the main complications resulting from PMMA use, focusing on esthetic and functional impairment, and to provide support for further in-depth research.

Materials and Methods

The current qualitative-descriptive study is a narrative review of the scientific literature from PubMed, the Virtual Health Library (VHL), and the SciELO databases. To prepare the review, we used the following descriptors: *Polymethyl Methacrylate*, *Cosmetic Techniques*, *Postoperative Complications*, *Dermal Fillers*, *Face*, and *Malpractice*, with alternating term combinations employing the Boolean operator *AND*. The inclusion criteria were articles available in full text through free or paid access, with no language restrictions, published from 2003 to 2023. The studies found were selected after we read their titles, abstracts, and full texts. We excluded duplicates and theses. Moreover, we checked the references from the selected studies to expand the scientific foundation. A total of 27 studies comprised the review. Doubts and disagreements among authors were solved by consensus.

Study Limitations

As a qualitative-descriptive study, the level of scientific evidence is low. However, the impact of the current study on public knowledge about PMMA complications is significant, since it provides timely and accurate information. Although the present study sporadically mentions medical procedures, its methodological rigor is not enough to guide medical treatments for PMMA complications. The databases may have influenced study selection. As such, the authors advise caution, as potentially different results may arise from other databases. Lastly, many articles included in the review are case reports; as a result, complications from a given case may not be valid for every population, requiring caution when extrapolating data.

Review

The use of PMMA can cause acute or chronic complications,[22,23] which can be mild (self-limiting and requiring no treatment), moderate (requiring monitoring and treatment), or severe (requiring immediate intervention to avoid injected tissue loss).[24] Late complications can occur years after filler injection and often require more complex treatments.[25]

Acute Complications

Early complications include pain at the injection site, erythema, edema, allergy, bruising, nodules resulting from superficial PMMA injection, and the most severe complication: tissue necrosis.[24]

Pain, erythema, edema, and bruising are usually common and resolve spontaneously, but lasting redness and itching may only improve with corticosteroid treatment.[26] Some patients may develop contact dermatitis due to previous sensitization with unnoticeable issues at the time of application. Itching and allergy treatment can use topical or intradermal corticosteroids and complete microsphere removal. One study[27] reported a case of allergic dermatitis within 24 hours of the PMMA filling in the nasal region of a 28-year-old patient. The subject presented local itching and erythema evolving within 72 hours into a large lesion involving both nasal wings and the bridge of the nose. Condition reversal required complete PMMA removal, and, at the 1-year follow-up, the patient presented healthy skin.[27] Telangiectasia can occur in subjects with thinner skin at the application site. It is often self-limiting, disappearing within 6 months, but may require laser treatment.[26]

Acute nodules result from asymmetrical and irregular application of PMMA. Superficial PMMA application can lead to palpable nodules, and, in this case, the only solution is surgical removal.[27,28]

Tissue necrosis is rare but very serious. It occurs due to partial or complete blood vessel occlusion.[25,29,30] This vascular obstruction potentially occurs by 3 mechanisms: 1) direct intravascular occlusion (resulting from filler injection inside the vessel); 2) blood vessel compression after the application of high amounts of PMMA, leading to tissue ischemia; and 3) delayed occlusion by intravascular platelet aggregation around the filler.[31]

A randomized trial in rabbits[31] examined the use of hot compresses to promote the recanalization of vascular occlusions and prevent tissue necrosis. Hot compresses may cause vasodilation and resume the blood flow. The study[31] concluded that immediate use of a hot compress can promote vasodilation and partial return of blood flow in early

obstruction, reducing the chance of necrosis; however, it cannot solve an embolism caused by the intravascular application of PMMA.

A Brazilian report[32] described cases of lip and nose necrosis after PMMA filler procedures in these regions; these lesions resulted from blockage of the facial artery or of its branches towards the nose and lips. The facial areas with most cases of intra-arterial injection are the lips, forehead, and nasolabial fold.[30] Control and treatment of lip complications are complex and sometimes impossible, requiring surgical excision of the nodules, the labial mucous membrane, and/or the orbicularis oris muscle.[33]

An injection of PMMA filler into the glabella region may lead to blindness. Although a rare complication, it may happen due to the connection between the supratrochlear artery and the ophthalmic artery.[32,34] In one report,[35] PMMA infiltration into the glabella affected branches of the ophthalmic artery, culminating in the propulsion of microspheres through the blood flow to the central artery of the retina and to the ciliary arteries, leading to blindness, ischemia of the cornea and iris, and total ophthalmoplegia. Furthermore, injections in the frontal region are potentially harmful to vision, as the forehead presents rich vascularization. As such, applications in this area may lead to infiltration in the large anastomotic network between the internal and external carotid circulations, which are close to the eyeball, resulting in flow obstruction and subsequent blindness (►**Table 1**).[36,37]

Injections of PMMA directly into arteries or close to them can cause vessel embolism and result in necrosis. This effect occurred after nasolabial fold applications affecting the right angular artery, the superior labial coronal artery, and the right inferior labial artery, leading to right hemiface necrosis.[38] Fat embolism syndrome is another condition potentially resulting from PMMA. It features fat emboli in the systemic circulation, causing direct capillary tissue damage, inducing a systemic inflammatory response, and resulting in

Table 1 Description of the reviewed articles

Author/Year	Title	Objective	Study Type	Conclusion
Silva and Curi[35] (2004)	Blindness and total ophthalmoplegia after aesthetic polymethyl methacrylate injection	To describe the case of a female presenting amaurosis and total ophthalmoplegia after PMMA injection	Case report	The authors believe this is the first report of blindness following PMMA microsphere injection, demonstrating the risk of its administration into the glabellar area
Medeiros et al.[25] (2014)	Complications after polymethyl methacrylate (PMMA) injections in the face: a literature review	To review several PMMA-associated complications	Literature review	PMMA is widely used due to its affordability, availability, and easy application. However, some complications are severe and permanent, and they can be confused with other types of oral lesions
Kurimori et al.[23] (2019)	Severe complication due to inappropriate use of polymethyl methacrylate: a case report and current status in Brazil (*Complicação grave do uso irregular do PMMA: relato de caso e situação brasileira atual*)	To report a severe complication of inappropriate PMMA use and discuss the current Brazilian reality	Case report and literature review	The seriousness of the reported case highlights the need to combat bad practices by unqualified professionals and the stricter control of PMMA commercialization by regulatory entities
Haneke[24] (2014)	Adverse effects of fillers and their histopathology	To address the types of fillers, their histopathological findings, and therapeutic modalities	Narrative review	It is essential that doctors have the proper qualification and use appropriate techniques, and that patients correctly follow postprocedure guidelines to avoid complications
Carle et al.[36] (2014)	Cosmetic facial fillers and severe vision loss	To describe three patients experiencing sudden vision loss after injection of three different dermal fillers	Case report	The filler likely enters the central retinal artery through the external-internal carotid anastomoses and becomes embedded in the retinal tissues, potentially leading to severe or irreversible vision loss
Lee et al.[37] (2020)	Ocular complications of soft tissue filler injections: a review of literature	To investigate visual impairment secondary to filler injection and discuss the related vascular anatomy, pathophysiology, and prevention of filler-related ocular complications	Literature review	A previous study reported that the injection site most commonly associated with blindness was the glabella; however, the site currently most commonly associated with blindness after filler injections is the nose. Extreme care is required to avoid the internal carotid artery branches

Table 1 (*Continued*)

Author/Year	Title	Objective	Study Type	Conclusion
Castro et al.[38] (2007)	Extensive facial necrosis after infiltration of polymethyl methacrylate (*Necrose facial extensa após infiltração com polimetilmetacrilato*)	To report the case of a female patient who developed necrosis in the right hemiface due to infection after PMMA infiltration in the nasolabial fold	Case report	This report demonstrates the risk of injections in the nasolabial region, especially with alloplastic materials used in bioplasty
Carpaneda and Carpaneda[39] (2012)	Adverse results with PMMA fillers	To demonstrate the correlation between the clinical application of PMMA and the pathophysiology of acute and late complications	Retrospective observational study	Initial complications result from vascular impairment, but later events occur due to capsular contracture involving PMMA particles. The contracture causes local tissue hardening and clinical nodulation at the implanted areas
Paulucci[40] (2020)	PMMA safety for facial filling: review of rates of granuloma occurrence and treatment methods	To review and compare granuloma rates in published studies and to compare therapies and their efficacies	Literature review	Considering the actual risks and benefits of PMMA, the authors say it is a safe filler; doctors and patients should be aware of the potential risks when deciding whether to use it
Liu, Beynet, and Gharavi[42] (2019)	Overview of deep dermal fillers	To analyze semipermanent and permanent injectable fillers	Literature review	Dermal fillers yield excellent cosmetic outcomes with short recovery time. The future development of new dermal fillers will advance the ability to optimally reshape the aging face
Tachamo et al.[43] (2018)	Hypercalcemia associated with cosmetic injections: a systematic review	To systematically review the published literature on cosmetic injection-associated hypercalcemia	Literature review	Hypercalcemia resulting from cosmetic injections can be severe and may occur years after the procedure. Granulomas are a potential cause, especially in middle-aged women with non-parathyroid hormone-related hypercalcemia and, sometimes, with elevated calcitriol levels
Woodward, Khan, and Martin[44] (2015)	Facial filler complications	To define facial filler complications and their treatment, providing suggestions to avoid serious adverse outcomes	Literature review	————
Souza et al.[41] (2016)	Late complication of cutaneous filling after a facelift: a case report (*Complicação tardia de preenchimento cutâneo após facelift: relato de caso*)	To present the case of a patient who underwent a facelift with a chin prosthesis implant to correct a PMMA application after 7 years	Case report	Clinical treatment is the first option for complications. Surgery is reserved for selected cases with unsuccessful clinical treatment, as in this case
Rosa and Macedo[46] (2005)	Adverse reactions to subdermal filler substances (*Reações adversas a substâncias de preenchimento subcutâneo*)	To present four cases of adverse reactions after using the following filling materials: polyacrylamide, polymethyl methacrylate, and poly(dimethylsiloxane)	Case series	The development of an ideal substance to fill soft tissues has not occurred yet. Therefore, these procedures may result in adverse reactions due to the substance used or an error in the application technique
Goldman and Wollina[45] (2019)	Polymethyl methacrylate-induced nodules of the lips: clinical presentation and management by intralesional neodymium: RAG laser therapy	To review PMMA fillers, known associated adverse events, and treatment options	Literature review	These events may develop several years after filler placement. Treatment is complex, but intralesional laser, alone or with surgery, seems a promising tool

(*Continued*)

Table 1 (*Continued*)

Author/Year	Title	Objective	Study Type	Conclusion
Manfro et al.[13] (2021)	Case reports of hypercalcemia and chronic renal disease due to cosmetic injections of polymethyl methacrylate (PMMA)	To report clinical cases of hypercalcemia and chronic kidney disease after cosmetic PMMA injections	Case reports	A multidisciplinary collaboration may help to unravel the actual frequency and relevant aspects of hypercalcemia and renal damage associated with PMMA fillers
Cannata-Ortiz et al.[14] (2016)	Small vessel microembolization and acute glomerulonephritis following infection of aesthetic filler implants	To highlight the risks of esthetic fillers and emphasize monitoring for potential renal complications	Case report	Esthetic filler implants can cause small vessel microembolization. Recognizing the characteristic morphology can speed up diagnosis
Oliveira et al.[22] (2020)	Fat embolism syndrome secondary to the use of polymethyl methacrylate in bioplasty: a systematic review (*Síndrome da embolia gordurosa secundária ao uso de polimetilmetacrilato na bioplastia: uma revisão sistemática*)	To highlight clinical studies regarding fat embolism syndrome in patients undergoing PMMA infiltration in bioplasty	Systematic review	The study highlights that knowledge of PMMA composition, physiological tissue reactions, absorption time, and persistence is essential
Lemperle, Romano, and Busso[26] (2003)	Soft tissue augmentation with artecoll: 10-year history, indications, techniques, and complications	To clarify PMMA advantages, effects, indications, contraindications, implantation technique, potential side effects, and complication treatment	Literature review	The authors consider PMMA reliable and predictable, attributing potential complications to the lack of skill and familiarity of doctors with it
Shah et al.[27] (2017)	Allergic contact dermatitis caused by polymethyl methacrylate following intradermal filler injection	To report the case of a patient who underwent a procedure to increase the tip of the nose with PMMA and developed allergic contact dermatitis	Case report	The application of PMMA can lead to sensitization and development of an allergic reaction, which can evolve into unfavorable outcomes
Friedmann, Kurian, and Fitzpatrick[28] (2016)	Delayed granulomatous reactions to facial cosmetic injections of polymethyl methacrylate microspheres and liquid injectable silicone: A case series	To report four cases of late granulomatous reactions to PMMA and injectable liquid silicone developing years after application	Case series	Delayed granulomatous reactions to permanent fillers can occur months to years after the procedure and are often refractory to treatment
Christensen et al.[29] (2005)	Adverse reactions to injectable soft tissue permanent fillers	To investigate the cause of adverse inflammatory reactions in facial tissues after the application of different types of permanent synthetic fillers	Observational study	Inflammatory nodules appear to be linked to low-grade bacterial infections maintained by biofilms on the injected materials. Some fillers have shown a greater tendency to form late nodules with bacteria, necrosis, and fibrosis
Rayess et al.[30] (2018)	A cross-sectional analysis of adverse events and litigation for injectable fillers	To determine the risks of injectable fillers and analyze factors raised in litigation due to injectable fillers	Cross-sectional study	Despite variations in material and application site, injectable fillers can cause adverse effects such as swelling, infection, and, in severe cases, necrosis and blindness
Sun et al.[31] (2023)	Early warm compress treatment can promote recanalization of vascular embolisms and reduce tissue necrosis after polymethyl methacrylate injection	To build a model of intravascular injection embolism and observe the effectiveness of warm and cold compresses in controlling the condition	Randomized controlled clinical trial	Early-stage warm compress after intravascular PMMA injection leads to vascular embolism recanalization and reduces tissue necrosis

Table 1 (*Continued*)

Author/Year	Title	Objective	Study Type	Conclusion
Vent and Lemperle[32] (2014)	Prevention and treatment of complications after polymethyl methacrylate-microspheres injections	To analyze the particularities of PMMA as a facial filler, addressing the application technique, adverse effects, and complication management	Literature review	PMMA is a viable option when used judiciously by experienced professionals with proper technique. Knowledge of the risks and potential complications is essential to ensure safety and good clinical outcomes
Salles et al.[33] (2008)	Complications after polymethyl methacrylate injections: report of 32 cases	To report and analyze complications resulting from PMMA use in procedures performed by professionals from different specialties	Case series	Complications ranged from acute to late manifestations, with different origins, including technical, infectious, and immunological
Limongi et al.[34] (2016)	Complications and management of polymethyl methacrylate (PMMA) injections to the midface	To analyze and report complications associated with PMMA facial application	Literature review	Surgical treatment has been shown to be more effective than conservative approaches, such as corticosteroids

several organic manifestations, including pulmonary, cutaneous, neurological, and retinal lesions with no specific treatment other than supportive measures.[22]

Still, on embolism, there is a report[14] of renal microembolization by PMMA associated with poststreptococcal glomerulonephritis (PSGN). In this case, the patient had distal leg ulcers that appeared progressively after minimal trauma 1 year before admission and a history of PMMA application (20 years before, due to HIV-related lipodystrophy) in the affected region. The culture of ulcer secretion ulcers revealed *Streptococcus pyogenes*. A renal biopsy identified findings consistent with PSGN and PMMA in glomeruli. It was speculated that PMMA reached the blood vessels in the application region and spread up to the kidney, in addition to causing posttraumatic local microembolization followed by ischemia and ulceration. The ulcers enabled bacterial infection, leading to PSGN. In another possibility, PMMA had already reached circulation at the time of application, 20 years before, spread to the renal glomerulus, and remained there for all these years without causing symptoms. Therefore, the presence of PMMA in the glomerulus is an unexpected finding in a successful application, and it should be considered a potential consequence of PMMA injections.[14]

Regarding the acute inflammatory reaction to PMMA, the lesion presents with a cellular infiltrate consisting mainly of neutrophils, lymphocytes, macrophages, and fibroblast-like cells, in addition to irregular and loose connective tissue around the PMMA microspheres.[39]

Chronic Complications

Late complications include chronic inflammation, persistent granulomas due to foreign bodies, ulceration from tissue necrosis, late allergic reactions, filler migration, and infection.[24] Implant displacement may result from facial movements altering PMMA positioning, causing the reappearance of marks that had previously disappeared after the application.[26]

Granulomatous reactions may occur in response to PMMA. Its proposed pathogenesis is an immunological cross-reaction with T cells and macrophage activation causing these immune cells to identify PMMA microspheres as incompatible in size with phagocytosis, evolving into granulomas; the microspheres may subsequently reach local lymph nodes.[28,29,40,41] After 3 months, the histological analysis reveals that the PMMA microspheres are completely encapsulated by fibroblasts and collagen fibers, with a minimal presence of macrophages. After 10 years, PMMA microspheres remain intact, accompanied by mature and robust collagen fibers, and the capillary vasculature is completely preserved.[42]

In a case series,[13] a granulomatous inflammatory reaction surrounded PMMA globules years after the application; this reaction increased the levels of extrarenal CYP27B1 (mainly in skeletal muscles), leading to greater extrarenal production of calcitriol, culminating in higher serum and urinary calcium levels. Severe hypercalcemia with hypercalciuria favors the formation of interstitial fibrosis and nephrocalcinosis, leading to chronic kidney disease.[13] In a study,[43] approximately 82% of the cases of hypercalcemia resulting from PMMA-secondary granulomas progressed with renal failure, and 2 resulted in death.

Another chronic complication is nodule formation. Nodules can be inflammatory or non-inflammatory. Inflammatory nodules result from infections caused by a lack of local antisepsis. In these cases, bacteria enter through the injection ports of the needle/cannula and settle at the site. The infection may result from biofilm development, that is, aggregates of encapsulated organisms, which hinder the action of several antibiotics against bacteria in biofilms.[25,30,44] In cases with no spontaneous resolution after drainage and site lavage, a combination of corticosteroids and antibiotics or a nonsteroidal anti-inflammatory drug may be useful. The ideal treatment for late complications consists of surgical PMMA removal; however, in most cases, the benefits of surgical intervention do not outweigh the risks.[29]

One study[34] observed 11 cases of complications after facial PMMA application, with a range of symptoms, in patients aged 36 to 62 years. Six subjects received

corticosteroid injections and showed minimal clinical improvement. Nine out of the 11 patients underwent surgical PMMA removal, which improved edema, erythema, and nodularity.[34]

Chronic complications often include granulomatous inflammatory reactions, skin discoloration, formation of fibrotic nodules, edema, erythema, allergy, and eyelid malposition.[34] The ideal treatment remains unclear, but corticosteroids may play a role. Treatment varies according to the severity and location of the adverse events, and it may include surgery for volume reduction or tissue reconstruction. In addition, advanced intralesional laser techniques have shown efficacy in treating nodules and granulomas.[45]

Given the complications arising from dermal fillers such as PMMA, the literature[46] has described some critical recommendations regarding this product to prevent future problems arising from its inappropriate use. These recommendations emphasized not proposing PMMA use to underage patients, the careful selection of procedural indications, and not applying this permanent filler without the patient having first tested absorbable fillers and having an actual idea of their effects. Recommendations also reinforce performing the injection in a completely-sterile environment, limiting the number of needle penetrations and the PMMA amount, and the meticulous monitoring of the patient after the procedure.[46] Ultrasound and Doppler can also reduce the risks of the procedure, as they ensure correct positioning and injection of PMMA.[32]

Conclusion

The complications associated with PMMA in esthetic procedures are particularly noteworthy, as they are potentially preventable to a certain extent. From acute inflammatory reactions to permanent and potentially fatal deformities, there are several risks with severe effects. There is no antidote for PMMA, and corticosteroids and surgical procedures are required to overcome its adverse effects, which open the door to many undesirable therapeutic phenomena, including severe and irreversible damage.

Careless administration of PMMA, the lack of adequate regulation, and the pursuit of immediate outcomes contribute to the incidence of these complications. Therefore, it is essential to implement strict regulatory and educational measures for professionals and patients to protect the health and safety of those seeking esthetic improvements.

Financial Support
The authors declare that they did not receive financial support from agencies in the public, private or non-profit sectors to conduct the present study.

Clinical Trials
None.

Conflict of Interests
The authors have no conflict of interests to declare.

References

1 Machado R-A, Oliveira L-Q, Martelli-Júnior H, Pires F-R, Carvas J-B, Rogerio V-E, et al. Adverse reactions to the injection of face and neck aesthetic filling materials: a systematic review. Med Oral Patol Oral Cir Bucal 2023;28(03):e278–e284. Doi: 10.4317/medoral.25713
2 Chacur R, Menezes HS, Chacur NMBDS, Alves DD, Mafaldo RC, Gomes LD, et al. Replacement of gluteal implants by polymethyl methacrylate filler: case report. Case Reports Plast Surg Hand Surg 2019;6(01):20–24. Doi: 10.1080/23320885.2018.1549946
3 Cohen JL, Rivkin A, Dayan S, Shamban A, Werschler WP, Teller CF, et al. Multimodal Facial Aesthetic Treatment on the Appearance of Aging, Social Confidence, and Psychological Well-being: HARMONY Study. Aesthet Surg J 2022;42(02):NP115–NP124. Doi: 10.1093/asj/sjab114
4 Díez-Pascual AM. PMMA-Based Nanocomposites for Odontology Applications: A State-of-the-Art. Int J Mol Sci 2022;23(18):10288. Doi: 10.3390/ijms231810288
5 Nie F, Xie H, Wang G, An Y. Risk Comparison of Filler Embolism Between Polymethyl Methacrylate (PMMA) and Hyaluronic Acid (HA). Aesthetic Plast Surg 2019;43(03):853–860. Doi: 10.1007/s00266-019-01320-w
6 Soares FMG, Costa IMC. Lipoatrofia facial associada ao HIV/AIDS: do advento aosconhecimentos atuais. An Bras Dermatol 2011;86(05):843–864. Doi: 10.1590/S0365-05962011000500001
7 Stoops K, Brown JM, Santoni B, Groundland J. Thermal properties of polymethyl methacrylate vary depending on brand and type. J Orthop Res 2023;41(03):614–618. Doi: 10.1002/jor.25389
8 Shiraki A, Sakimoto S, Oie Y, Soma T, Miki A, Usui S, et al. Inferior Removal of Dislocated Polymethyl Methacrylate Intraocular Lens and Scleral Refixation in Glaucomatous Eyes. Ophthalmol Ther 2022;11(02):881–886. Doi: 10.1007/s40123-022-00477-z
9 Kishikawa T, Fujieda H, Sakaguchi H. Comprehensive analysis of cytokine adsorption properties of polymethyl methacrylate (PMMA) membrane material. J Artif Organs 2022;25(04):343–349. Doi: 10.1007/s10047-022-01323-6
10 Mezzina L, Nicosia A, Baratta GA, Palumbo ME, Scirè C, Mineo PG. Effects of Simulated Solar Wind on Polymethyl Methacrylate Thin Film. Nanomaterials (Basel) 2022;12(12):1992. Doi: 10.3390/nano12121992
11 Marić I, Zore A, Rojko F, Škapin AS, Štukelj R, Učakar A, et al. Antifungal Effect of Polymethyl Methacrylate Resin Base with Embedded Au Nanoparticles. Nanomaterials (Basel) 2023;13(14):2128. Doi: 10.3390/nano13142128
12 Leão RdS, Maior JRS, Lemos CAdA, Vasconcelos BCdE, Montes MAJR, Pellizzer EP, Moraes SLD. Complications with PMMA compared with other materials used in cranioplasty: a systematic review and meta-analysis. Braz Oral Res 2018;32:e31. Doi: 10.1590/1807-3107bor-2018.vol32.0031
13 Manfro AG, Lutzky M, Dora JM, Kalil MAS, Manfro RC. Case reports of hypercalcemia and chronic renal disease due to cosmetic injections of polymethylmethacrylate (PMMA). J Bras Nefrol 2021;43(02):288–292. Doi: 10.1590/2175-8239-JBN-2020-0044
14 Cannata-Ortiz P, Gracia C, Aouad Y, Barat A, Martinez-Gonzalez MA, Rossello G, et al. Small vessel microembolization and acute glomerulonephritis following infection of aesthetic filler implants. Diagn Pathol 2016;11:2. Doi: 10.1186/s13000-016-0453-y
15 Costa YC, Aurelio MG, María HGS, Mauro V, Carlos B. Embolia pulmonar por polimetilmetacrilato. Rev Argent Cardiol 2009;77(02):129–130. Available from: https://www.redalyc.org/pdf/3053/305327028011.pdf
16 Atiyeh B, Ghieh F, Oneisi A. Safety and Efficiency of Minimally Invasive Buttock Augmentation: A Review. Aesthetic Plast Surg 2023;47(01):245–259. Doi: 10.1007/s00266-022-03049-5
17 Sousa AMSd, Duarte AC, Decnop M, Guimarães DdF, Coelho Neto CAF, Sarpi MdO, et al. Imaging Features and Complications of Facial Cosmetic Procedures. Radiographics 2023;43(12):e230060. Doi: 10.1148/rg.230060

18 Tetzner AC, Viana LRM, Abreu LG, Mendonça EF, Arantes DAC, Vasconcelos ACU, et al. Adverse Reactions to Cosmetic Fillers in the Oral and Maxillofacial Region: Clinico-Pathological, Histochemical, and Immunohistochemical Characterization. J Oral Pathol Med 2025;54(03):141–150. Doi: 10.1111/jop.13604
19 Agência Nacional de Vigilância Sanitária - Anvisa. PMMA. Ministério da Saúde [online]. 2024. Disponível em: https://www.gov.br/anvisa/pt-br/assuntos/campanhas/estetica/pmma
20 Conselho Federal de Medicina. Requerimento do CFM à Anvisa visando a proibição de uso do polimetilmetacrilato (PMMA) como substância de preenchimento: fundamentação técnica e científica. Janeiro de 2025 Disponível em: https://portal.cfm.org.br/wp-content/uploads/2025/01/PMMA-ANVISA-versao-5.0-WORD-VERSAO-FINAL-21022025-11h20.pdf
21 De Waal R, Cohen K, Maartens G. Systematic review of antiretroviral-associated lipodystrophy: lipoatrophy, but not central fat gain, is an antiretroviral adverse drug reaction. PLoS One 2013;8(05):e63623. Doi: 10.1371/journal.pone.0063623
22 Oliveira CGA, Sales FRD, Faria FA, Darwich Filho RZ. Síndrome da embolia gordurosa secundária ao uso de polimetilmetacrilato na bioplastia: uma revisão sistemática. Rev Bras Cir Plást 2020;35(02):206–211. Doi: 10.5935/2177-1235.2020RBCP0035
23 Kurimori KT, Mendes M, Milcheski DA, Monteiro AA Junior, Gemperli R. Complicação grave do uso irregular do PMMA: relato de caso e a situação brasileira atual. Rev Bras Cir Plást 2019;34(01):156–162. Doi: 10.5935/2177-1235.2019RBCP0025
24 Haneke E. Adverse effects of fillers and their histopathology. Facial Plast Surg 2014;30(06):599–614. Doi: 10.1055/s-0034-1396755
25 Medeiros CC, Cherubini K, Salum FG, de Figueiredo MA. Complications after polymethylmethacrylate (PMMA) injections in the face: a literature review. Gerodontology 2014;31(04):245–250. Doi: 10.1111/ger.12044
26 Lemperle G, Romano JJ, Busso M. Soft tissue augmentation with artecoll: 10-year history, indications, techniques, and complications. Dermatol Surg 2003;29(06):573–587, discussion 587. Doi: 10.1046/j.1524-4725.2003.29140.x
27 Shah V, Chaubal TV, Bapat RA, Shetty D. Allergic contact dermatitis caused by polymethylmethacrylate following intradermal filler injection. Contact Dermatitis 2017;77(06):407–408. Doi: 10.1111/cod.12779
28 Friedmann DP, Kurian A, Fitzpatrick RE. Delayed granulomatous reactions to facial cosmetic injections of polymethylmethacrylate microspheres and liquid injectable silicone: A case series. J Cosmet Laser Ther 2016;18(03):170–173. Doi: 10.3109/14764172.2015.1114642
29 Christensen L, Breiting V, Janssen M, Vuust J, Hogdall E. Adverse reactions to injectable soft tissue permanent fillers. Aesthetic Plast Surg 2005;29(01):34–48. Doi: 10.1007/s00266-004-0113-6
30 Rayess HM, Svider PF, Hanba C, Patel VS, DeJoseph LM, Carron M, Zuliani GF, et al. A Cross-sectional Analysis of Adverse Events and Litigation for Injectable Fillers. JAMA Facial Plast Surg 2018;20(03):207–214. Doi: 10.1001/jamafacial.2017.1888
31 Sun Y, Jin M, Wang G, Xie H. Early warm compress treatment can promote recanalization of vascular embolisms and reduce tissue necrosis after polymethyl methacrylate injection. Sci Rep 2023;13(01):1872. Doi: 10.1038/s41598-023-29043-8
32 Vent J, Lemperle G. Prevention and treatment of complications after polymethylmethacrylate-microspheres injections. Facial Plast Surg 2014;30(06):628–634. Doi: 10.1055/s-0034-1396703
33 Salles AG, Lotierzo PH, Gemperli R, Besteiro JM, Ishida LC, Gimenez RP, et al. Complications after polymethylmethacrylate injections: report of 32 cases. Plast Reconstr Surg 2008;121(05):1811–1820. Doi: 10.1097/PRS.0b013e31816b1385
34 Limongi RM, Tao J, Borba A, Pereira F, Pimentel AR, Akaishi P, Cruz AAVe. Complications and Management of Polymethylmethacrylate (PMMA) Injections to the Midface. Aesthet Surg J 2016;36(02):132–135. Doi: 10.1093/asj/sjv195
35 Silva MT, Curi AL. Blindness and total ophthalmoplegia after aesthetic polymethylmethacrylate injection: case report. Arq Neuropsiquiatr 2004;62(3B):873–874. Doi: 10.1590/s0004-282X2004000500025
36 Carle MV, Roe R, Novack R, Boyer DS. Cosmetic facial fillers and severe vision loss. JAMA Ophthalmol 2014;132(05):637–639. Doi: 10.1001/jamaophthalmol.2014.498
37 Lee W, Koh IS, Oh W, Yang EJ. Ocular complications of soft tissue filler injections: A review of literature. J Cosmet Dermatol 2020;19(04):772–781. Doi: 10.1111/jocd.13213
38 Castro ACB, Collares MVM, Portinho CP, Dias PC, Pinto RA. Necrose facial extensa após infiltração com polimetilmetacrilato. Rev Bras Otorrinolaringol 2007;73(06):850. Doi: 10.1590/S0034-72992007000600019
39 Carpaneda EdM, Carpaneda CA. Adverse results with PMMA fillers. Aesthetic Plast Surg 2012;36(04):955–963. Doi: 10.1007/s00266-012-9871-8
40 Paulucci BP. PMMA Safety for Facial Filling: Review of Rates of Granuloma Occurrence and Treatment Methods. Aesthetic Plast Surg 2020;44(01):148–159. Doi: 10.1007/s00266-019-01522-2
41 Souza RNd, Mendoça SdG, Alencar EC, França ALdA, Araújo EGd, Leite LAdS. Complicação tardia de preenchimento cutâneo após facelift: relato de caso. Rev Bras Cir Plást 2016;31(02):269–272. Doi: 10.5935/2177-1235.2016RBCP0043
42 Liu MH, Beynet DP, Gharavi NM. Overview of Deep Dermal Fillers. Facial Plast Surg 2019;35(03):224–229. Doi: 10.1055/s-0039-1688843
43 Tachamo N, Donato A, Timilsina B, Nazir S, Lohani S, Dhital R, Basnet S, et al. Hypercalcemia associated with cosmetic injections: a systematic review. Eur J Endocrinol 2018;178(04):425–430. Doi: 10.1530/EJE-17-0938
44 Woodward J, Khan T, Martin J. Facial Filler Complications. Facial Plast Surg Clin North Am 2015;23(04):447–458. Doi: 10.1016/j.fsc.2015.07.006
45 Goldman A, Wollina U. Polymethylmethacrylate-induced nodules of the lips: Clinical presentation and management by intralesional neodymium:YAG laser therapy. Dermatol Ther 2019;32(01):e12755. Doi: 10.1111/dth.12755
46 Rosa SC, Macedo JLS. Reações Adversas a Substâncias de Preenchimento Subcutâneo. Rev Bras Cir Plást 2005;20(04):248–252. Available from: https://rbcp.org.br/Content/imagebank/pdf/20-04-11.pdf