JBNC
JORNAL BRASILEIRO DE NEUROCIRURGIA
BRAZILIAN JOURNAL OF NEUROSURGERY

Correction of Cranial Asymmetry with PMMA: case report

Correção de Assimetria Craniana com PMMA: relato de caso

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ABSTRACT

Cranioplasty is a reconstructive procedure used to restore the skull anatomy and to repair defects in its bones or subcutaneous tissue. The aim of this study is to present the use of polymethylmethacrylate (PMMA) as a subcutaneous filler for the correction of skull deformities. The analysis of a PMMA filling of the skull (scalp) was performed and its use to correct cranial deformity was effective and safe.

Keywords: *PMMA; Filler; Cranioplasty; Reconstructive procedure*

Resumo

A cranioplastia é um procedimento reconstrutivo para restaurar a anatomia craniana e reparo de defeitos ósseos ou de tecido subcutâneo. O objetivo deste estudo é apresentar o uso de polimetilmetacrilato (PMMA) como preenchedor subcutâneo para correção de deformidade craniana. Foi realizada a sua análise como um preenchedor de crânio e seu uso para correção de deformidade craniana foi efetivo e seguro.

Palavras-chave: *PMMA; Preenchedor; Cranioplastia; Procedimento reconstrutivo*

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Received July 3, 2020
Corrected Nov 29, 2021
Accepted Jan 25, 2022

INTRODUCTION

Cranioplasty is a well-established reconstructive procedure used to restore the skull anatomy and repair bones defects, both congenital and traumatic. Skull defects can result in deformities, lack of brain protection, and a variety of symptoms, such as chronic headaches and mild developmental delay. The prosthetic material used in these cases is a dense polymethylmethacrylate (PMMA) implant designed for bone repair. The use of PMMA for restoration is usually based on biocompatibility factors and cosmetic results[1-7].

Regarding the biocompatibility, many autograft, xenograft and allograft materials have been used in cranioplasty. Many features have been suggested to describe the ideal material for cranioplasty, such as tissue tolerance, simplicity of manufacture, easiness of sterilization, low thermal conductivity, radiolucency, light weight, biomechanical reliability, resistance to infections, no heat swelling, and low cost. It should also be ready to use, but there is no perfect material which would fit all these criteria.

Over the time, metals, ceramics, plastics, and recently resorbable polymers and biomaterials have been used in craniofacial reconstructions. Polymethylmethacrylate (PMMA) is a thermoplastic and transparent polymer material most often used as allograft material for cranial reconstructions with good long-term results. PMMA has proved to be superior to metals due to its light weight, low cost, malleability, radiolucency, and lack of thermal conductivity. The biggest advantages of this material are its flexible intraoperative application and its unlimited possibilities of being adaptable to individual anatomy.[1.4.6.7]

Cranioplasty is one of the oldest known neurosurgical procedures, being an intervention to correct the cranial defects both aesthetically and functionally[2,3,5,7]. Customized craniofacial implants (CCI) are often used to restore brain protection and to reconstruct acquired cranial deformities.[4.7] Polyetheretherketone (PEEK) and polymethylmethacrylate (PMMA) are the most commonly used materials in implants. Overall, these polymers have similar properties, being easily moldable, biologically inert, and able to maintain bone biomechanical properties.

PMMA has an extensive history dating back to the 1940s. However, a major disadvantage for its application is that liquid PMMA, in high density, releases an exothermic reaction with the potential for injury to nearby nervous structures. Considering this potential, the industry has developed solid prefabricated CCIs made of PMMA in an attempt to avoid such inconvenience. Thus, customized PMMA implants can now be delivered to the operating room in a solid state[4-7].

Even though the bone problem of cranioplasty has been solved, there is still the aesthetic aspect. To deal with this issue, when there is lack of volume in a certain part of the scalp, low density PMMA (10% and 30%), in a gel state, is applied under the scalp with the intention of demonstrating that PMMA can be used to correct cranial deformities.

CASE PRESENTATION

A 24-year-old male patient came to the clinic due to a head deformity. He felt social embarrassment because of deformities on his face (flattened forehead, small chin) and skull (scalp area with lateral and posterior deformities) and the treatment with PMMA filling in the affected areas was suggested (Figures 1 and 2).

The first application of PMMA in the affected areas was in January 2012, followed by several applications (total of 59 mL) with three-month intervals or more until the end of the treatment in 2015. The most significant complication was hair loss in the beginning of the treatment, which was spontaneously completely recovered after nine months. After five years follow-up no adverse effect was observed (Figure 3, 4 and 5).

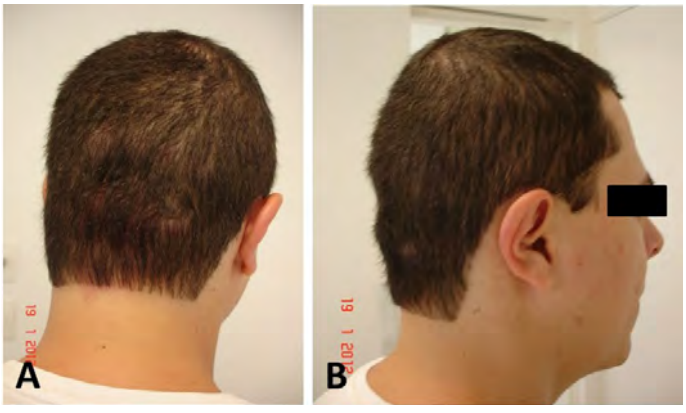

Figure 1. Pre-operative image. A. anomalies of the cranial, temporal and occipital regions; B. Forehead.

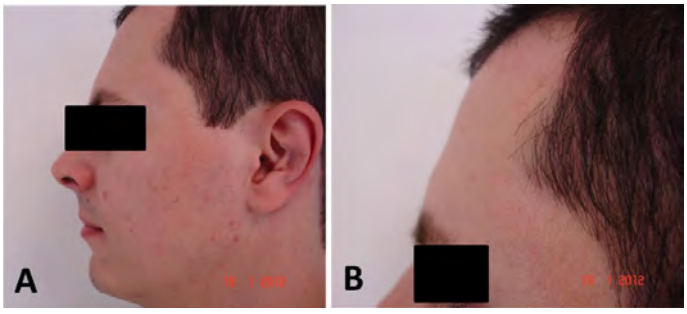

Figure 2. Pre-operative image A. forehead and chin anomalies; B. forehead anomaly.

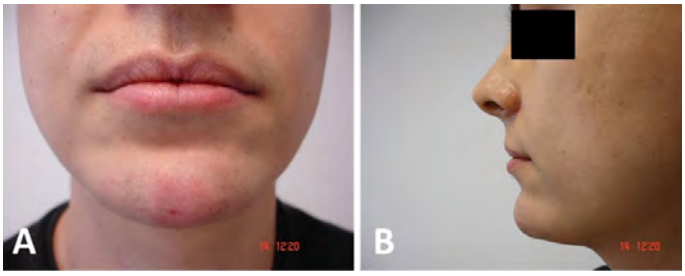

Figure 3. A and B. Post-operative image. Correction of chin deformity.

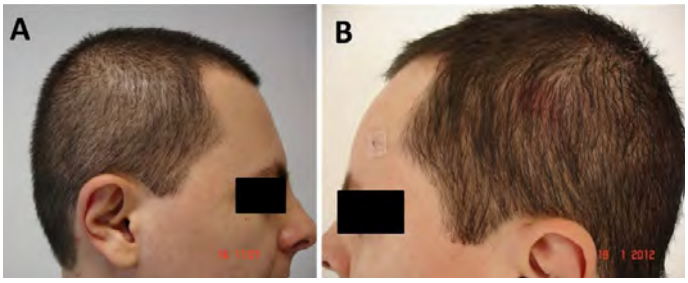

Figure 4. Post-operative image. A. Correction of deformities in the occipital and temporal regions; B. Correction of forehead deformity

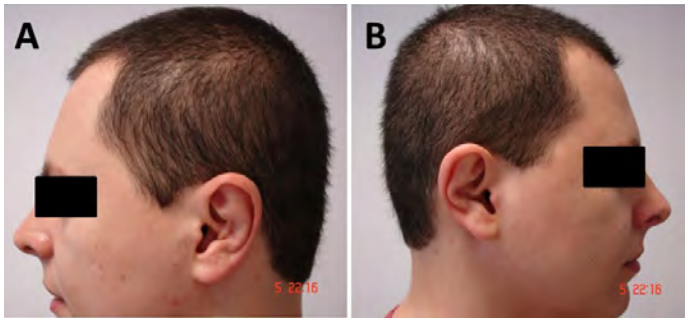

Figure 5. Post-operative image. A. Correction of deformities in the occipital and temporal regions; B. Correction of forehead deformity.

This case report was submitted to Plataforma Brasil (an online system run by the Brazilian Federal government), and approved by the Research Ethics Committee of the Universidade Veiga de Almeida (UVA/RJ) (CAAE protocol number 30721820.3.0000.5291).

DISCUSSION

The use of PMMA to replace skull bones has already been established[1-7]. The use of PMMA in the scalp was based on the previous experiences of the staff using the polymer in other parts of the body[8-13]. In the present case, PMMA 10% and 30% in the form of gel, used to correct cranial deformities, were injected under the scalp in several points of the skull.

Initial results, with alopecia in the treated area, were unexpected and lead the professional team to rethink the application. The most probable cause for this side effect is that the post-procedure edema decreased blood circulation in the hair bulbs, which caused ischemia and hair loss. Subsequent applications, after full hair recovery, were done with a lower volume of the polymer; thus, correcting the problem.

The aesthetic result was obtained after several sessions of filling with PMMA 30% and 10%. The final result (Figure 6) of the correction of the forehead, chin, and entire scalp area were satisfactory. In follow-up after almost 10 years, computed tomography (CT) images were also taken from the patient (Figures 7, 8 and 9).

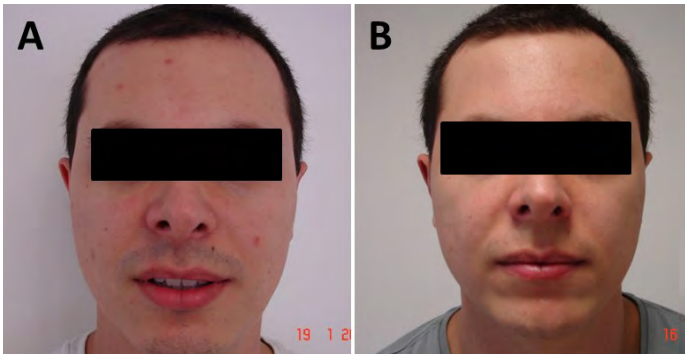

Figure 6. A. Pre-operative image (2012); B. Post-operative (2015) after correction of cranial region, forehead, and chin.

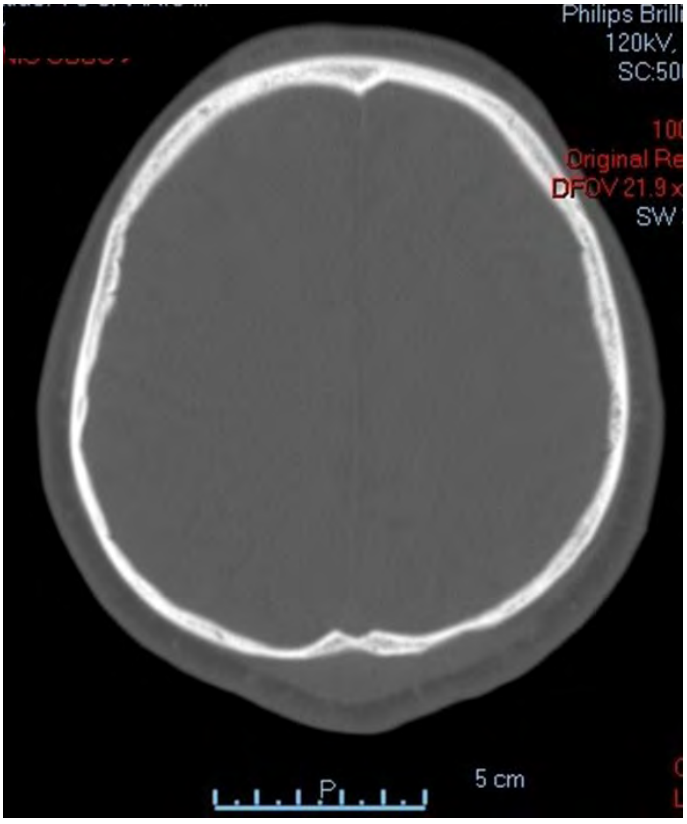

Figure 7. CT, Axial view in bone window with local evidence of implant in frontal and occipital regions (December, 2021) in follow-up almost 10 years after the first implant application.

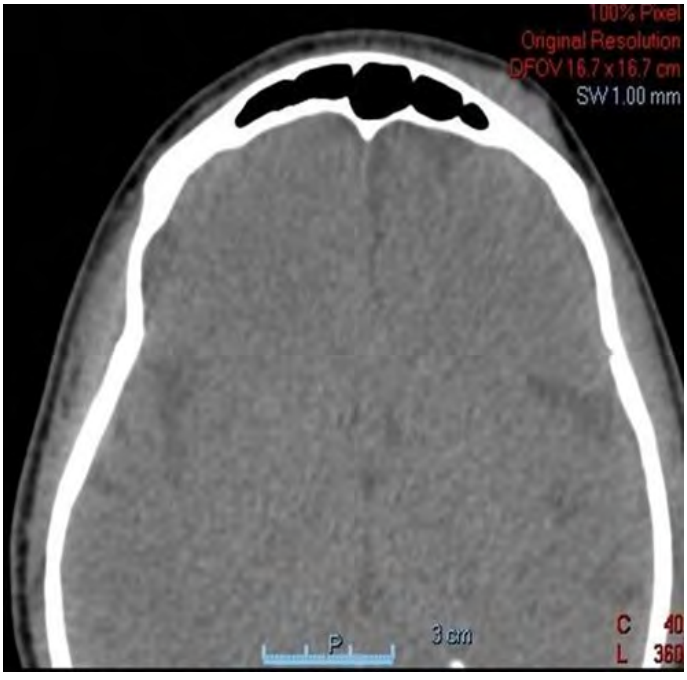

Figure 8. CT, Axial view (December, 2021), in follow-up almost 10 years after the first implant application.

Figure 9. CT, Sagittal view evidencing implant in the temporal and chin region (December, 2021) in follow-up almost 10 years after the first implant application.

CONCLUSION

The use of PMMA to correct cranial deformities was effective and safe. Cranioplasty with application of PMMA in the form of a low-concentration gel under the scalp provides a safe, affordable, and cosmetically acceptable alternative for the cranial shape reconstruction.

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Funding: *nothing to disclose*
Conflicts of interest: *nothing to disclose*
Ethics Committee Approval: *Universidade Veiga de Almeida (UVA/RJ); CAAE protocol number 30721820.3.0000.5291.*