PriMera Scientific
Medicine and Public Health
Volume 8 Issue 4 April 2026
DOI: 10.56831/PSMPH-08-282
ISSN: 2833-5627

Geometry Simplifying Symmetry: An Innovative Technique to Obtain Symmetry in Cranial Implants

Type: Research Article
Received: February 17, 2026
Published: April 07, 2026

Citation:
Monika Nandan., et al. "Geometry Simplifying Symmetry: An Innovative Technique to Obtain Symmetry in Cranial Implants". PriMera Scientific Medicine and Public Health 8.4 (2026): 21-29.

Monika Nandan[1]*, Anurag Jain[2], Harmeet Singh[3] and Gautam Khatak[4]

[1]*Senior Resident, Department of Dental Surgery, VMMC and Safdarjung Hospital, New Delhi, India*

[2]*Professor and Consultant, Department of Dental Surgery, VMMC and Safdarjung Hospital, New Delhi, India*

[3]*Staff Surgeon (NFSG), Dental Department, A.B.V.I.M.S and Dr. RML Hospital, New Delhi, India*

[4]*H.O.D, Dental Department, A.B.V.I.M.S and Dr. RML Hospital, New Delhi, India*

***Corresponding Author:** Dr. Monika Nandan, Senior Resident, Department of Dental Surgery, VMMC and Safdarjung Hospital, New Delhi, India.

Abstract

Establishing symmetry in cranial prosthesis is important for better esthetics. This article presents an extremely simple and inexpensive technique for obtaining symmetry with the help of simple geometrical instruments. As a prosthodontist, it is required that maximum corrections be made at the wax up stage. Hence, major corrections are not needed in the final prosthesis after curing with clear heat-polymerizing acrylic.

Keywords: cranioplasty; polylactic acid; polymethylmethacrylate; esthetics

Abbreviations

HA- hydroxyapatite, PMMA- polymethyl methacrylate, PEEK- polyether ether ketone.

Introduction

Craniectomy is performed in cases of brain swellings, complex skull fractures, intra-cranial infections, tumors, traumas, congenital deformities, etc. all of which jeopardize the functional and psychological status of the patient [1, 2]. Autologous bone should always be preserved and used later, but in many circumstances it is not possible because of comminuted fractures, tumor invasion, and various other factors [3]. The alloplastic materials that have been used for cranial reconstructions are hydroxyapatite (HA), polymethyl methacrylate (PMMA), titanium, and polyether ether ketone (PEEK) [4-6]. The use of PMMA dates back to World War II. Light weight, low radio-opacity, strong resilience to functional stresses, easy handling, and good biocompatibility and aesthetic results have made it the material of choice over a period of time [7, 8]. It has been proved by various studies that well contoured cranial implants require less surgical time, fewer screws to fix the prosthesis, and provide better aesthetics, which increases the social performance of the patient [9]. The present article describes

a simple and cost effective technique to accurately obtain symmetry in cranial implants. It requires simple geometrical instruments like a clinometer, calibrated compass, a leveler, graph paper, a graphite marker, and a permanent marker.

Materials and Methods

1. On a graph paper, mark the center and draw two lines at crossing at 90^0 each. Divide each quadrant into 6 equal parts by drawing lines at 15^0 each (Fig. 1).
2. Put the 3-D printed polylactic acid model (PLA) on the paper. With the help of thread and marker, draw lines in the sagittal plane from the mid of the frontal region to the mid of the occipital region. In the coronal plane, draw lines from a chosen landmark (near the temporal region) to the same landmark on the contralateral side. (Fig. 2 & Fig. 3).
3. With the help of a calibrated compass, which has a metal pin at one end and a graphite marker at the other, draw concentric lines of radius 1cm, 2cm, 3cm, and so on. Keep a leveler on the calibrated compass to ensure that the level remains parallel to the floor as there is no cant on the defect side (as it will not allow the circles to be concentric). Highlight the lines made with graphite with the permanent marker. Hence, at the end, we have intersections of three lines (Fig. 4, 5 & 6).
4. Put an aluminum foil on the defect side (to avoid wax from sticking to the PLA model) and do an arbitrary wax up.
5. Keep the calibrated compass along with the leveler on the non- defect side. With the same level maintained on the leveler, turn the compass on the defect side and add wax till the level of the needle point of the calibrated compass (Fig. 7 & 8).
6. Now, at the intersection of the three lines, keep the clinometer at its 90^0 mark and measure the angle (the red pointer) first on the non- defect side and then on the defect side. (Fig. 9 & 10).
7. If the angle is less on the defect, then add wax till the angle matches and we get a similar inclination value, hence, an improved contour. In case of more inclination reduce the amount of wax added.
8. Finish and polish the wax pattern properly to obtain a smooth surface. Carefully remove the wax pattern and flask the pattern in way similar to dentures.

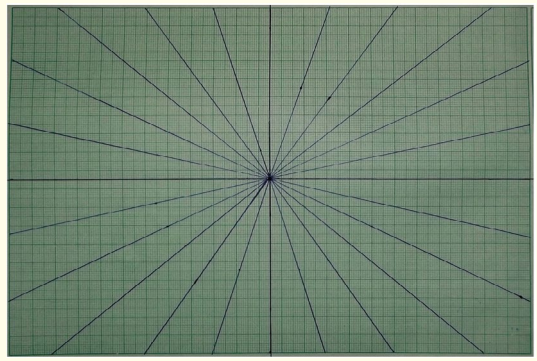

Figure 1: Graph paper.

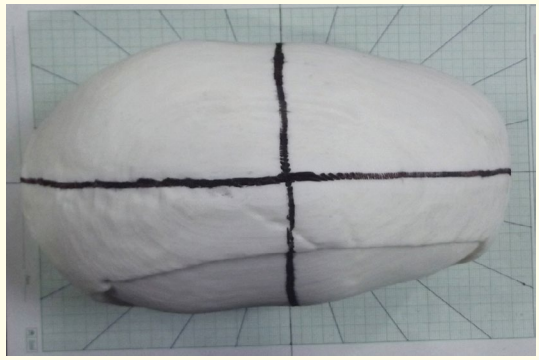

Figure 2: Coronal and sagittal lines.

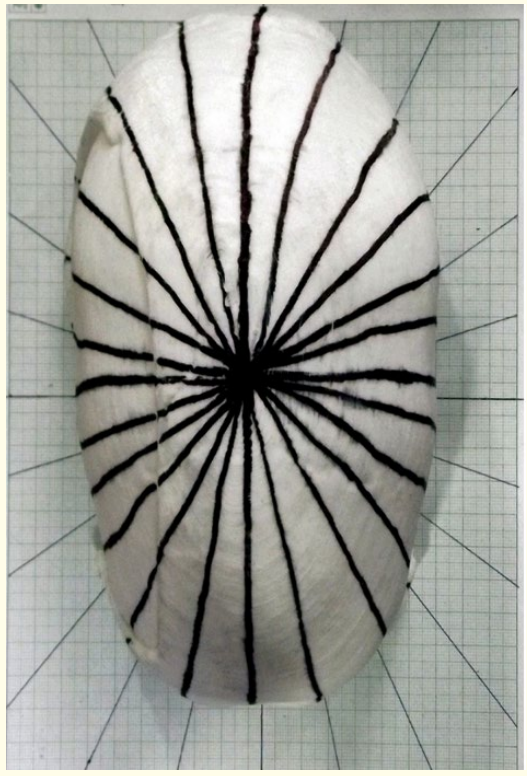

Figure 3: Lines from the center (at 15^0 angle between them).

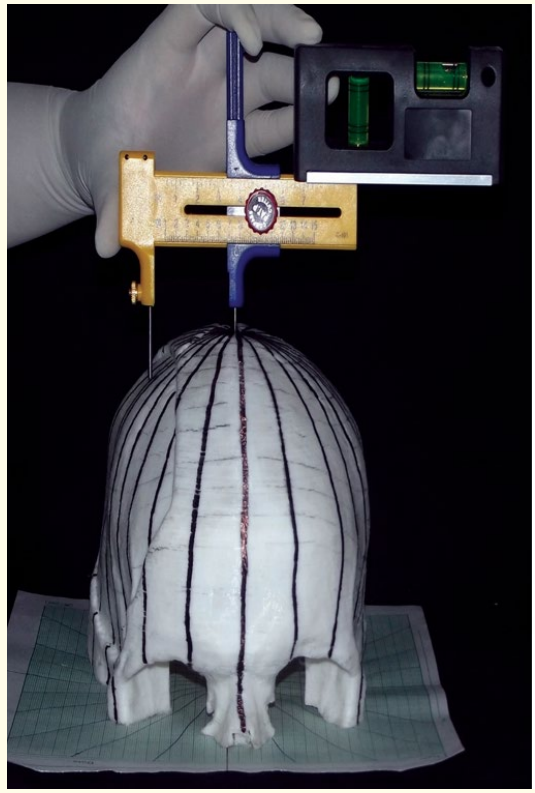

Figure 4: Concentric lines.

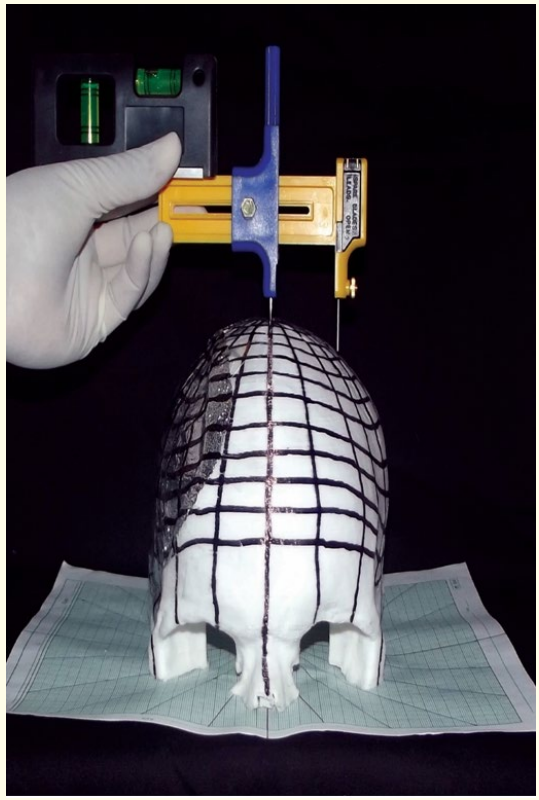

Figure 5: Concentric circles highlighted.

Figure 6: Intersection of all the three lines.

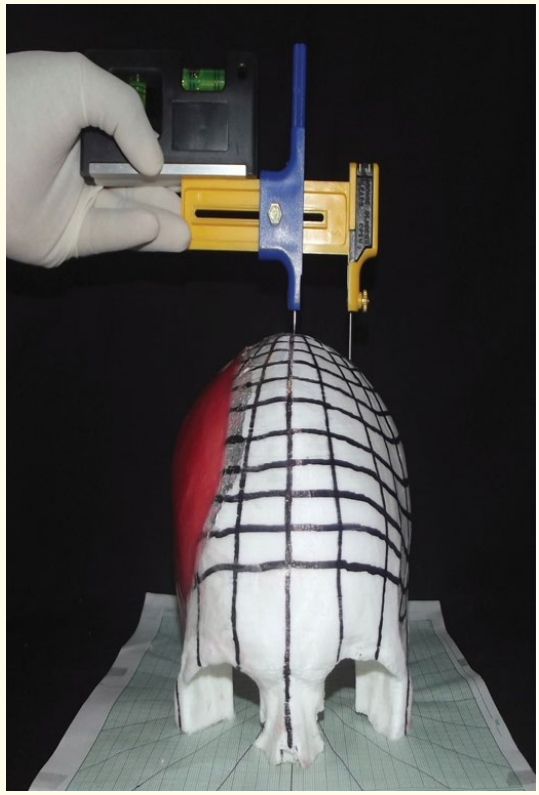

Figure 7: Leveler-use on non-defect site.

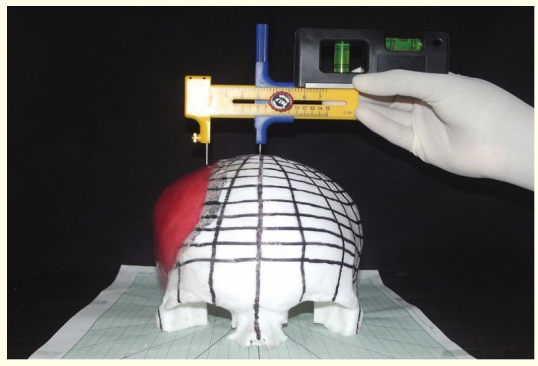

Figure 8: Leveler - use on defect site.

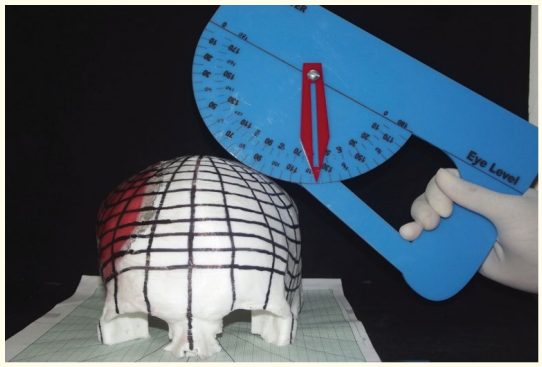

Figure 9: Clinometer- checking angle at non-defect site.

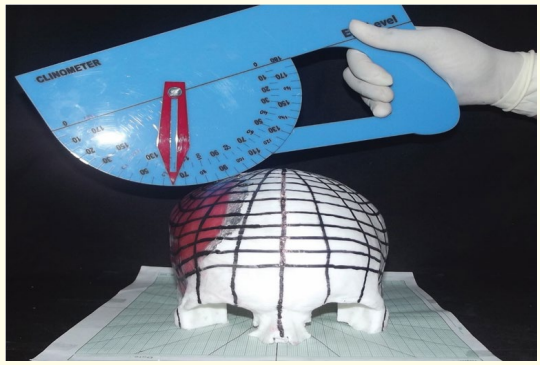

Figure 10: Clinometer- matching angle on the defect site.

Results and Discussion

This technique offers three-dimensional symmetry with the help of simple geometrical instruments. The benefits of this technique include enhanced aesthetics, better fit, fewer adjustments needed during surgery, which decreases the average surgical time. The wax pattern on the 3D printed model is more accurate as compared to the impression of a shaved scalp because the impression is obtained at the tissue level rather than bone level. There are several techniques that involve manual shaping of the polymethylmethacrylate(PMMA) using the cranial borders of the defect as the guide [10]. However, the cosmetic results are not satisfactory [11] and exothermic reactions during polymerization can cause damage to the soft tissue [12]. 3-D printed customized molds have been developed to obtain symmetry of cranial implants, however the cost of the mold approaches the prosthesis [13]. Their fabrication also requires commercial and industrial 3D printers, which are not in the affordable range in middle and low income countries [14]. The present technique would lead to a better fit of the cranial implant, requires less time for fabrication, and is an economical alternative with similar aesthetic and functional results. Also, this technique can be used for large cranial defects crossing the midline. Hence, the present technique can be used in any kind of defect- large or small, crossing or not crossing the midline, and even deep and depressed cranial defects.

Conclusion

The present technique is a very simple, novel, and innovative way to obtain symmetry. It offers an advantage over other techniques that are too expensive to be in the affordable range for all patients. It can also be used for all kinds of defects, irrespective of the size and depth of the cranial defect. At the same time this technique can also be used for obtaining symmetry in other craniofacial defect.

Conflict of interest

There is no conflict of interest among the authors.

References

1. Joseph TM., et al. "Prosthetic rehabilitation in neurosurgical cranioplasty". J Indian Prosthodont Soc (2018): 76-81.
2. Pavaiya A., et al. "Cranioplasty with alloplastic cranial implant". J Indian Prosthodont Soc (2009): 109-11.
3. Artico M., et al. "Bone autografting of the calvaria and craniofacial skeleton: historical background, surgical results in a series of 15 patients, and review of the literature". Surg Neurol [Internet] (2003): 71-9.
4. De Bonis P., et al. "Cranial repair: How complicated is filling a "hole"?". J Neurotrauma 29 (2012): 1071-6.
5. Stefini R., et al. "Use of "custom made" porous hydroxyapatite implants for cranioplasty: postoperative analysis of complications in 1549 patients". Surg Neurol Int (2013).
6. Honeybul S., et al. "A randomized controlled trial comparing autologous cranioplasty with custom-made titanium cranioplasty". J Neurosurg (2017): 81-90.
7. Marchac D and Greensmith A. "Long-term experience with methylmethacrylate cranioplasty in craniofacial surgery". J Plast Reconstr Aesthet Surg (2008): 744-52.
8. Jaberi J., et al. "Long-term clinical outcome analysis of poly-methyl-methacrylate cranioplasty for large skull defects". J Oral Maxillofac Surg (2013): e81-8.
9. Policicchio D., et al. "Comparison of two different titanium cranioplasty methods: Custom-made titanium prostheses versus precurved titanium mesh". Surg Neurol Int (2020): 148.
10. Chrzan R., et al. "Cranioplasty prosthesis manufacturing based on reverse engineering technology". Med Sci Monit (2012): MT1-6.
11. Marbacher S., et al. "Intraoperative template-molded bone flap reconstruction for patient-specific cranioplasty". Neurosurg Rev (2012).
12. Slimani M., et al. "Methylmetacrylate (PMMA) cranioplasty technique: Technical interest of intraoperative modeling and review of the literature". Ann Chir Plast Esthet (2023): 99-105.
13. da Silva Júnior EB., et al. "Cranioplasty with three-dimensional customised mould for polymethylmethacrylate implant: a series of 16 consecutive patients with cost-effectiveness consideration". 3D Print Med (2021): 4.
14. Tan ETW, Ling JM and Dinesh SK. "The feasibility of producing patient-specific acrylic cranioplasty implants with a low-cost 3D printer". J Neurosurg (2016): 1531-7.