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Case Report

Customized 3D printing: A novel approach to migrated orbital implant

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Abstract

This paper describes a novel approach to treat migrated orbital implants post socket surgery. Implant migration may hinder the final aesthetic outcome of a custom ocular prosthesis. Once an implant migrates within the orbit there tends to be fibrosis around the implant. This fibrosis does not allow for centeration of the implant during repeat surgery. Hence treatment of a migrated implant traditionally involves implant removal with dermis fat grafting. Dermis fat graft though an option, needs a second site surgery that may be unacceptable to many patients. Also the rate of graft necrosis is as high as 40%. This paper describes a technique to create a custom orbital implant that allows recenteration of the migrated implant centrally, using 3-dimension (3D) printing and rapid prototyping to construct the patients affected orbit. This orbit is used as a mould to create the custom orbital implant that aids in volume augmentation as well as recenteration of the migrated orbital implant.

Keywords: Orbital implant, 3D printing, Migration, Custom designed, Secondary implant, Computer assisted, Patient specific implants

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Introduction

Orbital implant migration following evisceration or enucleation surgery has been observed with porous as well as non-porous implants.[1] When the migrated orbital implant affects prosthesis placement and centeration surgical correction of migration is required. Treatment options include implant exchange and dermis fat graft.[2,3] Secondary orbital implants have a 25% rate of resurgery of which 13% is attributable to implant migration.[3] Dermis fat graft though an option involves a second site scar that may be unacceptable to many patients. In previously operated sockets the rate of graft necrosis is higher.[4]

3D printing technology along with computer aided design and prototyping is currently being used in the treatment of complex orbital fractures.[5] Using these techniques, an individual prototype skull model that resembles the patients orbit can be obtained before surgery. We describe a novel, cost effective, minimally invasive technique of designing a custom orbital implant using 3D printing of the patients orbit.

Case report

A 16-year-old male patient presented to us for a tilted and unstable custom ocular prosthesis. On examination, he had a decentered prosthesis with its inferior edge resting on the lower eyelid margin (Fig. 1A, C). This was resulting in

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frequent fall of prosthesis from the socket. There was shelving of the inferior fornix with inferotemporal migration of the orbital implant (Fig. 1B). The implant was palpable anterior to the inferior orbital rim. There was no apparent conjunctival surface loss. Volume loss was evident in terms of the superior sulcus deformity. Computed Tomography scan of the orbit showed an 18 mm orbital implant migrated inferotemporally into the extraconal space (Fig. 1D). He had undergone three socket surgeries in the past starting with an evisceration with implant for a painful blind eye followed by implant exchange and fornix formation sutures twice for inferotemporal implant migration with shallow inferior fornix. Owing to the recurrent inferotemporal implant migration we anticipated fibrosis in the orbit and hence did not consider an implant exchange. The patient denied dermis fat graft due to donor site morbidity. Hence we decided to place a customized implant in the inferotemporal orbit that would push the migrated implant centrally.

3D printing details

DICOM images from the computed tomography scan were rendered as 3D models and the region of interest around the orbit was segmented and exported as a binary STL. This was sliced into several 2D layers using proprietary 3D Printing software. To build an accurate 3D model, support structures were generated to provide structural integrity to the model being 3D Printed. Distinct tool paths were generated for the model and the support structures in CMB format, which was then 3D Printed in the Stratasys Fortus 250 mc, an additive manufacturing system that employs Fused Deposition Modeling (FDM). 3D Printing was done at 178-micron layer thickness and with high-density infill to get a rigid model. The model was 3D Printed with Stratasys ABS P430 material and supporting structure was made with Stratasys ABS SR30. Once the 3D Printed model was ready, the support structures were dissolved in an ultrasonic agitation tank resulting in the final orbit model (Fig. 2A).

Custom implant fabrication

Using this skull model as a mould, a PMMA implant was fabricated to sit in the basin of the inferior orbital fissure (Fig. 2B) of this patient to push the migrated implant centrally. The implant was sterilized prior to surgery.

Surgery details

Through an inferior transconjunctival approach the periosteum was incised just within the orbital margin and reflected to expose the basin of the inferior orbital fissure. The customized orbital PMMA implant was placed subperiosteal, conforming to the pre-designed shape of the floor of the orbit. It was found to be stable intraoperatively. The pre-existing spherical implant was pushed to a central location in the orbit on placement of the customized implant. This was checked for on table by palpating through the palpebral fissure and post-operatively with CT orbit. Conjunctiva was closed and inferior fornix forming sutures were taken. Conformer was placed and suture tarsorrhaphy was performed. Six weeks postoperatively, CT scan of the orbit showed the customized orbital implant in place and with intraconal migration of the spherical implant (Fig. 3C). A customized ocular prosthesis remained stable and central thereafter till his last follow-up of 2.5 year (Fig. 3A, B, D).

We believe that the customised implant that customized implant that was placed in the basin of the inferior orbital fissure lies posterior to the orbital rim and hence does not shallow the fornix. The customised implant, by pushing the migrated spherical implant that was lying anterior to the orbital rim, centrally, now allows the deepening of the fornix which had failed on previous attempts of fornix formation

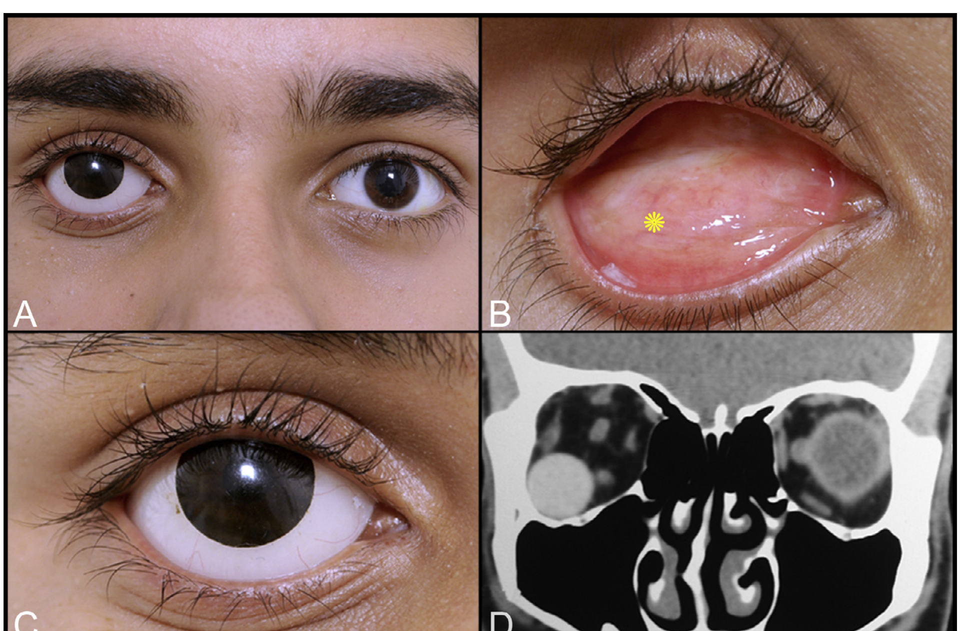

Fig. 1. Pre-operative examination details. A: right decentered prosthesis with superior sulcus deformity, B: inferotemporal migration of implant highlighted with * and shelving of the lower fornix, C: Inferior edge of the prosthesis resting on the lower eyelid margin with increased inferior scleral show, D: CT orbit in the coronal plane showing inferotemoral spherical orbital implant migration.

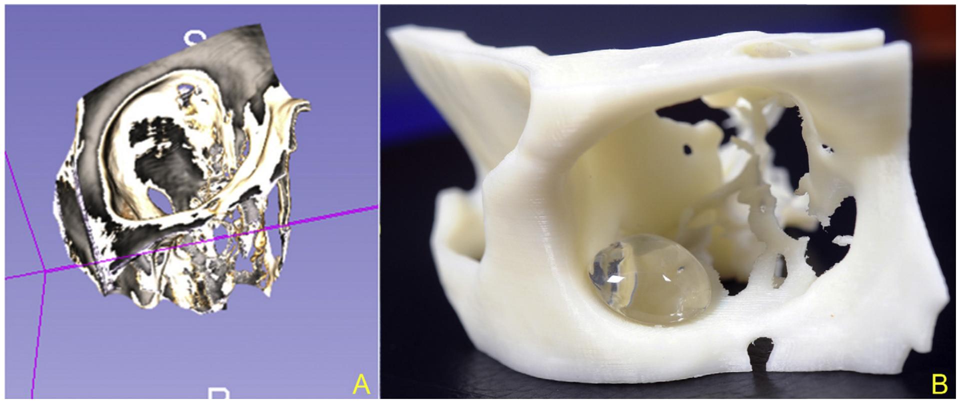

Fig. 2. Skull models in soft copy and 3D. A: skull model built in 3D using DICOM images of the patients CT orbit, B: skull model printed in plastic and used as a mould to fabricate an orbital implant from PMMA.

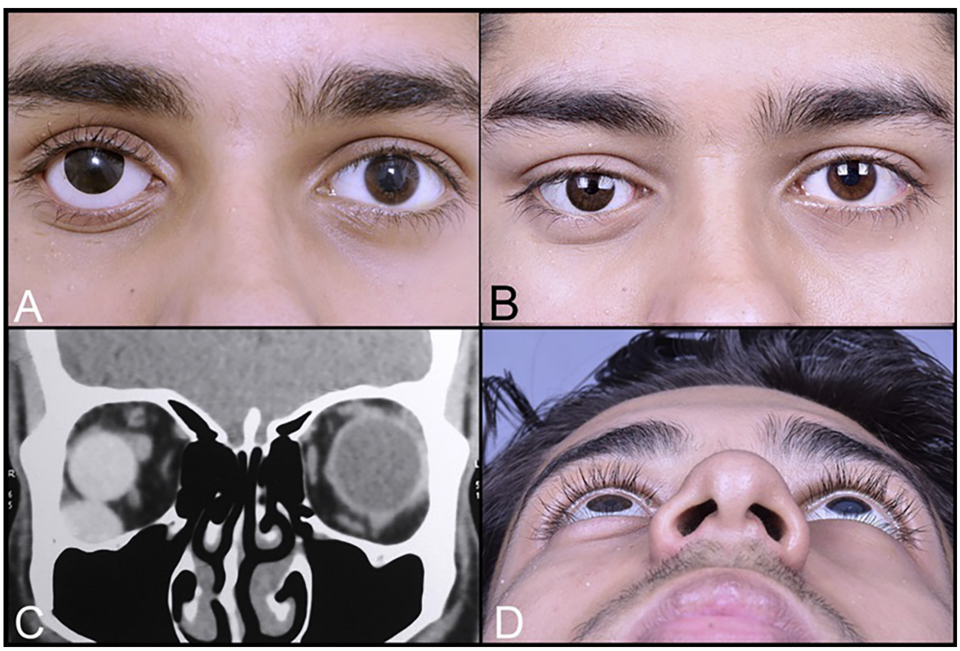

Fig. 3. Comparison of pre and post-operative result. A: pre-operative standard view photograph of the patient with superior sulcus deformity and decentered ocular prosthesis, B: post-operative standard view photograph of the patient with correction of the superior sulcus deformity and a better fitting ocular prosthesis. C: post-operative CT orbit of the patient showing an inferotemoral implant pushing the spherical implant towards the central intraconal space. D: post-operative birds view showing adequate orbital volume correction with both the implants in place.

with implant exchange. In the post-operative course the patient does show a bulge of the lower eyelid that we assume was due to resolving post-operative edema. However on the last follow-up, 2.5 years after the surgery, there was a significant reduction in the bulge. Nonetheless, a patient who has undergone fornix deepening surgery is always likely to have residual shallowing of the fornix and is more prone to repeat shallowing or shelving of the fornix over a period of time, which in the authors opinion is the natural history of a patient undergoing fornix formation sutures.

Conclusion

Customized orbital implant offers a novel and cost-effective way to centre orbital implants in patients with recurrent implant migration. This is especially true for patients who have associated volume loss. Pre-operative 3D Printing enables us to determine the exact shape of the custom implant.

Conflict of interests

The authors declared that there is no conflict of interest.

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