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3D PRINTED MID-FACE NON-DELAYED PROSTHETIC RECONSTRUCTION AFTER CANCER SURGERY OF ORBIT (EXENTERATION).

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Abstract

Cancer surgery on face due to basal cell carcinoma forms large defects and deformities. Sometimes the defects are being surgically reconstructed. The quality of life of patient after surgery for facial skin cancer needs immediate reconstruction to solve not only somatic, but also psychological esthetically affected problems. Plastic, surgical reconstruction sometimes is a good method of choice if the defect covers upper face components or soft tissue segments of buccal region. In exenteration of orbit or total nasal surgery due to cancer it can be problematic because of impossibility of adequate esthetic restoration failure. There are many cases, when plastic surgery is not enough for facial defect reconstruction. In majority of cases mid-face defect includes a whole organ as eye and/or orbit, or nose and the quantity of remaining soft and bone tissue limits soft and hard tissue grafting.

The only method of mid-face reconstruction after orbit exenteration is orbital epithesis fabrication and defect prosthetic treatment. With good esthetic results, this method makes possible further cancer surgery results monitoring, which is so important for the patient before survival rate of 5 years.

3D planning and mid-face printing solve the problem of orbital defect prosthetic reconstruction in early stages of post-cancer treatment with non-delayed methodology of 3D planning and printing. For better esthetic appearance iris of ocular is color matched in digital technologies and printed on an ink printer, technologically covered with several acrylic layers for further color stability.

The epitasis itself is made of platinum silicones. Volcanization mode is preferred with heat curing in a dry oven. Mechanical properties of silicone epithesis are enhanced mixing thixotropic agents into silicone mixture before packing silicone in flask to have a good consistence after deflasking the epithesis.

Keywords: *prosthetic rehabilitation, 3d printed mid-face, orbital epithesis.*

Introduction.

The face is a common area for the development of skin cancers given its frequent exposure to ultraviolet (UV) radiation from the sun, which is the main cause of Non-Melanoma Skin Cancer. While complete eradication of the tumor should be the primary goal in facial skin cancer management, it is also imperative to maximize cosmetic and functional outcomes. The purpose of this review is to discuss the surgical management of facial Non-Melanoma Skin Cancer, with a focus on diagnostic techniques, staging, excision, and reconstruction [*Badash I et al, 2019*].

Basal cell carcinoma (BCC) is derived from keratinocytes in the basal layer of the epidermis, and there is some evidence that the malignant cells arise from immature pluripotent cells of the inter-

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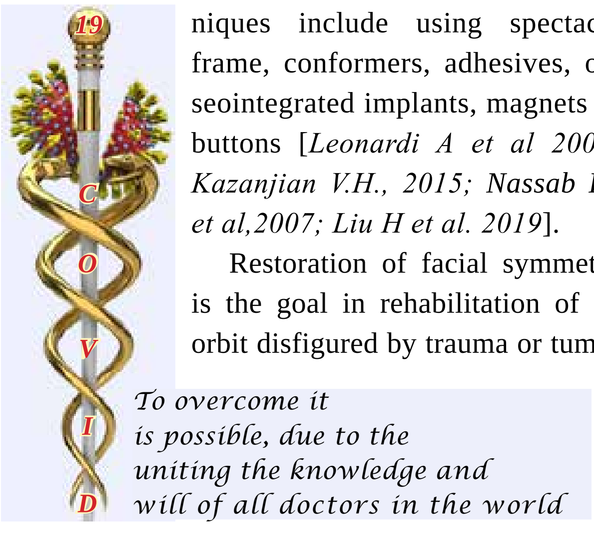
follicular epidermis and the outer root sheath of hair follicles. Basal cell carcinoma metastasizes very rarely but may be locally aggressive and invade nearby structures. It has various subtypes that are classified according to their clinical and histopathological characteristics. Noduloulcerative and superficial basal cell carcinoma are the most common subtypes and generally involve the face and neck. Morpheaform, infiltrative, and basosquamous subtypes occur less commonly on the face, but are more locally aggressive than other types of BCC [*Dubas L.E, Ingraffea A., 2013*].

Loss of tissue, whether congenital or traumatic or resulting from malignancy or radical surgery, is accompanied by esthetic and psychologic effects. This loss is more pronounced when the affected part is the eye and all orbital contents, resulting in gross mutilation [*Hanasono MM et al., 2009*]. Success in maxillofacial prosthetics depends on the full cognizance of the principles that underlie facial harmony, color matching, anchorage and retention, weight bearing and leverage, durability and strength of materials used, tissue compatibility and tolerance [*Hussein S. et al 1995; Deranian H.M., 2007; Goyal A. et al, 2012; Kazanjian V.H., 2015*].

Exenteration of the orbital contents as well as removal of a part of maxilla with an ablative surgery for the removal of a malignant tumor can severely affect a person in terms of function, esthetics and psychological trauma. A well-retained, user-friendly, removable maxillofacial prosthesis is the key to successful prosthetic rehabilitation in such cases. Various retentive techniques include using spectacle frame, conformers, adhesives, osseointegrated implants, magnets or buttons [*Leonardi A et al 2008; Kazanjian V.H., 2015; Nassab RS et al,2007; Liu H et al. 2019*].

Restoration of facial symmetry is the goal in rehabilitation of an orbit disfigured by trauma or tumor extirpation. Successful rehabilitation may require replacement of repositioning of the orbital walls and/or construction of a complex orbital prosthesis. Preoperative communication among the head and neck surgeon, ophthalmologist, and maxillofacial prosthodontist is essential [*Huang YH et al, 2016*].



Major head and neck resections may result in ocular defects that are functionally and/or aesthetically incapacitating. Restoration of the eyelid and orbit must address lateral canthal laxity, midface ptosis, eyelid retraction and ptosis, globe malposition, and dysfunctional lacrimal drainage. Here we discuss lateral canthal reconstruction, midface-lifting, eyelid spacer grafts, gold weight placement, surgical approaches to the orbit, free flap options for orbital reconstruction, and endoscopic lacrimal surgery. Successful outcomes in eyelid and orbital reconstruction depend upon proper knowledge, planning, and multidisciplinary management [*Deranian HM, 2007; Badash I et al., 2019*]. Prosthetic rehabilitation of an orbital defect plays an important role in restoring aesthetics of the face. The eye is a vital organ, the loss of which requires a tailored approach for post-defect rehabilitation [*Dubas LE, Ingraffea A., 2013; Pruthi G, 2014*]. Advance treatment modalities such as implant-supported orbital prosthesis have a superior outcome in terms of retention and esthetics, but due to economic factor, it is not affordable for all patients [*Goldberg RP, 2003*]. But this is not the only condition, when we make a choice on for an adhesive retained orbital or any facial epithesis. If we have an aim to reconstruct the orbit with no serious delay after cancer surgery, with an opportunity of post-cancer monitoring of the tissues, sometimes we make a choice of a non-implant reconstruction [*Lemon JC, 2005*].

The fabrication of orbital prostheses is complex and time-consuming. A virtual orbital prosthesis and its negative mold are presented by using a 3D printer. This method avoids damage to the soft tissue or patient discomfort and reduces the time and skill required to fabricate a custom orbital prosthesis [*Veit JA et al, 2007*]

Maxillofacial prosthetic materials are used to replace facial parts lost through disease or trauma. Silicone rubbers are the materials of choice, however it is widely accepted that these materials do not possess

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ideal properties [*Stanley Jr RB, Beumer J., 1988*].

While computerized tomography (CT) and magnetic resonance imaging (MRI) technologies are highly commendable for their applications and usage, sometimes cases involving facial anatomy restoration may not necessarily require these highly sophisticated technologies. A suitable replacement that is also non contact and allows fast image capture is the laser digitizer surface scanner [*Miles BA et al., 2006*].

So, as we see, a lot of technologies are involved in the process of digital creature of facial epithesis from planning to realization.

Our case report is devoted to a method of immediate prosthetic reconstruction of post-exenteration orbital defect using 3d planning and printing methods, CT scan analysis of mid-face, orbit reconstruction using platinum room-temperature vulcanizingsilicones with a methodology of intrinsic pigmentation.

Case report: An 82 years old female patient with a post-surgical defect of right orbit after a month of surgery was sent from The National Blokhin Cancer Center, Moscow to our Department for Maxillo-facial Prosthetics, National Research Center for Otorhinolaryngology, Federal Biomedical Agency. Patient had a history of basal cell carcinoma, which was removed one month ago by orbital exenteration (Fig.1). No chemotherapy or radiological therapy was planned. Patient wished to be esthetically restored as soon as possible, to be able to look on herself in a mirror. This was her only wish.

Observation of orbital prosthetic field found out a lot of free space for even an implant retained orbital prosthesis reconstruction, but it would postpone the abilities of immediate prosthetic restoration, so we planned to recover the eyeball by using digital technologies.

At first we made a new CT scan and 3D printed

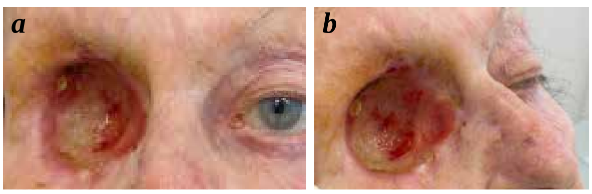

FIGURE 1. Patient with orbit exenteration, face (a) and profile (b).

the midface. We decided not to go on a conventional way of taking silicone impressions from prosthetic field not to make traumas of the newly forming skin surfaces. CT scan was made with open eyes to have all parameters of the remaining left orbit.

On the 3D printed mid-face we planned the boarders of prosthetic orbit (Fig. 2).

FIGURE 2. 3D printed midface model.

The next step was the making of a digital eyeball from crystal clear acrylic with color matching of the missing iris, digital iris printing on a digital ink printer and covering it with 3 layers of monopoly sirup. The color of scleral lens was pigmented due to scleral tones of the remaining sclera of left eye.

Eyeball orientation: The eyeball orientation is going to be a very serious procedure, that accents esthetic components and total appearance of a newly restored mid-face.

After eyeball polymerization, we went to the appointment of eyeball orientation on wax shell of prosthetic orbit, made from a baseplate wax on the 3D printed mid-face model. The correct boarders of a wax pattern sitting on the prosthetic field of patient's midface show the accuracy of a CT scan duplication and 3D printed model with soft tissue exposition. We make the necessary measurements and try to fit the acrylic eyeball into a necessary depth in orbital wax-up pattern not to interfere the esthetic parameters of orbital prosthesis

After finishing the orientation of acrylic ocular in a wax-pattern of orbit we put it again on a 3D printed model and finally modelling all anatomical contours of missing orbit (Fig. 3).

Final orbital wax-up model try-in: After final contouring of eye length, opening, upper and lower eyelids on a wax-pattern, correcting the boarders of the epithesis, we make the final try-in of a wax orbit on the prosthetic field, checking prosthetic

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stability in mimic movements, observing thinner rims of wax perimeter, that is usually one of the factors of esthetic appearance of face after prosthetic reconstruction (Fig.4 and Fig.5).

FIGURE 3. Ocular location, face (a), profile (b) and ¾ profile (c)

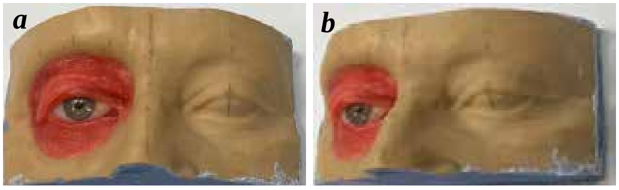

FIGURE 4. Wax pattern of orbit on 3D printed model, face (a) and side view (b)

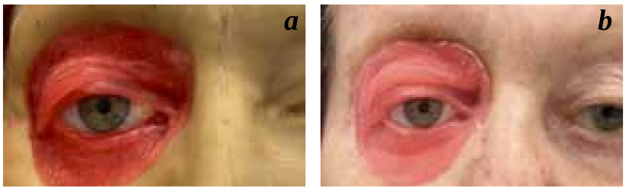

FIGURE 5.Orbital epithesis wax-up ready for try-inn (a) and orbital epithesis wax-up try-in

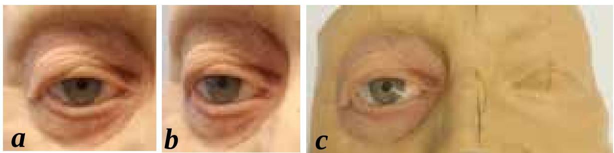

FIGURE 6. Silicone epithesis ready on 3D printed model, face (a), side view (b) and Silicone intrinsically pigmented.

FIGURE 7. RTV Silicone orbit after delivery (a), Patient with exenterated orbit before prosthetic treatment (b) and with eye-glasses as a comuflage (c).

After orbital wax pattern final try-in, we matched the skin color in a conventional method of silicon pigmented samples. We used a Pentasil Shore A 20 room-temperature vulcanizing silicone (Russia) pigmented totally with intrinsic pigmentation. No extrinsic pigments were used at this time.

Packed the 3D model with a stone, changed the wax into silicone with a volcanization mode of 60 minutes in 82°*C*. As in all types of room-temperature vulcanizing silicones, it is possible to shorten the volcanisation time by heat curing, so we did it, too.

After de-flasking the orbital epithesis, we trimmed the boarders of silicone epithesis, put eyelashes and delivered the epithesis using a silicone adhesive of Technovent G 406 (Bolton, UK).

Due to high resolution of thinned prosthetic boarders, the perimeter of silicone epithesis is hardly seen, being comuflaged by a thin layer of vaselin, which makes the prosthetic boarders invisible. Patient has a very good retention in static and functional conditions due to large space of prosthetic field and satisfactory extension of gluing boarders. Eyeglasses are not being used for an auxiliary retention. They are serving as decorations and, sure, patient needs to care them to see better (Fig.6.).

Intrinsically pigmented silicone epithesis sits on the prosthetic field with no stresses on the base of prosthetic field covered with thin skin tissues. Boarders of epithesis are being fixed gently to the perimeter of orbital defect impressing with a high esthetic resolution (Fig.7)

CONCLUSION

Prosthetic orbit is a chance for the orbital cancer survived patient to have a post-surgery non-delayed esthetic reconstruction. Orbital epithesis is made of an acrylic digitally printed iris eye-ball and an intrinsically pigmented room-temperature vulcanizing silicone shell, which is stable to detergents. 3D printing of a mid-face model from CT scan in a soft tissue exposition, makes possible the wax-up and epithesis fabrication with no stressful silicone impressions and stone casts, directly on a 3D model, 3D printed mid-face model makes possible a short time non- delayed prosthetic post-cancer reconstruction.

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