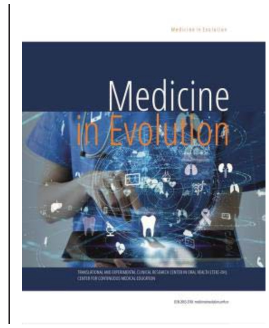
# Custom ocular prosthesis - experience of an anaplastology laboratory in western Romania

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## Abstract

The oldest ocular prosthesis was discovered in Iran, made for a woman who lived between 2900-2800 BC. Over time, techniques for making ocular prosthesis have improved and new materials have emerged to perfect the look. Today, the techniques for making an ocular prosthesis are sophisticated and the physiognomic results can achieve perfection.

This is a case report of a patient with left eye loss and details the stages of making an ocular prosthesis in an anaplastology laboratory in Timisoara. The technique describes the fabrication of an ocular prosthesis with materials that are inexpensive, readily available and regularly used in maxillofacial prosthetics. The prosthesis, although non-functional, provides good integration into the patients' physiognomy and the aesthetic effect is high. Ocular prosthesis restores patients' self-confidence and prevents social embarrassment.

**Keywords:** ocular prosthesis, technique, experience

## INTRODUCTION

An ocular prosthesis creates an illusion of a normal eye and its surrounding tissues, and maintains the volume of its socket [1]. The accurate duplication of color, contour, size and orientation, similar to a natural eye, is important in order to obtain realism and symmetry [2]. The methods of fabricating ocular prostheses have progressed over the years to provide superior cosmetic replacement of the enucleated or eviscerated eye [3].

The oldest ocular prosthesis was discovered in Iran, belonged to a woman, and dates back to approximately 2900-2800 BC. The prosthesis has a hemispherical shape and a diameter of 2.5 cm. It was made of a very light material, probably bitumen paste. The surface of the artificial eye is covered with a thin layer of gold, engraved with a central circle (representing the iris). Tiny holes are drilled on both sides of the eye, through which a gold wire could hold the eyeball in the desired position (Figure 1) [4]. Later, BC and AD, such prostheses were made by Egyptian and Roman priests. The modern era of prosthetics begins around 1600 AD, with the achievements of Italian, French and German doctors in collaboration with local artisans. In 1943 production of acrylic ocular prostheses began in the U.S. [4]. Acrylic ocular prostheses proved to be superior, non-fragile, with enhanced aesthetic possibilities such as determining corneal and pupil dimensions and painting conjunctival vessels [5].

Nowadays, techniques for making ocular prostheses vary from simple to complicated. The ocular prostheses can be prefabricated or custom made, the latter offering better fit and aesthetics (Figure 1).

Figure 1. From the oldest eye prosthesis to custom made ocular prostheses in the anaplastology laboratory

A multidisciplinary approach including an ophthalmologist, oral-maxillofacial surgeon and maxillofacial prosthetist should be considered for an aesthetic and stable outcome [4].

The etiology of ocular and orbital defects is diverse:

- Congenital eye diseases
- Puncture with sharp objects (glass, needles, nails)
- Surgical procedures in cases of irreparable trauma
- Surgical interventions required by tumors (basal cell carcinoma, squamous cell carcinoma, retinoblastoma, malignant melanoma, etc.) [4].

Surgical procedures performed by ophthalmologists or oral-maxillofacial surgeons in these clinical situations are of several types:

- Evisceration is the surgical procedure that involves removal of intraocular contents while leaving an intact sclera (usually performed by ophthalmologist).
- Enucleation is the surgical procedure that involves removal of the globe while leaving all other surrounding structures (usually performed by ophthalmologist).

Exenteration is the surgical procedure that involves the removal of all tissues inside the eye socket, including the conjunctiva, eyeball, orbital fat, muscles, vessels and nerves, and partial or total eyelids (usually performed by oral-maxillo-facial surgeon) [6, 7, 8].

## MATERIAL AND METHODS

Making an ocular prosthesis is complex and requires a succession of clinical and laboratory stages. Below we describe in detail the technique of making an ocular prosthesis in the anaplastology laboratory.

**Consultation. Case examination**

A 65-year-old male patient reported to the anaplastology laboratory with a defect in his left eye. The defect was caused by trauma due to a tree branch puncture five months ago. On inspection, the sclera and iris were absent, with orbital fat and intact eyelids observed. The muscle function of both the upper and lower eyelid seemed normal. No inflammation was present. As in many such situations encountered at the laboratory, the only option available to the patient was an ocular prosthesis (Figure 2).

Figure 2. Case examination

Figure 3. Impression of the defect

After obtaining the informed consent, the patient will be registered in the laboratory records, noting personal data, history of the disease, other diseases he suffers from (anamnesis). Clinical examination of the eyeball defect area is performed. It is checked if there is enough space for an eye prosthesis and if the inferior conjunctival fornix is capable of retaining this prosthesis.

To start making the ocular prosthesis, a minimum of 6 weeks must pass after the eyeball removal surgery. After this time the shape of the eye defect is stable and no longer undergoes major changes in terms of shape or volume [4].

The tissues must be normal in appearance, free of sutures, ulceration and inflammation, which could affect the fitting or wearing of the ocular prosthesis. If this is not the case, the patient should be referred to an ophthalmologist or maxillo-facial surgeon and the prosthesis should be postponed until the situation has improved [1].

**Impression of the defect. Measurements and comparisons**

Before the impression is made, the healthy eye is examined and measured: iris diameter, iris color and appearance, color of the sclera, density and arrangement of the scleral vasculature [9]. Prepare the materials and instruments needed for the impression: low-flavor alginate (especially menthol), bowl, spatula, water, tweezers, 10 ml syringe, bib, examination gloves. Remove the dressing or old eye prosthesis if present. With the patient lying on his back, the area to be examined is cleaned.

The alginate is prepared in a creamy consistency and is injected with the help of the syringe into the eye cavity, taking care to fill both conjunctival fornices (upper and lower) without bubbles (Figure 3). Alginate hardening must be rapid in order to avoid discomfort to the patient, and not to irritate the orbital tissues. After the alginate has hardened, the eyelids are receding and the impression extracted. Until the model is cast, the impression should be kept in a moist environment.

The impression area is cleaned and the old prosthesis is reinserted or the eyelid dressing is restored.

**Making the working model.**

Disinfect the impression and remove excess material that has flowed back through the eyelid slit. The model will be cast in hard plaster (Moldano). The posterior part of the impression (the one that recorded the eyeball defect) is filled with plaster and turned over a pile of plaster on the table. After hardening, the plaster is insulated and the model lid, also made of hard plaster, is poured over it. Finish the model resulting from the final socket and separate the 2 components. Note the patient's name on the model (Figure 4).

Figure 4. The impression and the working model

**Making the wax-up and the acrylic model of the ocular prosthesis.**

Isolate the model by immersion in water for a few minutes. Melted wax is introduced through the eyelid slit of the model until it is filled. After curing the wax, the 2 components of the model are removed and the upper lid is removed. Smooth out the excess wax of the model and create maximum wax convexity at the position of the future iris (Figure 5).

The wax-up at the bottom of the model is impressed with the putty silicone. A funnel-shaped hole will be made in the upper part of this impression. Remove the wax-up from the model. The silicone cap is waxed onto the lower portion of the model (after sealing the lower portion of the model with Pectizol). Then, a white self-curing acrylate fluid paste is poured through the created hole by vibration. After curing, the acrylate is removed from the model and the silicone cap, processed and polished to a high gloss so that there are no irritating areas. This acrylic model will be adapted to the patient until a suitable physiognomic appearance is achieved and it is well integrated and tolerated. The acrylic mock-up will also be used to position the iris of the future eyeball prosthesis.

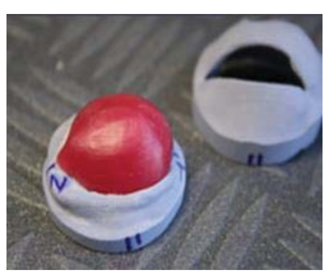

Figure 5. The wax-up of the ocular prosthesis

**Making the iris: making the iris disc, painting it, fixing the pupil, pressing, curing transparent acrylate. Unpacking, processing, polishing.**

A circle with a larger diameter than the iris of the patient's healthy eye is drawn on an acrylic plate. The circle is cut out with a milling cutter, then shaped into a round shape and given the appropriate diameter by clamping in a chuck and milling on a fine file. The diameter will be measured frequently until the required size is reached. The resulting disc is glued onto a holder that can be held comfortably in the hand.

Oil paints, the color of the patient's iris, will be applied to the surface of the disc. The paints are homogenized in advance with a light-curing varnish (Palaseal-Kulzer), which speeds up the curing of the different layers. When the painting is complete, a pupil made of black cardboard cut to the average diameter of the patient's pupil, is fixed in the center of the disc. The pupil is fixed with transparent self-curing acrylate.

The finished painted disc is detached from the support with which it was held. A Moldano plaster is inserted into a flask, allowed to harden and a shallow cavity is created, similar in shape to the iris and slightly larger in size. On the opposite side of the flask (also containing hard plaster) a shallow cavity, shaped like a calotte, is created.

The disc is fixed to the underside of the mold and glued with cyanoacrylate. Re-insulate the mold with Pectizol, insert, press and cure the transparent heat-curing acrylate. After the heat treatment, the artificial iris is unpacked, processed, finished and polished (Figure 6).

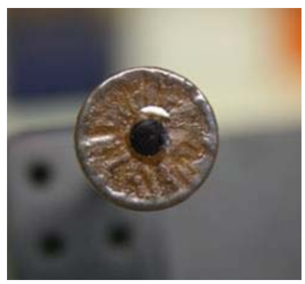

Figure 6. Painting the iris disc

**Mock-up and iris try-in: Try-in of the mock-up and its adaptation. Determination of iris position, preparation for insertion, wax fixing, try-in, position adjustment. Retouching the shape of the palpebral aperture.**

Check the patient's adaptation of the acrylic model by inserting it into the eyeball defect. The patient's comfort is the first priority in order to remove any areas of irritation. Then the eyelid opening is assessed, which should be similar to that of the healthy eye. If this is not the case, the necessary adjustments are made: acrylate is reduced or wax is added to the surface of the model.

Finally, the center of the pupil is marked with a dot. Around this point a space will be created in the model where the artificial iris will be inserted. This space should be wider than the iris, so that the iris position can be corrected. The iris should be in the same vertical plane and symmetrical to the midline of the iris of the healthy eye. Fixing the iris in the desired position is done with a special white wax. After the test, the iris mock-up is removed, and the patient's old prosthesis is reinserted into the defect, or the palpebral region is bandaged.

**Making the mold: finishing the wax-up, acrylic guide, packing. Removal of the wax-up from the mold, cleaning, mold isolation. Fixing the iris in the unique position.**

A small amount of self-polymerizing, non-retentive pyramid-shaped acrylate is applied to the surface of the iris (previously fixed in the wax-up during the test). Finish the surface of the wax-up by adding wax.

Packing the acrylic mock-up obtained in a flask of suitable size, using hard plaster. The lower part of the mold cover the back of the model up to the equator. After the hardening, isolate the surface of the plaster, put the lid on the flask and pour the upper portion, also in hard plaster. In this part of the mold will be found the pyramidal extension of the ocular prosthesis.

After the plaster plug, the flask is removed, the model is removed, the mold is cleaned and the surface of the plaster is isolated. The marginal surface of the iris is roughened with a burr to facilitate the adhesion of the acrylate to the final eye shield. The iris is fixed with adhesive in the resulting pyramidal recess in the upper portion of the mold. The mock-up used for the trial is discarded.

**Pressing, polymerization of acrylate. Scleral processing, vascularization, transparency.**

Prepare heat-curing acrylate paste in the color of the patient's sclera. In the coke phase the acrylate paste is placed in the mold and pressed (Figure 7). The polymerization process follows the regime recommended by the acrylate manufacturer. After polymerization, the eyeball is removed from the mold without destroying the mold.

The outer surface of the eyeball is machined, removing the acrylic pyramidal guide and excess sclera on the iris, and approximately 0.5 to 1 mm of the thickness of the sclera to make space for the transparent layer. The edge of the iris remains covered with a thin layer of sclera over an area of 0.3-0.5 mm from the edge inwards.

The textile fibers are then added, mimicking the vascularization on the surface of the healthy eye's sclera. The fibers are impregnated in a light-curing varnish (Palaseal - Kulzer).

Re-isolate the surface of the mold and re-insert the eyeball thus processed. Prepare a small amount of transparent acrylate, which is then baked into the mold over the artificial eye. The flask is pressed and polymerization is carried out. The polymerization regime is different from that applied to the sclera layer and is specific to transparent acrylate.

Figure 7. Pressing and polymerization of acrylate

**Processing, finishing, polishing.**

Once polymerization is complete, the ocular prosthesis is removed from the mold. The acrylic protrusion on the iris and irregularities on the surfaces of the prosthesis are processed. Finish with great care, no rough or sharp areas allowed. Then polish, the resulting external surface being convex, without bumps, and the internal surface respecting the relief of the globe defect (Figure 8).

Figure 8. Completed ocular prosthesis

**Insertion of the ocular prosthesis. Adjustments. Training the patient.**

After the ocular prosthesis is completed, it is inserted into the defect and compared with the healthy eye. Check the patient's comfort and appearance. In the case of eyelid slit incongruity, the surface of the prosthesis in that area is thinned to allow proper closure of the eyelid (Figure 9). Adjustments and finishing of irritated areas are also done. The ocular prosthesis is refinished and polished.

This is followed by the final insertion of the ocular prosthesis and instruction of the patient in its use, maintenance and cleaning, and the timing of future control.

Figure 9. Insertion of the ocular prosthesis

## RESULTS

We present below the results obtained by the same method in three other patients who came to the laboratory for an ocular prosthesis (Figures 10-12).

Figure 10. Post-traumatic loss of iris and sclera in the left eye

Figure 11. Post-traumatic sclera and iris defect of the left eye

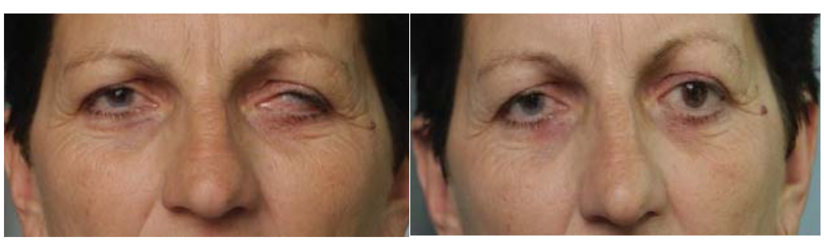

Figure 12. Post-traumatic sclera and iris defect of the left eye

## DISCUSSIONS

The steps involved in making an ocular prosthesis are similar to those involved in making most dental prostheses. The work involves the technician working directly with the patient over several days. A minimum of 3-4 sessions with the patient and many intermediate technical steps are required.

Custom-made ocular prostheses are well adapted to the orbit, as the manufacture of the prosthesis is based on the anatomy of the ocular defect, thus offering fitting advantages, and the position of the iris is similar to that of the natural eye [10].

Intimate contact between the ocular prosthesis and the tissue bed contributes to a more balanced distribution of the pressure of the prosthesis on the surrounding tissues. In addition, the voids in the prefabricated dentures are minimized in custom-made prosthesis. Thus, dust and other small foreign bodies, which can irritate the mucous membrane and act as a potential source of infection, will be in smaller quantities [1, 10].

## CONCLUSIONS

The own technique of manufacturing a custom-made ocular prosthesis described in the paper allows for good aesthetics and intimate adaptation of the prosthesis to the tissue bed. A well-made custom ocular prosthesis has a natural appearance and increased adjustability and also can maintain its orientation when the patient performs various eye movements.

The disfigurement resulting from the loss of an eye can have psychological and social consequences. An ocular prosthesis is absolutely necessary in these patients with various ocular defects and helps to restore aesthetic appearance and social reintegration. Ocular prosthesis, although it does not restore lost sight, remains the only aesthetic solution to resolve these cases.

The cosmetic and functional results of a customized ocular prosthesis accelerate the patient's return to a normal lifestyle.

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