VOLUME REPLACEMENT AFTER EYEBALL ENUCLEATION WITH POROTIC ORBITAL IMPLANT

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Introduction

In many cases, enucleation (removal of the eyeball) is the only solution to reduce complaints caused by large intraocular tumors, painful light-sensitive blind eyes developed after trauma, chronic inflammation, and multiple unsuccessful surgeries or to prevent sympathetic ophthalmia.

Removal of an eyeball induces a great transformation in the structure of the orbital tissues. During enucleation, a large amount of orbital soft tissue is removed, the extraocular muscles are separated at their insertion, the optic nerve and the branches of the ophthalmic artery and vein are cut deep in the orbit.

If the lack of the eyeball is not replaced, the artificial eye will show an enophthalmic ppearance, the upper eyelid fold becomes deeper and the patient can wear only a large, thick, concave artificial eye whose movement is restricted. Beyond the psychological trauma due to the loss of the eyeball, the patient's quality of life is greatly reduced by a significant facial asymmetry developed after the surgery.

Implants can be used to replace the bulbus and fill the orbital cavity. The implant covered by conjunctiva provides the place for the prosthesis that substitutes the ocular surface. Orbital implant made of hollow glass was firstly used by Mules after an evisceration in 1885, then by Frost after an enucleation one year later. Beyond the glass, many other types of orbital implants were used later, such as metal, bone, gold, silver, cartilege, silk, wool, titanium, silicone or plastic. Implantation of these materials was often unsuccessful, implants were rejected and infected, and therefore the volume replacement surgery was partially ceased. The real progress in the eighties of the twentieth century was discovery of the porotic implants.

The first type of these implants was developed from the limey skeleton of the marine corals (natural hydroxyapatite) by Perry (1991).

The porotic implants contain multiple interconnected channels, through which the orbital fibrovascular tissue grows into the implant and thereby prevents its migration and promotes its good integration into the surrounding tissues.

Animal studies have shown that fibrovascular tissue can be detected four weeks after the implantation and in appropriate case, fills the implant completely in 3-6 months. The vascularisation rate of the implant was checked by magnetic resonance imaging (MRI) or scintigraphic examinations.

There are four types of porotic implants which are used worldwide.

The firstly developed natural HA implant was made of a marine coral skeleton (belongs to the genus Porites) by A. Perry in 1991. Due to hydrothermal interventions, calcium phosphate was gained from calcium carbonate (Eye Integrated Orbital Implants Bio, USA). The structure of the natural HA implant is similar to the spongiosa of the long tubular bones, thereby, the body accepts it as an own tissue.

In order to prevent the destruction of the coral population, the French FCI (Issy-Les-Moulineaux, France) developed a synthetic HA implant, which has two available types: uncovered and coated with Vicryl mesh.

The porotic polyethilen implant was developed and has been sold under the name of Medpor implant (Porex Surgical Inc., Newnan, GA) in the early nineties. This implant was designed of a high-density polyethilen dust. This material is more malleable, its shape is changeable even during the surgery, the extraocular muscles can be fixed directly to the implant, as it is not as hard as the HA.

HA implant was also made of cattle bones. This type is not widely used and was proven to be much more fragile than the others. As in United States, the center of the implant is drilled six months after the implantation and a peg is inserted into the drilled hole, the material is important to be packed, and not to break.

The newest type of porotic implants is of aluminum oxide (Bioceramic). This material has long been used in dentistry and orthopedic surgery. It is easy to work with, bioinert, strong and only mild tissue reaction is noticed after its implantation. It is also distributed by the FCI.

The synthetic HA, the porotic polyethilen and the aluminum oxide have similar characteristics as the natural HA, however they are much cheaper.

The pore size is extremely important for fibrovascular ingrowth into the implant. It is about 300-700 microns in the natural HA, 100-500 microns in the porotic polyethilene, 300-500

microns in the synthetic HA and 500 microns in the aluminium oxide. All four implants have good pore size for inducing appropriate fibrovascular tissue ingrowth.

Calculation of the proper size of volume replacement is absolutely necessary for the best aesthetic result. Enucleation of an eye generally leads to 7 ml loss of soft tissue volume. Taking an average axial bulbus length of 24mm, this loss may be greater; it varies essentially between 5.5 and 9 ml. This value can be determined by ultrasound or with measuring the volume of the water displaced by the bulbus.

Orbital implants of 20 mm in diameter substitute 4.2 ml and 26 mm in diameter can replace 7.2 ml volume loss. An average volume of an artificial eye is 2.0 to 2.5 ml. The most often used orbital implant size is 20 mm in diameter and provides aproppriate replacement for the removed eye with a 2.5 ml artificial eye. If an implant, more than 22 mm in diameter, is inserted into the orbital cavity, the suture of the Tenon-conjunctival complex over the implant is feasible only with tension and this could be a high risk for wound separation.

In our clinic, we have had the opportunity to use porotic implants since 2002. According to our knowledge, this kind of reconstructive surgery is performed in Hungary only at the Ophthalmology Department of Semmelweis University in Budapest.

2. AIMS OF THE STUDY

1. To summarize our experiences with orbital implant insertion after enucleation in 80 patients between 2002 and 2009.

2. To describe our technique for creating a new conjunctival sack, which is suitable for wearing an artificial eye after removal of the orbital implant.

3. To compare our clinical experiences with the MRI results of patients wearing orbital implant.

4.. We examined, whether the Cone Beam CT (CBCT) is capable for detecting changes in shape and volume of the hard structure of the porotic orbital implant.

We analyzed whether the CBCT was suitable for density measurements. We searched for noticable density changes in connection with the time elapsed since the implantation. We also observed if it was possible to infer the structural alterations (vascularization rate) of the implant with the measurement of this density changes.

5. We examined whether the orbita modul of the CranioViewer software (being under development) was suitable for measuring the orbital volume. If it was, whether these measurements confirmed the assumption that orbital volume reduction is detectable after enucleation not only in children but adult patients as well.

3. PATIENTS AND METHODS

3.1. Orbital volume replacement with porotic implants after enucleation

The first hydroxyapatite (HA) orbital implant insertion after enucleation was executed at the Tömő utca section of Semmelweis University, Department of Ophthalmology, Budapest (functioned as the 1st Department of Ophthalmology at that time) in February 2002. Between December 2002 and February 2009, we performed HA orbital implantation in 80 patients. The implantation was primary in 58 and secondary in 22 cases. Causes of enucleation were microphthalmus in one case, microphthalmus cyst in another case, a large choroidea melanoma in 12 cases and painful blind eyes (without light perception) developed after severe injury, multiple ocular surgery or chronic uveitis in 66 cases.

The mean age of the patients was 38.75 years, the youngest was five and the oldest was 85 years old at the time of implantation. Diameter of the implants we used were 16mm in one case, 18mm in 26 and 20mm in the remained 26 cases. In most cases (53 patients), FCI synthetic HA, in the other 27 cases, FCI aluminum oxide (Bioceramic) porotic implants were inserted in the orbital cavity.

The follow-up included controls in every 3 month in the first two years, then every half year for another 2 years and yearly from the 5th year in asymptomatic cases. Those patients are excepted whose enucleation was required because of a malignant intraocular tumor. The follow-up of these patiens was based on the cooperation between the oncologists and the ophthalmologist.

3.2. Preparation of a suitable conjunctival sack for reception of an artificial eye after orbital implant explantation

Severe causes of surgical complications during removal of the implant:

1. In one case, the implant was located in exophthalmos due to the irregularly developed small orbital cavity after enucleation performed in early childhood.

2-5. Four patients presented with primary conjunctival insufficiency. 2.1: The indicator might have been diabetes which became decompensated and was difficult to set due to the altered living conditions of the patient. 2.2: The reason for enucleation was intraocular melanoma, but the patient's history included a previous treatment for prostate tumor. 2.3.: One and a half year after the secondary implantation, the patient was diagnosed with mammary tumor. In the 2.2 and 2.3 cases, the primary conjunctival insufficiency was considered as paraneoplatic phenomenon. 2.4: An inflammed, blind painful eye developed due to a severe injury was enucleated in a young man. The fragile conjunctiva due to injury and inflammation could be the cause of the primary wound dehiscence.

6. In one case, such a serious fungal infection developed that the conjunctiva almost instantly fell apart and disappeared from the orbital implant surface. Examination, after a positive local culture for fungi, revealed fungal skin infection on the back covered by clothes, which might have infected the conjunctival surface and caused the rapid course of inflammation.

7. An injured young man presented at our department with serious infection, as a consequence of negligation of the hygiene rules and control examinations several times. Despite of the successful conservative antiinflammatory treatment, the conjunctiva was so severly damaged that it necrotised on the implant surface.

8. In one case, the patient was asymptomatic for three years after enucleation and primary HA implantation. After the third year, conjunctival deficiency developed with severe superficial inflammation on the implant surface. The long-wearing poorly fitting prosthesis was the cause of the conjunctival erosion.

3.3 Comparison of the results of MRI examinations with the clinical experiences

Vascularisation of the porotic orbital implants can be assessed by in vivo scintigraphy or MRI examination. Animal studies indicate that four weeks after the implantation, fibrovascularis tissue can be detected within the porotic implant. Clinically, it is enough to know for sure in six months, that there is a proper vascularisation in the implant or not. In some cases, if the patient's complaint indicated, MRI recording were performed to compare the vascularisation rate with the clinical symptoms. We could obtain information of the implant vascularisation rate in case of eight patients.

3.4 Presentation of our results with densitometric analysis of the CBCT images and their clinical application

A large-volume CBCT device (iCAT Classic Xoran Technologies Arbour Michigan, USA) was used for the measurements (unit characteristics are 120KV, pixel size: 0.3mm, slice thickness: 0.3 mm, Field of View (FOV) hight: 6 cm).

Our first suggestion was that CBCT examination provides us the information if the porotikus implants undergo shape or significant volume changes.

Analysis of the images showed the origin shape of the spherical implant in every case (detachment of few spikes was noticed in some patient, especially in the area of the lateral and medial muscles, but this change was not significant and visible in each case).

Volume measurement was carried out with Mimics 12 software (Materialise, Leuven. Belgium).

In forty-six cases was determined the orbital implant density. We had two groups of patients to be evaluated. For density measurements, the commonly applied HU (Hounsfield) unit was used, but a special calibration of the formula was necessary for application of CBCT device.

In the first group (CBCT examinations accomplished between January and November 2009) two material with presumably constant density (the contralateral vitreous body and a specific area of the bony orbit) was used as benchmarks. The selected region is between the lower, upper, lateral orbital margin and the dorsal surface of sella turcica.The maximum HU and maximum linear attenuation coefficient values of this area were used for calibration.

In the second group of patients (CBCT examination performed between April to July 2011), four standard, 10 cm long and 5 mm in diameter high-density aluminum cylinder was applied for calibration, instead of the designated area of the orbit. Values of the orbital implant, the vitreous body and the aluminum cylinders HU (apparent density) were recorded. The interval between the implantation and the scanning time was calculated in days. The vitreous and an average HU value of the aluminum cylinders and the standard deviation were determined using ImageJ 1.42 q (National Institute of Health, Bethesda, Maryland, USA) automated evaluation program. Additionally, the Mimics 12 (Materiaiasel, Leuven, Belgium) software program was applied, which was suitable for analisys of porotic materials.

3.5 Measurement of the orbital volume on CBCT images with CranioViewer program orbital module

Because of the specific, complicated anatomical structure of the bony orbit, the exact volume measurement is difficult. The measurement is even more complicated by the fact that the inner surface is irregular due to the fissures and holes. Large-scale Classic iCAT device was used for the measurements. In these images, beyond the skull face the orbit is also visible.

The Cranioviewer orbital program software (being developed by Zsolt Markella and Tamas Vizkelety, MD version of January 12, 2011) was used for the analysis of the CBCT scans. During a CBCT scan, the head position nearly corresponds to the Frankfort horizontal plane. The gained selection of data may be rotated freely. The tested area was adjusted so that the most dorsal points of the right and left orbital apertures were connectable with a sraight line, which also meant the plane where the most ventral points of the orbital cavity formed a closed circuit. The bony orbital frame was denoted by red and blue lines both in the axial and the coronal planes. Slices were made at 4.8 mm intervals in ventrodorsal direction from the orbital aperture toward the apex. The device works with CBCT voxel sizes of 0.3 and 0.4, an integer multiple of these values can fit into the 4.8 mm wide slice. Five slices were made from the orbital frame to the apex.

After an appropriate adjustment, the intact and implanted orbit can be displayed and the cavity volume can be measured in the same plane.

The program outlines the bony border and encloses the foramens and fissures with a green line then automatically fills every slice with red colour and measures the area of the slice in mm^2.

The applied software has the advantage that with measuring of the area of the cross-sections at every 4.8 mm stepping in ventrodorsal direction, we gain information also about the ventrodorsal localization of the orbit deformation and not only about the shrinking or swelling related to the volume of the whole orbit. So this ventrodorsal registration is the best for the examitation of the anophthalmic orbit.

Our investigation reveald that analysis of the area of the analogue frontal levels, provided a much clearer image about the morphological changes of the bony orbit then evaluation of the orbital sack as a unique volume.

The measurements were performed on both sides, so in the intact and also the implant containing side. CBCT images of those patients were used as control group, whose records were made because of dental diseases. These patients had no history of malformations or any orbital injury. In the control group, orbital volume was also measured in both sides. The question was whether there was a difference between the right and left orbit of healthy people and also the enucleated orbit containing an implant and the intact orbit of the same patient.

All measurements were carried out in three different testing times by three different people. Paired t test was used to compare the differences between the groups. P values less then 0.05 were considered to be statistically significant.

4 RESULTS

4.1 Our experiences in the orbital volume replacement with porotic implants after enucleation.

Between December 2002 and February 2009, porotic orbital implant was used in 80 cases for volume replacement after enucleation.

In fifty-nine patients, no postopertive complication was observed after a long follow-up.

In twenty-one cases the following complications were found. Fourteen cases were treated of minor or larger conjunctival lack and conjunctival granulation tissue. In eight patients orbital implant was removed because of infection as a consequence of persistent, conjunctival dehiscence which did not respond to a conservative treatment. In two cases, the smooth surface was created by fascia lata and conjunctival flap covering. In the remaining cases, the conjunctival hiatus closed spontaneously after observation and appropriate treatment (5% povidone iodine drops, targeted antibiotic therapy and artificial tear gel for local protection).

Overall, during the reviewed period, in eight patients of the operated 80 cases developed so severe infection that led to orbital implant explantation. The other 13 cases recovered after proper conservative or minor surgical treatment.

4.2 How to perform a good conjunctival sack after orbital implant explantation

Because of severe complicated surface inflammation, conjunctival failure and irregular development of the orbital bony cavity, the porotic orbital implants had to be removed in eight cases.

Before the explantation, we attempted to treat the conjunctival wound many times with conservative medical therapy, granulation tissue excision, removal of the anterior part of the implant and covering the affected surface. When these efforts failed and the implant became infected, we decided to remove it.

Immediatly after removal of the orbital implant, a sterile silicone ball (20 mm in diameter) was inserted under the eyelids and the eyelid margines were sutured temporarly. A large central part of the bulbar conjunctiva was missing, but the tarsal conjunctiva and fornices

were intact. We supposed that a new conjunctival sac was formed along the smooth surface of the silicone ball stabilized by temporal blepharorrhaphy. In three month, along the smooth silicone ball developed a stable conjunctival sack with a slightly irregular surface, which provided a good support for the artificial eye.
In all but one patient succeded to create a conjunctival sack which is appropriate for wearing an artificial eye.

4.3 Comparison of MRI results and clinical experiences

Reports of the eight patients who underwent MRI examination:

1. NR male patient – After enucleation of a painful blind eye developed due to endogenous uveitis, HA orbital implant was primary implanted in 2004. After three years asymptomatic period, pyogenic granuloma formation was observed on the conjunctival surface then an extensive conjunctival dehiscence developed. MRI examination was requested because of the suspicion of orbital cellulitis. The study took place in 2007. MRI described high vascularisation of the implant and did not show inflammation of the orbit. Despite these results, the implant was necessary to be removed.

2. SZA male patient – Enucleation of an injured, inflammed, painful blind eye and primary HA orbital implant insertion was performed in October 2007. Primary conjunctival dehiscence and a consequent severe inflammation were observed. The possibility of a deeper inflammation also arose in this case; therefore, MRI was requested in October 2008. Deep infection was not identified and the vascularity of the implant was appropriate. Nevertheless, due to the severe surface inflammation, the implant also became infected and had to be removed.

3. JPZ female patient - In 2005 enucleation was performed with primary HA implantation because of painful microphthalmus. A few months after the surgery, a small subconjunctival cyst presented and removed properly. Three years following the surgery, a permanent severe intraorbital pain occurred. Ear, Nose and Throat examination did not reveal any alteration. In

2008, we requested an MRI scan beause of the possibility of an intraorbital cyst. MRI studies have shown negative results. We asked for evaluating of the vascularity level of the implant. No traces of vascularity were found in it. The patient is still completely asymptomatic, the conjunctival sac is intact, no inflammation has been observed, and the prosthesis fits properly.

4. NZS female patient - After previous enucleation of the severly injured eye, a secondary HA orbital implant insersertion was performed in 2003. Three years following the implantation, a greater or lesser pyogenic granuloma occasionally appeared on the surface of the conjunctiva and the patient complained of pain radiating to the orbit. After negative Ear, Nose and Throat findings, MRI scan was requested in 2007. The deep area of the orbit proved to be intact, but vascularity was detected only in the ventral side of the implant (the front below the surface). However, the conjunctival surface was continuously irritated and conjunctival coverage was necessary, because of hiatus formation. In this case, the poorly fitting artificial eye was assumed to cause conjunctival hiatus by mechanical effects.

5. SZZ male patient – Because of a painful microphthalmic cyst, enucleation was performed with primary HT orbital implantation in 2002. The patient was born with right optic disc and choroid coloboma. A number of brain cysts were also detected. He received treatment for epilepsy. The intracerebral cysts necessitated periodic MRI test. In 2007, we asked an opinion on the vascularisation level of the orbital implant. According to the contrast enhancement, only the upper and lateral surface of the implant was vascularisated. In 2007, the front surface of the implant was visible under the conjunctiva, but the conjunctiva itself was intact. The patient occasionally suffered from moderate inflammatory symptoms (due to wearing an improper arteficial eye and the continous rubbing). By 2009, the conjunctiva over the implant was no longer visible. The patient’s moderate periodic inflammatory symptoms still persist. The MRI examination preformed on neurological recommendation had already shown a vascularised implant. It is assumed that the inheredited poor vascularisation of the orbital soft tissue caused this prolonged fibrovascular reaction. (The implant vascularisation became completed only in seven years instead of a half year.)

6. HL female patient - Following an injury, enucleation was performed previously and then a secondary HA implantation was occurred in 2006. The primary conjunctival dehiscence associated with permanent inflammation necessitated an MRI examination in 2008. The image revealed complete avascularisation of the orbital implant. Contrast material accumulation was detected only on the surface of the implant, which was considered to be an inflammatory sign. The MRI results fully agreed with the clinical symptoms. The implant had to be removed because of inflammation.

7. MK male patient - In October 2006, the painful blind eye was enucleated and primary orbital implantation was carried out. Following the operation, his changed circumstances and the severe stress situation led to the decompensation of diabetes mellitus which was previously diagnosed at him. Primary conjunctival insufficiency developed as a consequence of his underlying disease. The MRI examination performed in 2009 showed the vascularisation of the posterior surface of the implant. The patient was observed, as no inflammation was detected and fibrovascularisation within the implant was clinically visible. Unfortunately inspite of every precaution, severe inflammation was occurred due to the long-acting conjunctival dehiscence and the implant had to be removed.

8. HP male patient - The painful blind eye due to secondary glaucoma developed after an injury was enucletated and primary HA implantation was performed in June 2007. Because of severe persistent inflammation, an MRI scan was requested in 2010, which found no visible vascularity in the implant. The permanent lack of conjunctiva and the severe inflammation required the removal of the unsatisfactory orbital implant.

In five cases, the MRI results did not correspond to the clinical experience. In three cases, lack of the implant vascularisation explained the clinical symptoms.

Patient	HA implantation	MRI examination	Vascularisation of implant	
1. male	2004	2007 suspicion of orbital cellulitis	Good	Removal
2. male	2007	2008 suspicion of orbital cellulitis	Good	Removal
3. female	2005	2008 suspicion of intraorbital cyst	No vascularisation	Symptom free
4. female	2003	2007 retrobulbar pain	Only the surface of the implant is vascularisated	Conjunctival covering because of conjunctiva erosion
5. male	2002	2007 and 2009 cysts in the brain	2007 - no vascularisation 2009 - good vascularisation	Symptom free Symptom free
6. female	2006	2008 suspicion of orbital cellulitis	No vascularisation	Removal
7. male	2006	2009 suspicion of orbital cellulitis	Well vascularised dorsal part	Removal
8. male	2007	2010 suspicion of orbital cellulitis	No vascularisation	Removal

4.4 Results of densitometry examination on CBCT images and their clinical usage

Advantages of CBCT over conventional CT devices:

1. Open form - the patient is seated during the test, the head is fixed, there is no feeling of confinement, and the detector moves around the patient's head

2. Quick Scan - a CT scan takes several minutes, while the CBCT need only 20-40 seconds for one scan, the whole test period is no more than 5 minutes.

The radiation exposure is 1% of the conventional CT which is identical to a dental panoramic X-ray. In case of a small child, the radiation exposure is 40% lower compared to an adult’s

In the first group (CBCT examinations between January and November 2009), a defined area of the bony orbit and the contralateral vitreous body were used as benchmarks suggested to have differrent contrast density. Our first results showed that HA implants had an average density of 699 HU, while the AO ceramic had a density of 270 HU. This difference arises from the diferent quality of the two types of implant materials. These types of measurements were essentially appropriate to distinguish the two types of porotic orbital implants with absolute certainty.

In the second group (CBCT examination between April to July 2011), four aluminum cylinder with standard high density, 5 mm in diameter, 10 cm in length were used for calibration. With this new calibration, the average density of HA implants showed a significant decrease over time. Density of the AO implants did not show significant decrease with time. Moreover, in this case, a slight increase was observed in density (results of only four patients were to be evaluated; therefore, we could not drow far-reaching conclusions). Explanation of this phenomenon requires further studies.

4.5 of Orbita volume measurement on CBCT images with CranioViewer program orbital module

The measurements were performed in twenty patients. In 5 patients, there was a significantly lower volume in the first 4 or all 5 measured slices in case of the orbit containing implant compared with the contralateral healthy one. In 12 patients, the measured value was significantly decreased only in 1, 2 or 3 slices in the operated orbit compared to the ocntralateral one. In 3 patients, there were no significant differences between the slices in the operated and the healthy orbits.

The control group, which consisted of 20 patients, who had never suffered from any orbital injury or undergone any orbital operation, exhibited a normal skeletal skull shape without any facial asymmetry. Their CBCT scans were made because of their dental problems. In this group, no significant differences were measured between the right and left orbital cavities.

5. CONCLUSIONS

5.1. Enucleation without volume replacement does not give adequate aesthetic rehabilitation for the patient. The artificial eye is in enophthalmos, its movement is limited (only a thick, heavy artificial eye is capable to fill the deep conjunctival sac). The large artificial eyes lead to eyelid problems soon, and corrective surgerical procedures are necessary.

Despite the complications described in the literature and experienced by us in every enucteated patient, orbital voume replacement is absolutely recommended. The implant integrates into the surrounding soft tissue, and provides the replacement of the lost eyeball. If the patient is provided with a thin artificial eye and an orbital implant after surgery, these together can offer an appropriate post-operative aesthetic, psychological and social rehabilitation. Requirements following enucleation: the best natural appearance, the maximum degree of similarity to the other side, satisfactory movement, appropriate position and glistering of the prosthesis, the color of the iris and the preparation of the pupil . These requirements are properly fulfilled by an orbital implant together with an artificial eye.

5.2.

In case of such a severe inflammation and /or persistent conjunctival dehiscence that the implant had to be removed, the proper reconstruction of the conjunctival sac for wearing an artificial eye is indispensable. We utilized that property of the conjunctiva that covers the deficiency along the smooth silicone ball surface. In three month, regeneration of the bulbar conjunctiva takes place and a proper conjunctival sack develops with suitable size and shape for wearing an artificial eye. All but one of our patients are able to wear a proper artificial eye in the created conjunctival sack.

5.3.

The implant vascularity can be detected by contrast (gadolinium) MRI scans In our cases, intraorbital disorders necrssitated the orbital MRI examinations. During the analysis of the eight tests we found that the results of the MRI scans are notalways agree with the clinical signs. . These few cases are not enough to make conclusions. There is a legitimate demand

for possibility to follow the degree of implant vascularisation (this is a reliable sign of orbital implant integration) in every patient with itraorbital. .

5.4

The CBCT iCAT high volume device can be an ideal method for in vivo following of the porotic implants. Images were quick to perform; the test is carried out in an open space, the radiation exposure is minimal. The initial results are encouraging. The density of the implants can be calculated by comparing the high-density material with standard weight applied to the CBCT iCAT images. In synthetic HA implants, density decreases with the time elapsed from the insertion date probably due to the fibrovascular tissue growing into the pores. Results of the few AO data requires further investigation.

5.5

It is well-known in the clinical practice that insufficient orbital development may occur on the operated side due to the inappropriate rehabilitation following an enucleation in childhood or even inspite of the proper rehabilitation compared to the contralateral side,

There are only a few articles in the literature about the orbital volume changes after enucleation in adulthood. According to radiological clinical experiences, CT scans showed a smaller orbit in the operated side compared to the healthy orbital cavity in adults as well. Only few instrumental measurements were carried out to verify or exclude this observation. Our measurements performed with the orbital module of the CranioViewer software program verified our conception. The results indicated that in the vast majority of cases decreased values were found in the operated orbit compared with the healthy side at least in one measured slice. In the healthy control group, there was no measurable difference between the two sides in any slice.

The explanation is not forthcoming yet. Further investigations are necessary to establish what structural changes are responsible for this volume reduction. It is our hope that analogous studies will lead to development of computer software specificially designed to measure the volume on CT scans more accurately and reproducibly, which would have a great value in estimations of orbital changes after enucleation. The proper well-reproducible calculation of

the volume measurement has a high importance in planning of the reconstruction after injuries and may also have a role in determination of the orbital implant.

6. OWN RESULTS

1. We in the Tömő utca section of Semmelweis University, Budapest, Department of Ophthalmology, applied first in Hungary the porotic orbital implant for volume replacement after enucleation in 2002. We operate as a national center and nobody else has perfromed this type of surgery in Hungary till now.

2 The method used for reconstruction of the conjunctival deficiency due to the implant removal was described as a unique in the literature (Lukáts Orbit 2002).

3. We compared MRI scans carried out in patients with orbital implant to the clinical experiences.

4. We were the first in the world to perform density analysis on CBCT images in case of intraorbital implant.The measurements were carried out with the calibration method specially adapted for the CBCT device.

5. First in the literature, we examined the volume of the orbit containing implant and also the contralateral healthy one with the orbit modul of the CranioViewer software on the previously conducted CBCT images.

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