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## **Innovations and New Techniques of Surgical Ophthalmology**

Since the introduction of microsurgery in the field of ophthalmology with the routine use of surgical microscopes, precision and security have been tremendously improved. Numerous new instruments have been invented to do justice to the small size and the optical function of the organ and surgical sutures which are not visible to the naked eye have been developed (Barraquer, Ignacio; Joaquin, Jose 1952-77). During a cataract surgery, the intervention carried out most frequently, the clouded lens used to be excised completely in earlier times and the patient had to wear thick cataract glasses as a compensation for the missing dioptres.

### **Cataract Surgery**

In the past 30 years cataract surgery was dominated by lens implantation surgery (Binghorst, Worst, 1960-70). The method of intracapsular cataract extraction was crowned by little success in the 1950ies as a result of material problems. Thus a shift in surgical technology took place in the 1960ies towards extracapsular lens extraction and implantation of an artificial lens.

In industrial countries the cataract glasses were quickly replaced by implants and the employment of increasingly precise technologies for lens extraction. The state-of-the-art method of cataract surgery is phacoemulsification of the lens with a 1.2mm thick instrument and a foldable lens insertion through a tiny 3mm cornea incision. Also infants of 2 years of age and older can be implanted an artificial lens after the lens extraction in order to prevent weak-sightedness.

In developing countries cataract, as a consequence of vitamin A deficiencies and the resulting drying of the cornea surface, and trachoma, caused by a bacterial infection transmitted by flies, are the most frequent causes for blindness. Some time ago large cataract-camps used to be the only possibility for blind people to get access to surgery that would give them their sight and also their normal lives back. Only in the past few years a change has taken place towards lens implantation under the surgical microscope. Without lens implantation the results were much worse and the dependence on thick glasses which easily broke or got lost and which were mostly unaffordable for poor people was a major problem. The Austrian association "Licht für die Welt" (the former Christoffel Blindenmission Austria) initiated

several projects with the participation of Austrian ophthalmologists, including the establishment of surgical institutions and local training centres for physicians and nurses, particularly in Africa.

Cataract surgery and trachoma surgery at the eyelids are the interventions carried out most frequently. In order to improve training and cooperation, especially with countries of the Third World but also with Eastern Europe and the USA, the Austrian Ophthalmologic Society (ÖOG) set up a “Commission for International Medicine” in 2004.

### **Refractive Surgery of the Cornea**

“Refractive surgery“ is used mainly in the USA because during this operation, in the course of which the refractivity of the cornea is modified, maximum comfort for the patient is always in the foreground. The treatment spares the patient to wear glasses or contact lenses but vision remains the same as with seeing aids. The radial keratotomy, originally coming from Russia (Fjodorov 1975 ), is a cheap method where tiny radial incisions flatten the cornea. Nowadays it has been replaced by the LASIK or LASEK method (laser in situ keratomileusis) using Eximer laser systems. Jose Barraquer Jr. (1975) in Bogota, South America, is considered the founding father of this refractory technique. From there, as well as later on from New Orleans, came most of the innovations in this field (Kaufmann 1981-88).

In the meantime millions of people around the world have undergone refractive surgery and in only 1 % of the cases complications of varying grades occurred. Nevertheless the advantages and disadvantages of the different techniques and the spectrum of indications are still being discussed.

### **Glaucoma Surgery**

The highly dangerous glaucoma is mainly combated by means of drop therapy for a reduction of the abnormally high eye pressure. Apart from filter-building glaucoma surgery, using antimetabolites (Mitomycin) for the reduction of the filter closure, other non-penetrating filter surgeries have been developed, such as the profound sclerectomy, which clearly lower the risk but are not yet as successful in reducing the eye pressure as other methods.

## **Retinal and Vitreal surgery**

The biggest progress in the field of ophthalmologic surgery in the past 20 years has clearly been achieved in retinal and vitreal surgery. Common retinal detachments, which are most frequent with myopic patients, can nowadays be healed in 95 % of the cases, using different methods such as episcleral surgery, intravitreal gas tamponades or vitreal surgery.

Vitreal surgery or the pars plana vitrectomy was still considered an experiment in the 1970ies (Machemer 70 , Klöti 69 ) and was only applied in the gravest cases of vitreal bleed or perforating eye injuries. Today it is a well-established and standardised method of surgery.

Vitreal surgery is regarded as one of the first endosurgical methods ever which guarantees the surgeon the sight into the eye via a lens system through the cornea. The diameter of the instruments penetrating the rear side of the eye via the pars plana is 0.5-1.0 mm.

Vitrectomy considerably lowered the blindness rate with diabetic eye conditions and enabled eyeball reconstructions after complicated penetrating eye injuries. Nowadays only 20 % of such cases are incurable, compared to 80 % in earlier times. The socio-economic relevance of this fact is enormous, because most patients with difficult eye injuries are working adult men. Also diabetic eye conditions constitute the most frequent vascular disease of middle-aged persons.

On top of that we are meanwhile able to heal complicated retinal detachments in more than 80 % of the cases, using a combination of retinal and vitreal surgery. For vitreal tamponades intravitreally expanding gases are increasingly used in the USA whereas in Europe purified silicon is applied. Several broad-based studies have shown that for cases of medium severance both tamponades show equal results, whereas for grave detachments the long-term tamponade with silicon oil has shown better outcomes.

The indications for vitrectomies have been widened considerably in the past decade, especially in the field of macular surgery (makula lutea – yellow spot of the retina). Thus macular holes, 70 % of which occur in women after the menopause and for which there was no therapy, can nowadays be closed in 80 % of the cases and thus restore the patients' reading ability.

Currently age-related macula degeneration (AMD) is the most frequent cause of legal blindness (i.e. 10 % visual acuity) in people aged 50 and older in industrial countries. There are two major forms of AMD: “dry” atrophic and the “wet“ exudative neovascular AMD.

These patients do not turn fully blind but they lose their central sight, and thus suffer a considerable loss of their quality of life, since they cannot read or watch television, cannot

drive or recognise people and have difficulties eating. Risk factors for the incidence of this disease, apart from age, are high lipid values, low pigmentation, nicotine abuse, vascular diseases and sometimes extreme exposure to light.

Originally laser surgery was applied for the neovascular forms but since four years the less exhausting photodynamic therapy has primarily been used for such cases. This therapy is a combination of photosensible pigments and a laser treatment which helps to close neovascular tissue under the macula at least temporarily. Unfortunately both methods can only slow down the normal course of the disease.

Surgical methods such as rotation techniques of the retina, where the centre of the retina is shifted over healthy pigment epithelium, or the transplantation of pigment epithelium cells were and are still tested in clinical research (Eckkart, 1999, Binder 2002- 2004). These methods lead to an improvement of sight with part of the patients and the possible complications are clearly lower than with the complicated rotation method. However, we need to continue research and improvements in this field. With mature techniques both methods might be suitable for patients suffering from dry macula degeneration (70 % of all AMD patients), for which there is currently no cure than vitamin treatment.

### **The retinal chip**

In eight to ten large-scale research centres a so-called „retinal chip“ is currently being developed for patients suffering from retinal blindness (e.g. retinopathia pigmentosa). It will be the task of the implant to stimulate the ganglion cells of the retina, of which blind persons still possess 30 %, so that the patient can develop a rough sight pattern. At the moment two principles are being tested: a photoelectric principle and a biochemical principle using neurotransmitters. The subretinal chip has already been permanently implanted in ten patients in Chicago (Chow) and in three patients in Los Angeles. The short-term results are promising but the long-term outcome remains to be seen. Other research centres in the USA, Germany and Austria have also carried out tests with human patients, but the bulk of the results only stem from animal testing. Therefore we only expect the broad application of retinal chips in five to ten years time.