visually impaired people can access its services without hindrance—or you and your employer may be in breach of the act
- Know where to go for information—the Disability Rights Commission has a helpline and a website (www.drc-gb.org); and the Royal National Institute of the Blind also provides advice and information on the DDA (www.rnib.org.uk).

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Corneal transplant

The first successful full-thickness corneal transplant: a commentary on Eduard Zirm's landmark paper of 1906

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The first successful full-thickness corneal transplant was performed in 1905

Despite attempts since the early 1800s, success in corneal transplantation remained elusive at the beginning of the 20th century.[1] Then, seemingly against the odds, one of the bilateral corneal transplants performed by Eduard Zirm in December 1905 on a 45-year-old farm labourer remained clear.[2] The patient had lime burns and would be considered a poor candidate for corneal transplantation today. The graft continued to function sufficiently well to allow the patient to return to lighter agricultural duties at home.

This remarkable outcome refuted Salzer's view, quoted by Zirm, that full-thickness grafts would never remain clear because of graft absorption and loss of histological identity. Although Fuchs had shown that graft integrity was indeed retained, he nonetheless believed that the seemingly inevitable clouding of grafts was a consequence of the healing process. Such opinions are entirely understandable, given the failure of any previous full-thickness graft to remain transparent for more than 2–3 weeks. Zirm's own comments and speculations on the reasons for his success provide a revealing insight into the thinking of the time.

CASE REPORT, SUMMARISED FROM ZIRM'S 1906 PAPER

Some 15 months after the lime burns, the patient's corneas were white–grey in colour and opaque with a flattened corneal curvature, but intraocular pressure was reported to be normal. Both eyes had light perception and the right eye could detect hand movements. The donor was an 11-year-old boy with an iron intraocular foreign body after a penetrating eye injury. Attempts to remove this foreign body ended in collapse of the eye and, with the father's permission, the eye was enucleated. Zirm kept the eye in warm physiological saline solution and began the transplant operation without delay.

After induction of deep anaesthesia, a 5-mm disc of opaque central tissue was cut from the patient's right cornea using a von Hippel trephine. A trephine of the same diameter had already been used to cut a disc of tissue from the peripheral cornea of the donor eye. The graft was positioned and a pedicle conjunctival flap sutured over it. For the left eye, a disc of tissue was cut from the centre of the donor cornea. The graft was kept warm and moist by placing it between two pieces of saline-moistened gauze and holding it over a steaming container of hot, sterilised water. A disc of tissue of the same size was removed from the centre of the patient's cornea and the graft inserted directly using just the gauze to manipulate the graft. Zirm noted that it fitted perfectly, a point he later emphasised as being one of the most important reasons why the graft was successful. The graft was held in place by two overlay sutures. After 1 week both grafts were clear, but in the next 2 weeks the right eye became painful, and the transplanted cornea and surrounding tissue were eventually excised. The graft in the left eye remained clear.

After 5 months, visual acuity was recorded as 3/50 and J16 unaided, improving to 3/20 with +5 DS. After 6 weeks, Zirm reported that the graft was completely transparent, allowing him to observe adherence of the iris at the wound interface. Several superficial blood vessels that had spread across the cornea were seen, but these stopped at the graft margin. The lens and vitreous were clear and the fundus normal by ophthalmoscopy.

FACTORS TO WHICH ZIRM ATTRIBUTED HIS SUCCESS

The quality of the donor tissue

The cornea had come from a young boy and the tissue was in good condition nutritionally. To emphasise this point, Zirm mentions a later graft in 1906 that, he believed, had failed owing to the use of tissue from an atrophied eye. He also stresses that corneas from other animal species should not be used. (Despite Bigger's report in 1837 of a successful corneal allograft performed 2 years earlier on his pet gazelle,[3] most of the attempts at human corneal transplantation that followed were in fact xenografts because it was thought important to use eye tissue from a living donor.)

The conduct of the operation

In addition to meticulous asepsis and general anaesthesia, Zirm mentions the following as important to the successful outcome. The donor eye was kept in warm physiological saline at near body temperature. To achieve complete contact around the graft–host interface and to avoid early loss of transparency, Zirm considered it essential for grafts to be cut only with a trephine, using no other instruments. Once the graft was cut, it was not treated with antiseptics but kept warm and moist until transplantation.

The graft was manipulated using only gauze and secured with overlay sutures. Zirm highlighted the point about the goodness of fit of the graft by citing four other transplants carried out in succession on the same day where the graft did not sit so well in the recipient bed (and, presumably, all failed).

The condition of the recipient eye

Zirm believed it important that the leukoma was a result of lime burns rather than infection and that the anterior chamber, iris and lens were relatively normal. In addition, the upper fringe of the pupil appeared to have bonded to the graft, thereby stabilising it, and blood vessels had spread across the recipient cornea, but without penetrating the graft. Indeed, he speculated on the benefit of trying to encourage vascularisation of the recipient cornea before transplantation to improve the nutritional status of the tissue, which Zirm considered crucial to the maintenance of transparency in the long term. Although it was believed at the time that the small nutritional needs of the cornea were supplied mainly via the limbal capillary arcades and the tears, Zirm noted Leber's belief that various substances, including proteins, pass through Descemet's membrane from the aqueous humour; hence the importance Zirm ascribes to the normality of the anterior chamber for the success of the graft.

A LATTER-DAY VIEW

From Zirm's report of the surgical technique, the absence of microsurgical equipment is in striking contrast with practice in recent decades. This made it impossible for him and his contemporaries to suture the graft–host junction directly and secure a deep anterior chamber. Wound closure was entirely reliant on a bridge of conjunctiva over the first (right) graft and overlay sutures to the conjunctiva in the second. Zirm emphasised the apparently good fit of the left donor cornea to the recipient bed, and it is virtually certain that early wound dehiscence was the cause of failure of the right graft. Moreover, the lack of antibiotics and steroids meant that grafts (indeed any surgical procedure) would have been prone to serious infection and inflammation, with little or no prospect for their control. It is therefore remarkable that even one of these grafts for chemical burns survived.

Even though the graft was cut from young donor tissue with a presumably high endothelial cell density, Zirm's careful handling of the tissue clearly helped lessen the risk of considerable endothelial damage. He remarked later to Henry Hartmann that the cornea was not treated with iodoform and other crude antiseptics, which would impair its viability.[4] Apart from the use of allogeneic tissue, there may have been other immunologically favourable factors—namely, the small size of the graft (only 5 mm) and the absence of vascularisation, both of which are known to favour survival.

In the late 1800s, partial-thickness lamellar grafts were thought to have a better chance of improving vision. Zirm's success refocused attention on full-thickness corneal transplantation for optical rather than reconstructive reasons. Today, there is a trend back towards lamellar techniques, with the aim of replacing only those parts of the cornea that are diseased; but most of the corneal transplants remain full-thickness grafts. Even though grafts for keratoconus and Fuchs' dystrophy are now expected to survive and function for many years, other indications, including chemical burns, still have poor long-term survival. Even in grafts with good survival, astigmatism remains a major postoperative problem compromising visual outcome. There are still many problems to solve and gaps to fill in our understanding of corneal transplantation.

Zirm showed undoubted skill and insight, but serendipity, as with many advances in medicine and science, must also have played some part in this remarkable achievement that paved the way for the successful treatment of many thousands of patients around the world with corneal disease.

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