CORNEAL GRAFTS

B. W. RYCROFT

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FOREWORD

IT GIVES ME much pleasure to write a Foreword to this comprehensive book on corneal grafting as it is the first book of its kind to be published in the English language. I have witnessed the tragedies in life of blindness due to corneal opacities and I have also seen the joy that has been brought to these patients by skilful corneal grafting. I look forward to the day when every large city both at home and abroad will have eye banks so that more and more of these blind persons can be restored to full vision.

One of the great features of this book is its international character, for leading ophthalmic surgeons from Europe and America have contributed to its chapters. I consider it reflects contemporary thought on corneal grafting at the middle of the twentieth century as each chapter is written by an authority on the subject, and I am certain that the conception of this book was to produce an outstanding effort which would do credit to international ophthalmology. This has undoubtedly been realized and the result is bound to become the reference volume on corneal grafting throughout the World. I wish it every success.

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND
LONDON, 1955 *CECIL WAKELEY*

PREFACE

MODERN KERATOPLASTY inherits from the nineteenth century an appreciation of surgical principles, conceptions of homoplasty, and sound ideas of antisepsis and asepsis. The twentieth century, so far, has contributed refinements of technique, the provision of fine instruments of precision, the antibiotic control of infection and further knowledge of biological reactions. Thus does blindness from corneal opacities begin to fade from the scroll of hopeless and untreatable eye diseases.

Yet formidable problems must be solved before the operation of corneal grafting becomes free from complications or consistently predictable in result. Apart from surgical skill, such problems are now mainly concerned with the immunological reactions of tissue behaviour and the preservation of donor material; they receive, therefore, special emphasis in this work, for it would appear that surgery moves towards a new era of transplantation. We, who share this work, pause for contemplation and collect our thoughts which we offer to our colleagues for consideration. We present them against the broad backcloth of tissue transplantation, for corneal grafting must never be regarded as a mere technical manœuvre of surgical dexterity but must always be studied with the problems of grafting elsewhere in the human body.

My first acknowledgement of indebtedness and my sincere thanks go to distinguished colleagues who have so willingly contributed the wealth of their experience to this work. All of us would have wished also to include another name—that of Vladimir Filatov. Special reference has been made in appropriate places in the text to co-operation which has come from many sources and for this valuable assistance I am grateful. Also, it must be obvious to everyone who has studied the subject that the magnificent work of Paufique, Sourdille, and Offret, "Les Greffes de la Cornée," has been my constant companion, guide, and inspiration.

During the anxious days when British public opinion was being moulded to accept an alteration in age-old legislation which would facilitate the supply of cadaver donor material, Sir Cecil Wakeley was a source of great strength in his official capacity as President of the Royal College of Surgeons of England and his influence undoubtedly helped to bring success to our plans. From Sir Archibald McIndoe and my colleagues at East Grinstead has always come constant encouragement and co-operation and the keen interest of Sir Harold Gillies has been much appreciated. Mr. Gordon Clemetson and Mr. Frank Summers have made their expert knowledge of medical photography and pharmacy readily available and to my assistant, Giles

Romanes, and my nursing staff I owe a debt of gratitude which spreads over many years; their loyal help has been invaluable.

The Medical Department of Messrs. Butterworth have controlled the difficulties of publication with great patience and efficiency and Miss D. M. Knight and Miss D. Owen have readily carried out the heavy work involved in the production of the typescript.

Finally, I remain profoundly conscious of the privilege in presenting this work on corneal grafting and hope that any inadequacy of translation has not misconstrued the thoughts of my colleagues.

Let this work be regarded as an interim report which enables us to take stock of our present position, to realize our gains and our failures and, accordingly, to be able to assess, with some measure of experienced confidence, our difficulties in the future.

LONDON, 1955 *B. W. RYCROFT*

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HISTORY

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"Why think, why not try the experiment?"

John Hunter (1728–1793)

FROM 1739 to 1815 a succession of wars ravaged Europe; armies were constantly on the move and it is little wonder that ailments like smallpox, trachoma, and venereal disease were rampant causes of corneal blindness. Eye injuries by war missiles at that period did not have the same significance as they have today, yet in 1818 it is mentioned that there were over 5,000 blinded soldiers in England, probably mostly from disease.

Before that period the study and practice of medicine had been wrested from the Church, and anatomy had become a dominant subject of interest. Leyden was the fashionable school, but the emphasis on surgery was shifting to Paris. Germany was reeling from the effects of the Thirty Years War, whilst England was busily engaged in several campaigns at home and abroad under the rule of a mad king.

The practice of physic was considered to be superior to surgery which was in poor repute. Ophthalmology was still submerged in general surgery and, as a consequence, fair game for quacks and charlatans. The tailor Reed became oculist to Queen Anne, and Wodehouse to James II, whilst the most picturesque of them all, Chevalier Taylor, opportunist as well as quack, roamed the fairs quoting Latin tags and selling secret remedies. Yet Taylor had some smattering of medical knowledge for he had known Cheselden and approached the treatment of eye disease on the anatomical basis of his day. An early English reference to superficial keratectomy is found in his writings of 1761 where he describes two methods. One was "to pare off the excrescence with a small curved knife, leaving as few inequalities as possible", and the other was "to scrub the eye with a small brush made of 'barley' bristles". In 1771, Pellier de Quengsy had the idea of implanting transparent material in the cornea but no experiments were made, and in 1775 Robert Mead advised that equal parts of glass and sugar would be efficacious when rubbed into the eyes daily. Erasmus Darwin (1797) wrote:

After ulcerſ of the cornea which have been large, the inequalitieſ and opacity of the cicatrix obſcure the ſight: in this caſe could not a ſmall piece of the cornea be cut out by a kind of trephine about the ſize of a thick briſtle, or a ſmall crow-quill, and would it not heal with a tranſparent ſcar?

It would appear from these restless thoughts that blindness due to corneal ulceration was a problem of increasing consequence in those early days.

In 1728, William Cheselden (Fig. 1) of London had introduced iridotomy for the treatment of incarceration of the iris which often followed the prevalent operation

of couching for cataract. The description of this operation and the solitary publication of Daviel (Fig. 2) in 1753 on the treatment of cataract by extraction of the lens instead of by couching, undoubtedly represent the foundation of intra-ocular surgery and did much to stimulate interest in the surgical treatment of eye diseases.

Fig. 1.—William Cheselden (1688–1752). (From Garrison's "History of Medicine" (1929) by kind permission of W. B. Saunders Co. Ltd, and the Royal College of Surgeons of England.)

Fig. 2.—Jacques Daviel (1696–1762). (From Handbuch der Gesamtem Augenkeilkunde and by courtesy of the Wellcome Historical Medical Museum.)

Gradually ophthalmology emerged as a separate specialty. Himly (Fig. 3) at Göttingen in 1772, gave the first course of separate eye lectures and, in the Vienna School of Ophthalmology which was founded a year later by Barth, there was a separate eye ward. Moorfields came into being in 1805, followed by the Royal Westminster Ophthalmic Hospital in 1816. A year later the first eye infirmary in the United States was founded at New London by Elisha North (Fig. 4) and in 1820 the New York Eye and Ear Infirmary was established. In France, du Villard had an Eye Dispensary at work by 1835.

PERIOD OF HETEROPLASTY (1800–1900)

Nineteenth century

The treatment of corneal scars by the transplantation of tissue had two phases. For most of the nineteenth century heteroplasty was in vogue since the natural tendency with any new method of surgery was first to try animal experiments, and then to apply them to human beings. The first half of the nineteenth century was a period of dismal effort and error in which the vague conceptions and thoughts of early workers were interpreted by many fruitless experiments. It is to be remembered that precise animal eye experiments such as corneal grafting would be particularly difficult at that period without anaesthesia. In the second half of the

nineteenth century the influence of antiseptic principles and improvements of technique, coupled with the lessons which had been learned earlier, brought about a change of thought and the century terminated with a conviction that homoplasty was to be a dominant factor for visual success.

Fig. 3.—Karl Himly (1772–1837).

(From the Graefe-Saemisch Handbuch by courtesy of Springer-Verlag, and the Royal Society of Medicine.)

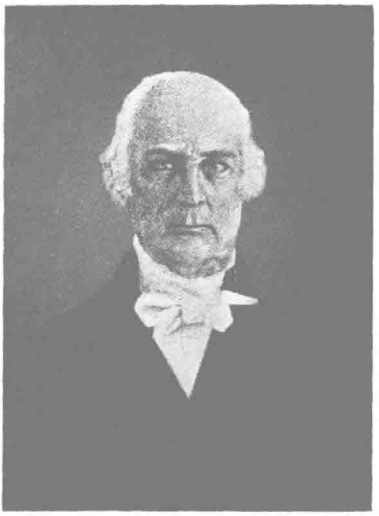

Fig. 4.—Elisha North (1771–1843). Founder of the First Eye Infirmary in the United States of America.
(From the American Encyclopedia of Ophthalmology and by courtesy of the Royal Society of Medicine.)

Period 1800-1850

The idea of corneal transplantation came from Himly in 1813, but it was first put into practice by Frans Reisinger in 1818; he incidentally also introduced atropin and hyoscyamus to ophthalmology as mydriatics. Schön (1827) was critical in theory of Reisinger's work and thought the technical difficulties would make success impossible; he felt that Reisinger's reports were not sufficient in detail. Mössner (1823) reported unsuccessful experiments and felt that corneal tissue would not heal when it was removed. This atmosphere of scepticism induced the Medical Faculty of Munich in 1830 to offer a prize for the best work in keratoplasty. Dieffenbach (Fig. 5), surgeon to the Charité Hospital in Berlin in 1831, and later succeeding Von Graefe's father at the University as Professor, was interested in corneal grafting as he was in all other forms of grafting and plastic surgery. As a result of his attempts at total keratoplasty he developed a wholesome fear of "suppuration, overgrowth and clouding". He had also experimented with rabbits, dogs, and pigs and had come to the conclusion that the isolated graft could not survive.

> "L'idée de Reisinger qui consiste a remplacer la cornée trouble d'un homme par la cornée claire d'un animal est, certes, une fantaisie audacieuse et serait le plus grand succès de la chirurgie si cette opération réussissait." (1831)

The record of many courageous trials about this time continues but they were bedevilled by gross infection, lack of anaesthesia, imperfect instruments, and immature technique. For example, Thome in 1834 had eight experiments with poor results; Drolshagen (1834) had much the same experience as well as Pawli, Munk (1840), Strauch (1840), and Feldman (1839).

Fig. 5.—Johann Friedrich Dieffenbach (1792–1847).
(From the Graefe-Saemisch Handbuch, by courtesy of Springer-Verlag, and the Royal Society of Medicine.)

But in the gloom of discouragement the experiments of Bigger (1837) came as a welcome shaft of light. In 1837 Bigger was on an expedition from Grand Cairo when he was captured by the Bedouins. During his captivity he had the opportunity to cross-graft the cornea of one gazelle on to another and he satisfied himself 10 days later that there was good healing and definite evidence of improvement of vision. By reports like this the feeble flame of interest in keratoplasty was kept alive, quenched as it almost was by the monotonous regularity of panophthalmitis. In 1841 Marcus surveyed contemporary work in keratoplasty and enumerated the following principles. (1) That there should be an exact correspondence in the size and form of the graft and the opening. (2) The graft must be rapidly transferred and there must be quick fixation. (3) The internal structures of the eye must be prevented from being pushed forwards into the opening of the cornea. It is evident that these observations were influenced by the need of rapid surgical dexterity and that control of infection and homoplasty had not yet gained prominence.

In 1844, Kissam, in New York, who had been impressed by Bigger's work, reported that in 1838 he had transplanted a portion of a young pig's cornea to the eye of a man blind from a central corneal leukoma. The graft was removed by a Beer's knife, and two lateral fixation sutures were used. This was the first attempt to transplant an animal cornea into man, and almost simultaneously

Wutzer (1844) reported the transplantation of a sheep's cornea into a human being; in both these cases the transplantation succeeded but the cornea became opaque.

There was also more attention paid to the manufacture of special instruments. The double knife of Königshofer was described in 1839, and Steinberg formulated his ideas of a trephine in 1843. Variations in technique were published: Von Walther, in 1840, was the first to have the idea of lamellar keratoplasty, and Mulhauer in the same year used triangular lamellar grafts with sutures from sheep to human beings. The results were very depressing. At this period it came to be accepted that a graft from one species to another would heal under certain conditions but the goal of translucency and improvement of vision was still far away.

Perhaps it was because of disappointing visual results with living tissue that surgeons turned to artificial transplants. Nussbaum, in 1853, embedded in himself gold, silver, copper, and glass balls so that he could determine which was the most inert substance. He chose glass, and had 3-millimetre buttons made which he transplanted into rabbits, with, however, the inevitable failure by infection. In 1859, Heusser placed a small piece of glass in a young girl's cornea which lasted for a period without failure, and in 1862, Abbate had 10-millimetre glass discs made with a gutta percha rim to fit into the sclera. These were retained in position for a time but no improvement of vision took place.

Period 1850–1900

But much needed encouragement was on the way from other developments in ophthalmology, for in 1851 Helmholtz described his ophthalmoscope, and 1845 saw the beginning of the stimulating impetus of von Graefe (Fig. 6), a pupil of Aarlt in Prague, Michel in Paris, Jeger in Vienna, and Bowman in London. Here was the foundation of modern ophthalmic surgery and the influence of this period continues to our day. Ophthalmology was now not only established as a separate specialty but by the work of von Graefe the vast possibilities of ophthalmic surgery were offered to the world.

Power in 1872 commenced experiments in corneal grafting with new hope, and reported his results on dogs, cats, rabbits, and human beings. Although his experiments were failures he focussed the international attention of ophthalmic surgeons again on corneal grafting and for the first time there came the hint that homoplasty was going to be necessary for success. Wolfe (1879) had followed Power's work and a year later varied his method by using on a human patient a dog cornea with a horizontal graft and conjunctival flaps to assist adhesion. He claimed some improvement in vision and as a result of his experience came to three conclusions. (1) That the cornea can maintain vitality and transparency when transplanted from one place to another, but to be successful it must be taken from a freshly enucleated human eye. (2) That all incisions in the cornea must be clean and that measurement of the graft must be exact. (3) That subjacent structures must not be damaged.

During this year von Hippel had become interested in keratoplasty but was naturally influenced by the early reports of persistent failures which were almost universal. He first tried a glass prosthesis with a gold rim which was embedded in the host cornea with the idea that it could be taken out from time to time and cleaned; the idea, however, was not successful.