THE USE OF FREE TRANSPLANTS IN RESTORING ORBITAL DEFORMITIES*

A REVIEW ARTICLE

H. C. DE WET, F.R.C.S., *Part-time Plastic Surgeon, General Hospital, Johannesburg, and H. F. Verwoerd Hospital, Pretoria*

The orbit is the one anatomical region where the domain of the plastic surgeon overlaps those of the otorhinolaryngologist, the neurosurgeon and the ophthalmologist. The subject is therefore of fairly wide interest to specialists and general practitioners. The emphasis will be placed more on principles than on details.

The anatomical orbit[1] is the area enclosed by the bony walls of the orbit, but the region referred to in this paper is taken to be that which is generally included in the clinical use of the term, viz. the orbital contents, orbital margins and their integumentary cover. This would then include the eyelids—which, to a varying extent, may be situated anterior to the true orbit—the malar prominence, and the eyebrows.

The transplants that are to be discussed may be classified as: (*a*) those consisting of normal body tissues and (*b*) those consisting of alloplastic materials.

Normal body-tissue grafts may consist of bone, cartilage, fat, fat and dermis, fascia, skin, or mucosa. These body tissues may in turn be used as autografts, homografts, or heterografts.

Alloplastic materials used may consist of either solids or fluids. Fluids were used at one stage in the form of injections of liquid paraffin, but this has gone completely out of fashion due to the development of paraffinoma tumours. The use of silastic fluid is today being extensively investigated, but is not in general use, due to the irretrievability of the fluid once it has been injected.[2-6] In animal experiments this fluid has been shown to be completely dispersed, and in fact even to be taken up by the macrophages in viscera in remote parts of the body.

Solids which are used as transplants consist of a variety of types. Thus the following materials have at one time or other been used: gold, silver, alloys such as vitallium, ivory, stainless steel, various plastic materials such as celluloid, Supramid, plexiglass, polyethylene, Polystan, methylmethacrylate, Paladon, ivalon, etheron and the different types of medical grades of silicone rubber.

Scales[7] postulates the following properties for any implant which must act as a synthetic tissue substitute:

1. It must not be physically modified by the soft tissue.
2. It must be chemically inert.
3. There must be no inflammatory or foreign-body reaction to it.
4. It must be non-carcinogenic.
5. It must not produce any allergy or hypersensitivity at any stage.
6. It must be capable of resisting mechanical strains.
7. It must be capable of fabrication in the form desired.
8. It must be capable of sterilization.

Of all the synthetic materials available to us today, the medical grade silicones seem to conform most closely to the above requirements as they are heat stable, unaffected by time, non-adherent to tissues, and elicit no tissue reaction. However, a foreign-body reaction may occur even from this material in the presence of dust, fingerprints on the surface, etc., and it is therefore mandatory to be sure that these materials are absolutely pure and clean when they are introduced into the body.

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TYPES OF ORBITAL DEFORMITIES CORRECTABLE BY USE OF FREE GRAFTS

The orbital deformities that we are referring to may be roughly divided into 4 groups according to the tissues mainly involved. However, in many if not in most cases, more than one tissue is involved and there must therefore be considerable overlap of these groups.

Bony Defects

Trauma. This is by far the largest group in a modern society with fast-moving traffic and machinery, and flaring tempers. Usually a fracture of some part of the facial skeleton causes the defect due to a displaced fragment or a comminuted fracture. More rarely, part of the bone may be missing in the case of an open injury.

Infection. Destruction of bone may follow acute or chronic pyogenic osteomyelitis. This, in turn, may be the result of previous trauma but may be primary. In some cases extensive bony loss may be seen in general malnutrition and debility in association with cancrum oris (synergistic gangrene).

Developmental anomalies. These include such deformities as mandibulofacial dysostosis (the Berry-Treacher-Collins-Franseschetti syndrome) craniofacial synostosis, and acrocephalosyndactyly.

Neoplastic disease. Defects may remain after the removal of benign conditions such as a dermoid cyst overlying bone, or a simple bone cyst. However, defects are more common following the removal of malignant tumour which lies close to bone or actually involves bone, e.g. antral carcinoma, invading basal-cell carcinoma or bone tumours.

Idiopathic conditions. Romberg's facial hemiatrophy, including the '*coup de sabre*' defect, may involve the orbit in some cases and give rise to marked deformities.

Eyelid Defects

Developmental anomalies. Examples of this include conditions such as coloboma or facial clefts extending into the eyes, ptosis, etc.

Trauma. Trauma of the lids often forms part of a generalized facial injury, particularly in motor-vehicle accidents where the front-seat passenger, not wearing a safety-belt, is thrown against the windscreen. Burns of the eyelids are another major cause of deformities which at one stage or other necessitate the use of transplants. These burns may be the result of injury of thermal, chemical or physical nature.

Neoplasm. In contradistinction to bony defects, malignant neoplasms are often the predisposing cause for defects of the eyelids, either by direct destruction or by

necessitating removal of the involved tissue. The deformities that result are often gross and tax the ingenuity of the reconstructive surgeon.

Facial palsy. Although the defect in this instance is not one of tissue bulk but rather of function, the methods used for correcting it often entail the use of a transplant and it is included here for that reason.

Other Soft-Tissue Defects

These may be real or apparent, the latter being the case when orbital contents are displaced out of the orbit into surrounding tissues, e.g. with a blow-out fracture of the orbital floor or a lateral comminution with displacement into the temporal fossa.[8]

The orbital fat volume may be decreased after trauma due to fat necrosis and fibrosis which develop in a percentage of cases, or it may be the result of generalized starvation and in some cases of facial hemiatrophy.

Eye-Socket Deformities

Following the enucleation or evisceration of an eye, the problem is always to make the patient appear as normal as possible even though he has lost the sight of one eye. An adequate prosthesis can only be fitted if the socket is large enough to hold it. When the socket is on the small side the prosthesis will tend to pop out or to stretch the lower lid so that it does not retain the artificial eye in the correct position. If this condition is allowed to persist, the tone of the lower lid eventually becomes so decreased that fitting a prosthesis becomes increasingly difficult.

To avoid this, adequate lining must be provided as soon as possible after removal of an eye.

An additional problem in fitting an eye prosthesis is the deepening of the suprapalpebral sulcus. This has to be corrected by a subcutaneous implant in many cases.

RESTORATION OF DEFECTS

Transplants are used in many parts of the body to restore defects. However, due to the specialized nature of the region under discussion, the techniques generally used have to be adapted accordingly. The presence of the highly vulnerable eyeball necessitates particular care to prevent injury, especially to the cornea, when operating on the eyelid. The loose connective tissue of the eyelids and orbit allows contracture of skin grafts applied to it, and the presence of the lacrimal apparatus and drainage system demands special consideration when restoring eyelid defects. It is mandatory that the contact between the punctum and conjunctiva be preserved if epiphora is to be avoided.

The eyes have often been described as the 'windows of the soul', and they are certainly the centre of attention when one person speaks to another. Accordingly the standard of reconstructive surgery in the area of the orbit must be very high if deformities are to be masked or made inconspicuous.

The Bony Socket[9]

Often these deformities are accompanied by overlying scars following an injury or infection. Correction of an orbital margin defect should be an elective procedure and the introduction of transplants at an early stage should be condemned in general. To give a transplant the best chance of not being rejected by the body, the overlying tissue must be healthy. If adherent scars are present it is sometimes necessary to do a preliminary scar excision and to restore healthy tissue to this region by local or distant flaps.

Infection—either recent or present—contraindicates the use of a graft. As a rule a minimum period of 6 months should be allowed after an infection, before an operation is performed. Furthermore, sequestra should be removed. The presence of the frontal and maxillary sinuses near to these defects jeopardizes the success of the operation, and accidental entry into these should be avoided at all costs.

Unless the bony defect is very gross, the operation is usually done more for cosmetic reasons than for protection of the contents of the orbit. Accordingly, the choice of material is fairly wide and may consist of any of the following:

Bone grafts are often used to restore bony deformities, and the autogenous graft from the iliac crest should be regarded as the material of choice by virtue of the fact that this bone can be incorporated by the adjacent tissue, when applying it in direct contact with bone deep to the periosteum. Homo- and heterografts may also be used, e.g. Kiel bone, or preserved rib, etc., but are probably not as good as the live autograft because of the fact that they are more likely to be resorbed. In facial hemiatrophy the chances of resorption are said to be much greater in the so-called active phase which may last for a period of 2 - 10 years, following the onset of the disease. In these cases it is possible that an alloplastic material is a better proposition.

Cartilage[10] may be used instead of bone to fill in defects. Cartilage has a greater tendency to warp and this is a definite disadvantage where precision contouring is called for, e.g. on the bridge of the nose.

Fat and dermo-fat implants may be used in some cases, particularly if there is a combination of defects involving soft tissue as well as bone, but they have the disadvantage of resorption, infection and cyst formation in some cases.

The use of foreign materials is a good alternative to bone and cartilage. The discovery of newer materials has made their use much more attractive as compared with substances used in the past such as vitallium, plexiglass, etc. Silastic and etheron have been shown to evoke minimal tissue reaction, and the versatile nature of silicone rubber,[2] which is available in all grades of consistencies, makes it possible to choose the right material for a particular purpose. As these materials are readily available and sterilizable by chemical and thermal means, and can easily be carved to the required shape, one is inclined to use them in preference to bone or cartilage. There is one disadvantage, however, viz. that these transplants remain mobile because they are never incorporated in the body tissues like bone or cartilage (although these latter materials also sometimes remain mobile). The tendency to displacement of these implants may be counteracted to some extent by multiple perforations of the implant which then allow body tissue to grow through from one side to the other.

Whatever the nature of the transplant, it is always advisable to make a mould of the defect before the

operation, so as to ascertain the approximate size and shape of the graft required. This saves much time at operation and can be recommended.

The pre-operative skin toilet must be thorough to avoid the introduction of sepsis. A discharging eye contraindicates the use of an implant, and must therefore be treated first. Antibiotics should be commenced before the operation, so that the haematoma around the implant contains an antibiotic in therapeutic levels. A haematoma in itself constitutes a danger and must be avoided as far as possible by a very meticulous haemostatic technique, allowing for a postoperative rise in blood pressure if hypotension was present at the time of operation. The large vessels in the area should be avoided as far as possible and carefully ligated when they have been severed. Wound closure over the implant must be done in layers, using fine absorbable material with minimal traumatization of tissues to prevent wound disruption, and the overlying skin must be treated with respect. Drains should be avoided where possible, and firm overlying pressure applied afterwards to prevent the formation of fluid collections. Sometimes aspiration of a seroma around the graft is necessary during the postoperative course.

The position of the skin incision for an implant to the infra-orbital margin is of importance. The lower eyelid is likely to become oedematous if the incision is made horizontally over the bone, and a marginal incision along the lower-eyelid free margin with a lateral extension is therefore recommended. By undermining the skin it is possible to obtain an adequate exposure to insert the prosthesis, keeping away from the orbital fascia.

In a small percentage of cases the graft may have to be removed, e.g. due to tumour relapse, threatened skin necrosis due to too large a graft, or infection of an underlying sinus, etc. Trauma to the grafted area may cause a haematoma, necessitating aspiration or removal of the graft.

Eyelids

Many of the techniques involved are based on the use of local skin and subcutaneous tissue flaps. We are here concerned with the use of free grafts and this fortunately limits the field to some degree.

Free grafts to the eyelids can consist of skin, fat, mucosa, fascia and cartilage. Allografts which may be used here consist of material to fill in the suprapalpebral hollow, e.g. polyethylene, ivalon, or silastic sponge. Recently Morel-Fatio and Lalardrie[11] have used a wire spring to obtain closure of the lid in facial palsy. This wire is implanted under the skin so as to force the lid down by its spring action. The levator palpebrae superioris muscle, which is not affected by the paralysis, then acts against the spring to open the lid. A similar mechanism makes possible the use of an implanted gold weight in the upper lid to correct the lagophthalmos following facial paralysis.

Pure skin loss in the eyelid due to, e.g., tumour excision, senile atrophy with resultant ectropion, radiation or other burns, needs replacement by free skin graft if local flaps are not adequate. Marginal incisions with release of the free margin of the eyelid by undermining of skin is the usual method of correction of the deformity. The defect thus created may then be filled in by a partial- or full-thickness graft. Wolfe grafts are used more often in the lower lid, while split-skin is probably better in the upper eyelid.

Immobilization of the graft bed is a *sine qua non* for satisfactory 'take' of a skin graft. To accomplish this a temporary tarsorrhaphy stitch is sometimes necessary, while at other times the application of a stent mould with a tie-over dressing suffices. It is important to overcorrect the defect and it has been said that in any eyelid release one should always cut the angular vessels, otherwise the release is inadequate.[12]

In partial full-thickness loss of an eyelid a simple method of reconstruction is to mobilize available conjunctiva and to cover this with either a flap or a free full-thickness postauricular graft. In the lid-splitting operation a free graft may also be used to cover the defect if a local flap is not available.

Where symblepharon exists in a severely scarred conjunctival sac it is sometimes necessary to use a mucosal graft to correct the adhesion. These grafts are rather difficult to take from the lip or cheek and shrink tremendously at operation. They are best applied over a ring mould in the conjunctival sac. Where a free graft is used in contact with the cornea, special care must be taken because epithelial cells can grow on an abraded cornea and cause serious opacities.

Cartilage from the pinna of the ear or nasal septum is sometimes used in the reconstruction of an eyelid to supply additional support where the tarsal plate is missing.

Cornea

Free corneal grafting is now a well-established procedure with a functional success-rate of good vision of about 80%.[13] The most interesting feature about these transplants is undoubtedly the fact that homografts may be used, and that permanent survival obtains in the majority of cases in contrast to other body tissues. The homograft rejection reaction does not seem to take place to the same extent as elsewhere, due to the paucity of blood-vessels on the cornea, in spite of the fact that serum antibody levels are increased after such an operation.

Eyebrows and Eyelashes

From the cosmetic point of view the reconstruction of a defect of either of these structures is very important. The eyebrows play a major role in producing facial expression, and particularly manifest the emotions of surprise and anger. The whole appearance can be changed by altering the position of the eyebrows, and cosmeticians are very much aware of this, as well as fashion designers.

Loss of an eyebrow in part or *in toto* may be restored by the use of a full-thickness hair-bearing graft from the opposite eyebrow (if the patient has thick eyebrows) or from the scalp. In order to preserve the hair follicles it is necessary to take some subcutaneous tissue with the graft. When a free transplant is used, meticulous suturing is necessary, avoiding any strangulation of tissue by the stitches, and with accurate apposition of skin edges. Haemostasis must likewise be adequate. Following the 'take' of such a graft there is initial complete loss of hair, which starts growing again in a few months' time. Scalp hair grows long and needs regular trimming.

An alternative method is to transpose the hair-bearing

skin either as a formal pedicled graft or on a vascular pedicle, i.e. as an 'island flap'.

Reconstruction of eyelashes is a more difficult and somewhat more uncertain procedure due to the fact that only 1 or 2 rows of hair follicles are required and these are not easy to transplant accurately.

Socket Problems

The cavity of the socket must be adequate to retain the prosthesis. The main problem is then to maintain the cavity in spite of the tendency for any free transplant which lines a cavity to contract. After enucleation of an eye the socket still contains much soft-tissue lining, and a free graft on this has no support. If left to itself it will contract down to almost nothing.

To counteract this tendency one may supply support on the deep surface of the graft by ensuring that the graft is in contact with bone in a few places (from which it can then not pull loose) and prevent contracture from within the lumen. During the operation of constructing a socket, following dissection in the soft tissues, a mould is made to fill the cavity completely, and this is then covered with the graft. This mould must be held in the optimal position by means of a bar connected to a fixed point, such as a dental cap-splint, or a plaster-of-paris head cap. For the best results this splint must be maintained for several months, otherwise the operation may have to be repeated.

The ideal lining for a socket is conjunctiva. Often there is not sufficient of this available and a free graft has to be used. It is advisable to avoid using skin and mucous membrane in the same socket. So, if only a small additional amount of lining is required in a conjunctival socket, mucosa from the lip may be used. If the defect is large, however, the conjunctiva should be removed and replaced with a split-skin graft on a mould.

Flaps are sometimes used as lining, but due to their bulk they defeat their purpose in many cases, for although they do not shrink, the cavity may become too small for a prosthesis.

At the time of enucleation of an eye the ocular muscles are sometimes sutured over an implant of some alloplastic material to provide motorization of a prosthesis. This procedure is unfortunately not always permanently successful and is not applicable in all cases, particularly when there is a shortage of lining for the socket.

CONCLUSION

It will have been seen from the above discussion that free grafts of a varied nature are available and are in use for reconstructive surgery of the orbit. The tendency today is to use the synthetic materials, particularly the silicones, because of the simplification of reconstructive surgery by this means. Some of us are more conservative and choose to use autografts of body tissues, even though the operation is then a more complicated one and the morbidity more prolonged. Whether this is a wise policy or not will probably only become apparent in the next generation when a long-term follow-up of the cases being treated now with allografts will be available, in addition to results of all the experimental work which is being done.

SUMMARY

The causes of deformities of the orbit and its immediate surroundings are described, and it is shown how these may be treated using free grafts in the form of homografts, heterografts and autografts on the one hand, and solid or liquid allografts on the other. It is of interest to note how the synthetic materials are being used more widely today in a variety of conditions by virtue of the degree of inertness of the material in the body. However, in the majority of cases the patient's own tissues are still the best, and often the only means of treatment available.

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