The wheel has now gone full circle as it were, and we are again in a position, but a much more confident position now, to investigate the hormone-dependence or otherwise of cancer in a target-organ.

The metal culture chamber of Trowell has been redesigned in glass, as shown in Fig. 8, the filter-well standing in medium directly in the bottom of the unit. The glass taps make the introduction and collection of gas from the unit more efficient, and elimination of the silicone-rubber sealing-ring has led to an increase in the amount of CO₂ recovered at the end of the culture period (Dickson and Leslie, 1966).

It is hoped eventually to establish a routine laboratory technique in which biopsy specimens from tumours will be disaggregated and their response to hormones and chemotherapeutic agents studied in such a filter-well system.

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Application of Plastic Surgery to the Care of the Injured*

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"Care of the Injured" is the basic theme of the lectures which are delivered annually at the Institute of Accident Surgery at Birmingham in memory of Alan Ruscoe Clark, who was devoted to this cause. "The injured" conjures up a diverse and diffuse class of patients abounding in complexities, complicated by infinitely variable factors resulting from different causes of injury. "The care" required is not confined to surgery or medicine, operating or resuscitation. It should commence with study to prevent injury at work, in the home, and on the roads.

It appears unusual for a plastic or dental surgeon to be consulted at an early stage in the treatment of injuries other than burns except at some specialized centres. More often plastic surgeons are called in to camouflage or tidy up disfigurements and disabilities which, in part at least, might have been avoided by earlier consultation. It should not require any

stretch of the imagination to associate plastic surgery with the care of the injured. It is the original and basic purpose of our specialty from the earliest writings of Susrata, about 700 B.C., through the Middle Ages to the time of Harold Gillies, Kelsey Fry, and Ivan Magill at the Cambridge Military Hospital, Aldershot, in 1915. This team was called upon to repair grievous missile wounds to face and jaws during the first world war. The second world war called for the repair of crashes, crushes, and burns, and it led to the regimentation of professional assets which resulted in an enlargement of interest and practice beyond the dreams of the original plastic surgeons.

This interest led to the correction of other deformities, congenital and acquired, the objective being restoration of normal function and appearance. Aesthetic considerations developed in surgery. This aspect of our work, important as it undoubtedly is, appeals to publicity and has been much over-emphasized. Nevertheless plastic surgery is now established in the United Kingdom and Commonwealth on a wide scale

* Based on the Sixth Ruscoe Clarke Memorial Lecture delivered to the Institute of Accident Surgery, Birmingham, on 6 May 1965.

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and is being practised with vigour throughout the world for the benefit of mankind. Function is always regarded as the fundamental consideration.

Skeletal Injuries of the Face

The skeleton of the face supports several highly specialized organs of the sensory, respiratory, and digestive systems and it is closely related to the brain. Socially the contour, colour, and configuration of the face are of great aesthetic significance, but of greater importance is the structural relationship upon which depends the performance of various noteworthy functions.

Fixation of these bones usually occurs earlier than is the case with fractures elsewhere. It is therefore more important to respect the orthopaedic principles of early reduction of displaced bones and stable fixation in satisfactory position until adequate union occurs, with the preservation of function throughout treatment rather than its tardy restoration.

The *mandible* must be of correct shape and freely mobile and powerful in order to eat and speak properly. The *maxilla* needs to be of proper shape and position and to be firm to allow mastication. Among late results of indifferent treatment are inadequate nutrition, infection of bone, and disturbances of speech. These are neither acceptable nor inevitable.

In this field the dental surgeon is a most valuable and esteemed colleague. Function of the teeth is seriously disrupted by displacement of position and relationship, particularly of upper to lower dentition, and also by loss of mobility of the lower jaw or of stability of the upper. Stable teeth remaining in each portion of either jaw are excellent posts whereby reduction can be obtained and sustained by various mechanical contrivances attached to these teeth.

Frequently the early treatment is inadequate, the main reason being delay in calling upon those with special training and experience in dental and plastic surgery. It is of no importance to consider whether these fractures belong to one specialty or to another. They should be treated early and competently. If the necessary skill is not at hand it must be consulted and brought to the patient at an early stage.

The malar or zygomatic bone.—Fractures of this bone are commonplace, but they are often very inadequately treated except in specialized centres. To some extent this is due to inaccurate diagnosis.

The simple arch fracture with angulation and depression may press upon the coronoid process of the mandible, and the same injury may also fracture this process. The unreduced fracture may push the mandible towards the opposite side, and it may produce a false fibrous or even osseous trismus. Early reduction by the Gillies subtemporal route is necessary, with subsequent observation and care in view of the risk of trismus.

Displacement of the body of the malar bone may often be accepted as causing only a little flattening of the cheek, but this is not easily judged in the early days when soft-tissue swelling disguises the defect. Neuralgia of the infra-orbital nerve may occasionally result from unreduced fracture of this type, and it should be treated by decompression of the intra-orbital canal. The variations in pressure while flying have been known to aggravate this sign. When in doubt, reduce!

Malar displacement often causes diplopia through interference with the action of the inferior oblique and inferior rectus muscles. There need be no alteration in the position of the globe of the eye to produce diplopia. The inferior suspensory ligament of the globe of the eye may be disrupted, resulting in a downward and outward displacement. Retention of the body of the malar in its corrected position after reduction may require wire fixation at one or two points. Suspensory pins may be preferred. The technique is largely one of personal preference, but the objective remains the same.

Fracture of the thin *bone of the orbital floor* occurs with prolapse of retro-orbital fat into the maxillary antrum. The

loss of support to the back of the eye results in enophthalmos. This displacement may occur either in conjunction with severe displacements of the body of the malar or from a compression injury over the orbit caused by an impact with a large soft body, when there need be no fracture of the infra-orbital margin or displacement of the body of the malar. The cause of enophthalmos can be obscure unless this condition is known to occur.

Early reduction is imperative. It is achieved by replacing the prolapse and supporting the orbital floor by means of a pack introduced into the maxillary antrum through a Caldwell-Luc approach. The palate must be stable, otherwise such a pack will push the palate downwards instead of thrusting the orbital plate upwards.

In some severe instances, and particularly in late cases, the floor of the orbit needs to be reconstituted by a bone-graft inlay. Perfect repositioning can be obtained only in early cases, although some improvement is usually possible. Fine adjustment of eye muscle balance may be required six months later after absorption and resolution of such a graft.

The Nose

Impact upon the nose may fracture the nasal bones and either distort or fracture the nasal septum, the anterior border of which supports the profile. The nose will be displaced to one side or the other or backwards; the direction will be determined by the direction of the force, and the degree of displacement will accord with the strength of that force. If displacement is to one side the septum is deflected; the anterior border is displaced to that side and there is compensatory bulging towards the other side. One or other nasal airway becomes obstructed. If the impact is from in front the nasal bones are collapsed, the septum is pushed back, and either it corrugates or it fractures, and the displaced cartilage is sandwiched side by side. In either case there is bilateral obstruction. In addition, the palatal margin of the cartilaginous septum is dislocated from the maxillary crest and comes to lie on one side or the other, obstructing the most important airway of the nose.

No fracture of the nose with displacement of the external features can occur without some displacement of the anterior border of the septum, and held as it is securely in a frame of bone the anterior border cannot be displaced without secondary distortion of the remainder of the septum, leading to some degree of obstruction. Therefore no nasal fracture can exist which has simply an aesthetic or cosmetic consideration; it must usually have a reflection upon function, and consequently it demands serious consideration and usually active reduction with centralization of the septum to re-establish the airway.

This has special significance to all who fly, whether regularly or occasionally. A displaced septum is a major factor in obstructing ventilation of the paranasal sinuses. Such obstruction leads to painfully disabling sinus and otitic barotrauma from inadequate recompression on descent of an aeroplane. Even with people who do not fly such obstruction may precipitate infection.

Although this is the functional argument in favour of the perfectly shaped and positioned nose, let us not despise the aesthetic aspect. It is mediaeval to regard an ugly blemish as a satanic stigma punishing some shortcoming in generations past and gone: surely we can do better than look down our own noses at the deformities of other people or at those who, in our happier days, have the ability to correct them? "The Almighty provided remedies out of the Earth and the Wise Man will not despise them."¹

¹ From an apothecaries sign of 1623 in the entrance hall of the Royal College of Surgeons of England.

One particular form of nasal fracture, the severe push-back, involves the uppermost part of the septum—the perpendicular plate of the ethmoid bone which is surmounted by the crista galli. Its displacement fractures the cribriform plate, causing anosmia and cerebrospinal rhinorrhoea.

To leave such a fracture unreduced is to accept a most undesirable interchange of cerebrospinal fluid into the nose and infected air into the meningeal cavities. The rational view is to reposition the displaced bones into good position to favour spontaneous healing of the defect. The majority of cerebrospinal-fluid leaks cease spontaneously under these conditions, and further operation is not required. The opposite view is that such activity may worsen the state of a serious head injury by reopening the wound. The risk of meningitis increases with delayed reduction for two reasons: first, the broken nose with poor airway tends to become infected despite nursing care, and, secondly, undue force is necessary to disimpact bones when reduction is delayed.

Early reduction with appropriate chemotherapeutic cover is usually indicated. Craniotomy to seal the leak from within appears to be necessary only for cases which come to treatment late, say after 10 days, or in which the leakage persists. However, as long as surgery remains an art and not an exact science, there cannot be a dogmatic ruling on such cases; they must be considered on their merits.

In dealing so briefly with the individual skeletal injuries of facial bones the picture is over-simplified. Several bones, sometimes all of them, may be fractured together, sometimes in severe comminution. The misery of such patients is always impressively relieved by the reduction of the fractures, stabilization, and most particularly by restoration of patency to the nasal airways.

These fractures are frequently associated with injuries elsewhere and with wounds of the soft tissues of the face. In general, treatment of the face must take its turn with other lesions, but acceptance of this fact is not to be construed as acceptance of delay while other conditions are treated. The disablement of various functions which follows these injuries has been described in order to claim a higher precedence for treatment than is at times accorded to the face.

Soft-tissue Injuries

It is in the care of the injured soft tissues, particularly of the skin, that plastic surgery is known to be most concerned. It has been claimed that orthopaedic surgeons are chiefly involved in the care of the injured, because in accident cases there is usually injury to bone, tendon, or muscle of the locomotor system. Skin is very often injured.

The Skin

This highly specialized organ of several functions is a remarkable subject for study and surgery. It is most variable in structure and in texture in different sites on the same body, and in the same sites in different individuals and races. It has powers of regeneration which are unsurpassed by any other tissue and which few can equal; it is robust, it is vital, and it is a unique structure in that by its creases are indicated the best lines for surgical incisions. Intact healthy skin is the best friend of the surgeon and of his patient.

Yet by many it is regarded as little better than the investment of the body, the wrapping of the parcel. It is sometimes regarded as an obstacle between the surgeon and the part on which he desires to operate, or as an impediment to safe surgery because it is sterilized with difficulty, if at all: aseptic surgery is jeopardized by skin.

This "devaluation of the skin" is encouraged by obscuring it in stockinet or other coverings through which incisions

may be made regardless or forgetful of such scars or other features which ought to be kept in mind in planning the surgical approach. The skin is often forcibly retracted or folded out of the way, and it may even be used as the fulcrum for heavy instruments handled by lusty assistants: it can be bruised and damaged during the course of an operation, with disastrous results.

The secret of skin surgery is gentle handling with an acute appreciation of the vitality and purpose of the structure.

It is widely assumed that plastic surgeons can remove scars: we cannot. A scar is nature's way of healing a wound, the result of a vital process which depends upon an adequate blood supply to the wound edges. If skin edges are brought together precisely with only such tension as is natural to normal skin elasticity, and if this accurate apposition is preserved without interference with the vital process of healing by movement or by strangulation with sutures, the minimum breadth of scar will result.

In the surgery of the injured two complications of this ideal situation often occur: the wounded skin may be devitalized by the injury and its edges irregularly torn and dirtied by foreign matter, or the skin edges will not meet without undue tension either because skin has been lost or the underlying structure has swollen beyond acceptable limits.

Treatment of Damaged Skin

There are two principles of treatment. Skin edges need to be trimmed only enough to provide a regular edge to make accurate apposition possible, and the edge should be cleaned of all dead or foreign material which would interfere with the healing process. The tension necessary to close the wound must never obstruct the blood circulation through the skin edges. Substitutes must be found either to relieve tension or to fill a defect. To attempt to force nature by straining on stronger and stronger sutures is to court disaster. It is far better to accept a defect than to increase it by using forceful measures.

In the face the vitality of the skin is so great that the edges of wounds need only be trimmed squarely, but all foreign material which could be incorporated in the scar as a tattoo must be removed completely by suitable solvents and the vigorous but careful use of the sharp curette. Unless this is undertaken at primary treatment, heavily marked skin will usually come to excision in order to eradicate ugly stains on the face.

Skin may be sutured to mucosa without detriment in order to cover bone and to gain time for more favourable circumstances.

Occasionally, completely avulsed skin will yield a free skin graft which should fit the area exactly under ideal tension, that of normal skin. Incompletely avulsed skin, especially a tubular or sleeve avulsion, presents a temptation to reposition it which is almost irresistible. It may, however, have lost most of its blood supply and venous drainage. The underlying part may be crushed and swollen. Undue tension is often needed to obtain repositioning: such skin is likely to die. Usually it is wiser to anticipate the loss except in special areas such as the scalp, which has an extremely rich blood supply.

Burns

The largest surface wounds encountered in surgery are the result of burns. What real progress is apparent in recent years? We know more of the constitutional turmoil occasioned by burns, but the more we learn the more complex the picture becomes. There is better control of infection by relative asepsis and by chemotherapy. Nevertheless, the ubiquitous *Pseudomonas pyocyanea* leads too often to septicæmia and death. One reason is that the dry eschar or pellicle of the exposed burn

is not always managed properly: underneath the pellicle, in the words of the psalmist: "I have seen the wicked in great power and spreading himself like a green bay tree." Early removal of an infected pellicle and exposure of the wound to enable it to dry is one of the best ways to kill this killer before it becomes established in the blood-stream.

The improved prospect of survival presents plastic surgeons with greater dilemmas as the ratio of available donor sites diminishes in comparison with the area to be grafted. More patients are able to receive really skilled treatment earlier than ever before; this is due to the increased number of plastic surgeons available in this country.

The successful, permanent growth of the homograft remains elusive. It remains axiomatic that loss of skin can be repaired only by skin of the same individual patient unless he may have a willing identical twin.

Grafting of Skin

All loss of skin should be repaired with skin at the earliest possible moment. There is no dressing which can heal the wound other than the patient's own skin. This ought usually to be the primary treatment. Therefore all surgeons who undertake the care of the injured ought to be, or ought to make themselves, competent and skilful in the proper cutting and in the technique of application of the split-skin graft.

Where tendons, joints, cartilage, or bone are exposed without any soft-tissue cover, such as paratenon or periosteum, such free grafts cannot live: they are essentially parasitic, they will die unless they can derive nutrition from the host, and they cannot do so from an avascular base. For the same reason a free graft cannot heal a callous fibrosed ulcerating wound.

In these cases skin cover must be supported by its own blood supply, and is thereby limited in size, shape, and in distance from the donor site, because it cannot immediately be completely detached.

Free and pedicled skin grafts each have varieties, but one essential difference must be stressed: as the free split-skin graft leaves a donor area from which further skin develops, and, when the graft has been properly cut, further grafts may be taken, it may be regarded as "expendable."

The pedicled flap graft is "irredeemable." It is a definitive step. There is a loss, a defect at its donor site which must be repaired by some other plastic surgical procedure. Should such a flap be lost the same opportunity can never occur again. Even if the flap is replaced fibrosis limits its future use and usually restricts any variation from the original shape, size, or purpose.

Whereas the split-skin graft may properly be regarded as a dressing technique which most surgeons ought to master, the use of the full-thickness free graft and of the pedicle-flap graft requires special study, as the loss can prove disastrous. Colour, texture, and practicability are better if these flaps are planned than if they are selected at random. Few measures can be so disappointing and disastrous as the simple so-called "relaxing incision" in the skin of the calf to cover the tibia: such a cut usually has to be prolonged beyond original expectations until the result is a long, narrow bi-pedicled slough.

Fractures Complicated by Loss of Skin Cover

The basic problem is a small but most vicious circle: inadequate cover leads to infection and death of bone, and this prohibits skin coverage. The accident is not always directly responsible for loss of skin over a fracture. It also occurs as a result of plaster fixation, open operation, excessive tension in the anxiety to close a wound, intervention through unstable skin, rough handling, bad planning of incisions, and haematoma formation.

Early skin healing is essential to preserve the function of underlying parts and to promote the healing of bone. Delay in healing leads to contractures which may demand relief by surgery, and this often requires skin replacement. Delayed union of bone may require that stable and secure skin be provided to permit a safe surgical approach. In some instances the improvement in circulation which results from adequate skin-grafting may make further intervention needless. Sturdy skin should therefore replace unstable scars.

Severe lesions of this character can usually be materially simplified by the use of the primary or delayed-primary split-skin graft. Such simple measures can reduce morbidity. The focus of our problem is the established wound with exposure of bone and lack of soft-tissue cover. Long-standing osteitis should not be allowed to confuse this issue: instead, it is necessary to consider how chronic bone infection can be avoided.

Once primary healing fails a system of management is required which is completely opposed to the closed technique desirable in clean well-covered cases (Morley, 1961, 1963; Brown, 1965). An open method is required: the defect must be revealed and accepted, sloughs must be removed, and soft tissues prepared for skin-grafting. It is quite useless to compromise on this issue, for irreparable damage is done where the conventional treatment is maintained though it is apparent that it has failed. The obscuring plaster cast must never cloak a failure to make a bold and unconventional decision.

The internal fixation and stabilization of such fractures is not simply a matter of election but it is one of necessity. Without it, every little movement of the bone ends and each dressing of the wound disturbs the fracture line, ruptures the delicate healing process in the depths of the wound, pumps infected discharge into intricacies of the wound, and spreads sepsis. Any external apparatus obstructs the approach to the wound. No attempt should be made to close such a wound other than by split-skin grafts. Periosteum should never be stripped from bone in this condition for the purpose of fixation or, indeed, for any other reason.

With the bone ends controlled it is upon the healing of the soft tissue that treatment must concentrate. A most scrupulous dressing technique is necessary. All discharge must be removed as frequently as is necessary to prevent stagnation, but without prodding to form cavities in the depths of the wound. Local chemicals are not used, except normal saline solution, and as soon as practicable immersion in the normal saline bath is of very great value. In other words, the exposed bone must be accepted and ignored once it has been established: treatment is of the soft tissues, much as if they had been burned—which, incidentally, may be the cause of the skin loss. This may be heresy to the conventional belief, but there can be no compromise; the technique must be accepted and followed faithfully or not at all.

As exposed soft tissues are cleansed and early granulations favour skin-grafting, split-skin grafts are applied as dressings as and when they are acceptable. To maintain nourishment of the patient, autografts are stored in the domestic refrigerator and anaesthetics avoided where possible. This method is termed the "creeping substitution" of skin for granulations; creeping a little day by day towards healing.

Eventually the wound is virtually healed with skin, except that bone is exposed: that is to say, the soft tissues are healed right up to the bone. Skin grafts will not grow upon bare bone or a metal plate, but granulations will cover parts of a plate and the neighbouring bone; these should then be grafted.

Once the soft tissues are covered with skin and the fracture is held by internal fixation there should be no hurry to excise any dead bone. Free drainage is a cardinal necessity of this technique. There is no doubt that the extent of sequestration is surprisingly small with this technique, particularly when local chemical action is avoided, as this must militate against

survival of tissues which are damaged. This applies to bone as much as to any other viable tissue, and, for the same reason, the dosage of diagnostic irradiation ought to be drastically limited.

A sequestrum separates naturally by the formation of granulation tissue at a line of demarcation. Removal of the fully separated sequestrum leaves this bed of granulation tissue, which will soon accept a skin graft. If a sequestrum be chiselled away, compact bone will be exposed and skin is not likely to grow upon it: sequestration will probably proceed. At this stage the internal fixation may usually be removed.

If bone union is occurring and the skin cover is sufficient no further action is necessary: let it proceed to consolidation. Should the skin-grafted area prove unsatisfactory from instability or adherence, it may be excised at convenience and permanent cover substituted by a definitive pedicled flap.

If bone union is not occurring a period should elapse to ensure quiescence and that there is no residual infective process in soft tissues or bone. Then the skin graft should be excised and stable definitive skin cover provided. Premature use of the definitive pedicled flap may be disastrous.

At open operation the plastic surgeon should co-operate with his orthopaedic colleague; the plastic surgeon ought to raise the skin flap and protect it from damage. He should suture it carefully himself, and, despite protest, he should insist upon the wound being drained by suction for 48 hours rather than risk a haematoma.

Established gross or long-standing infection is due to an unwise persistence with a closed or insufficiently exposed wound. It occurs where the surgeons have not had the courage to abandon the conventional technique and adopt this heretical open method wholeheartedly. It is worth while laying such wounds open very widely and proceeding as in cases of non-union; but the problem is not the same—osteitis is easier to avoid than to cure, and more of these cases come to amputation.

This technique, suitable for robust and young patients, does not necessarily apply to the elderly, where it may be wiser to amputate. A prosthesis is a good substitute for an indifferent lower limb, but it can be a burden and nuisance in the tropics.

Economically we may be at an advantage over the civilian, because the Services will retain a patient on full pay and allowances if there is a reasonable prospect of fitness within 18 months. This period appears reasonable also in considering whether to persist in saving a limb or amputating, but a great deal depends upon the character of the patient and whether he is "with you" or not.

Other Fields

Much should be written in appreciation of rehabilitation, welfare, and resettlement, but these subjects are too important to dismiss shortly; they could worthily absorb the whole period of the lecture. Nor will space permit a survey of elective reconstructive work. One example of close co-operation is outstanding: the field of hand surgery. Training in plastic surgical technique is a great advantage in hand surgery, and this is a field of happy relations between our specialties. In the British Club for Surgery of the Hand we are all interested in hand surgery but not in the label of any individual surgeon. It is unfortunate but inevitable that the degree of specialization necessary to the highest achievement leads to some partition, some individualism, almost isolationism, of surgical practice. But the characteristic lesion of the modern accident patient is multiple injuries, frequently requiring the simultaneous attention of specialists in several different fields.

Summary

The restoration of normal function and appearance following injury is best achieved by adopting plastic-surgical procedures at the time of the initial treatment, and not by referring the patient for camouflage at a later stage.

Skeletal injuries of the face require early correction of deformity, as fixation of bones occurs early and normal function can be preserved only by adequate reduction.

Skin loss should be treated by skin cover at the earliest possible moment. The indications for split-skin and pedicle grafts are described.

Fractures complicated by skin loss are treated by promoting soft-tissue healing, which will accelerate bony union.

It is essential to the application of this knowledge that the skills and the necessary equipment should be made available at the time and place that they are required.

I wish to record my thanks to Air Marshal Sir Richard Nelson, Director General of Royal Air Force Medical Services, for permission to deliver this lecture and to publish this account of it, but I emphasize my sole responsibility for the opinions expressed therein.

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Post-mortem Study of Small-intestinal Mucosa

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[WITH SPECIAL PLATE]

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Histological examination of the small-intestinal mucosa at post-mortem examination has always proved unrewarding because of the high incidence of autolysis. Peroral biopsy has clearly defined the major abnormalities and answers the need for diagnostic information. However, there are at least two aspects that could be usefully studied if post-mortem material was readily interpretable. The prevalence of abnormal

mucosal patterns in disease states and communities could be assessed, and the extent and distribution of these lesions in the whole small intestine could be accurately mapped out.

It has already been shown in a case of the coeliac syndrome that the small-intestinal mucosa can be easily examined post mortem by the dissecting microscope, though histological examination showed extensive autolysis (Creamer and Leppard, 1965). In this case the appearance of the post-

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