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## EDITORIAL

*The editors submit a new review of plastic surgery for international distribution. Is such a journal actually necessary? The answer to this question will be found in the history of plastic surgery over the past forty years, i. e. since the First World War. Until then plastic surgery had not existed as a specific branch of surgery. Great surgeons performed individual operations perfecting or extending long-established methods, but that was all. Many achieved considerable success and some wrote important monographs. They had no successors, however, and built up no schools which might have carried on the development of plastic surgery as a separate branch.*

*The First World War, with its tremendous numbers of gunshot and shrapnel injuries to the face, jaws and soft tissues, brought about a radical change, for which the army medical corps were completely unprepared. Facial injuries put all others in the shade and special stations for these were rapidly established, while except for fracture and internal injuries, the other parts of the body received comparatively little attention. Most of the new stations were staffed by stomatologists or otorhinologists, who were chiefly interested in their own particular branch, i. e. the jaws, nose and ears. Where the director of the station was a surgeon, with an interest in problems related to the reconstruction of different parts of the body and different tissues, true institutes of plastic surgery developed. The head surgeon formed a team in which he included specialists of allied branches, stomatologists, otorhinolaryngologists and orthopaedic surgeons.*

*Some of these wartime stations still remained after the end of the war, when they were usually incorporated into stomatology institutes.*

*The repair of the economic damage caused by the war resulted in a rapid rate of development in every direction. This meant an increase in industrial and transport injuries and in their sequelae, with which only plastic surgery was capable of coping. The victims demanded redress and pointed out the results achieved during the war. A great demand for specialized departments and institutes of plastic surgery arose, but a hard fight had to be waged before they were finally established, or before the need for them was recognized and the necessary public funds were made available. The representatives of the wider branch of general surgery were particularly opposed to the specialization of plastic surgery, which they regarded as a split in the branch.*



*In Czechoslovakia, the Prague institute established for the Seventh Army Corps of the quondam Austro-Hungarian army had fortunately not been abolished, but had gone over directly from the treatment of soldiers and war disabled to the treatment of civilians, with the support of the Ministry of Social Welfare and the Ministry of Health. The opposition of the surgeons ceased when they saw that their own position was not in danger, but that, on the contrary, plastic surgery was often an added support in resolving difficult problems. From 1929 onwards, lectures on plastic surgery were permitted at the Charles University in Prague and in 1932, thanks to Professor A. Jirásek, the leading surgeon in the country, Czechoslovakia became the first country in the world to recognize plastic surgery as a special branch of surgery and to specify the conditions for qualification in this branch.*

*In 1948, the original institute became a clinic of the Medical Faculty of Charles University and demands on plastic surgery grew to such an extent that further clinics were established in Brno (Doc. V. Karfík), Bratislava (Doc. Š. Demjén) and Košice (Dr. R. Erdélyi). Elsewhere the struggle for recognition of plastic surgery lasted longer, but before the Second World War this question had finally been settled in most countries, institutes of plastic surgery had been recognized and been given support, with the result that, after critical analysis, methods of plastic surgery could be tested on a large scale and systematized. When the Second World War started, plastic surgery was well prepared and performed very successful work, leaving no doubt as to the importance of this branch of surgery.*

*The moral value and importance of plastic surgery is now fully acknowledged. It has its own literature, which is concentrated in a number of specialist reviews published in western countries. The best known of these are Plastic and Reconstructive Surgery, directed with admirable success by Robert H. Ivy in U. S. A. and the British Journal of Plastic Surgery, founded and directed by A. B. Wallace. Later a Latin American, French and Italian journal appeared, under Sanvenero-Rosselli, replacing the review founded in 1934 by Arturo Manna.*

*Plastic surgeons in the People's Democracies would like to get into closer touch with these centres in western countries. That is one of the purposes of the new journal. It is not intended for publication of papers from the U.S.S.R., China and the People's Democracies only, but will also accept communications from workers in western countries.*

*Prague was chosen as the place of publication because Czechoslovakia was the first country to recognize plastic surgery as an independent branch. For the same reason, at the first international congress of plastic surgeons in Stockholm in 1955, the Czechoslovak delegate was elected at the suggestion of the Russian delegate as representative of the U.S.S.R. and the People's Democracies in the newly founded International Association in Stockholm.*

*The present journal has an important mission, therefore. It will inform plastic surgeons in other countries of the work of specialists in the U.S.S.R. and People's Democracies and will in turn inform the latter of advances made elsewhere. It will encourage peaceful cooperation in this branch of surgery. This is a very great task, since the importance of plastic surgery will continue to*



increase, in the field of traumatology, in the solution of problems associated with congenital defects and in the transplantation of tissues and organs.

With further technical advances, plastic surgery of accident injuries and of their sequelae will increase and the plastic surgeon will participate in increasing measure in research on the pathology of injuries and on their prevention.

The menacing increase in the numbers of congenital defects will necessitate extensive research on their aetiology and pathogenesis and energetic measures for the prevention of these defects will have to be undertaken. This work can be successful only on the basis of international cooperation. The first steps have already been taken; at the suggestion of the Czechoslovak representative the International Association of Plastic Surgeons has established a committee to investigate the problems of harelip and cleft palate.

Questions of the transplantation of tissues and organs are becoming increasingly important and require the participation of a large number of scientific workers. Plastic surgeons must also take part in this work and be kept informed of the results. The same applies to research on cytobiology and cytopathology.

There still remains the question of cosmetic operations. H. Ivy stated that this question had already been studied by J. S. Davis, who found that people were becoming universally appearance-conscious and discussed the importance of surgery whose purpose is to raise man's social and professional capacity and support his self-confidence, as seen from the development of cosmetology in the U.S.S.R. There is no doubt that the higher cultural standards and the lightening of labour which can be excepted from automation in industry will make people increasingly sensitive to cosmetic defects and they will not be inclined to suffer in silence once they know that remedy is possible. Measures must be taken to prevent the spread of charlatanism, like that which occurred after the First World War. Associations of plastic surgeons must guard against invasion of their ranks by enterprising quacks — signs of which are already evident.

The present journal has set itself the task of studying all developments in plastic surgery from the scientific and technical aspect and also with reference to its ethical implications, with the aim of contributing to progress in this branch of science in particular and to medical science in general.

Academician F. Burian

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Director: Doc. V. Karfík

## THE MAIN FEATURES OF FACIAL RECONSTRUCTIVE SURGERY IN CZECHOSLOVAKIA

V. KARFÍK

Several millennia of the history of plastic surgery have not brought so much progress as the two World Wars and the period between them. The XIX<sup>th</sup> century meant making use of all hitherto known methods. The French surgical school with Ollier and Reverdin in the foreground, laid the first scientific foundations for the knowledge of tissue transplantation. It thus became the founder of a new science and the first fighter for the rights of a new branch of surgery. Only the mass occurrence of injuries during the First World War gave rise to the systematic usage of plastic methods in surgery. Among these injuries, it was above all facial injuries that gave the impetus to our specialised branch.

Facial reconstruction immediately showed, however, that it is the question of a branch which requires complex work, based on the special knowledge and the experience of experts in several disciplines. As a matter of fact success was achieved already in the centres during the First World War where a "happy quartette" met, if I am to use the figure of speech of Sir Harold Gillies. This quartette is made up of a plastic surgeon, a stomatologist, an ophthalmologist, and a physician-neurologist. The best results were achieved, where further experts, i. e. otorhinologist, a dermatologist, a physiotherapist, an anaesthetologist, and laboratory assistants were added, thus making the orchestra complete and reaching complete polyphony and harmony in work.

On the basis of this first development in plastic surgery, which was confirmed and made full use of by the war-surgery of the Second World War it was shown for the first time that modern medicine can no longer be a one man business. A worker in our branch, who quit the team or was deserted, stood still in his development.

The unfortunate history of some successful teams, set up during the First World War and dissolved after the end of the war, give evidence of this fact. Many a talented plastic and dental surgeon found himself in isolation and had to return to his original specialisation or continued work in a narrow field, in the majority without any possibility of further work in the broad field of plastic surgery. With admiration we look upon the work of the plastic surgeons, veterans of the First World War who, with the support of the public, succeeded in continu-

ing in peace time the work they had begun. We admire the work of the oldest English departments and the departments of reconstructive surgery in the Soviet Traumatological Institutes. We feel, however, that what was done, was possible for the most part only through the great personal enthusiasm and sacrifice, wherever modern plastic surgery was born. The war merits of plastic surgery were not forgotten, but the possibility of continuing the work begun during the war was limited in most countries by the economic conditions of the difficult post-war period, no matter whether it was in the victorious or in the defeated countries. In the majority, reconstructive work was done only as a side line of the surgeons practice and often had the character of charity, if it was not stopped due to an incorrect understanding of social care for the invalids of the Great War. On the Continent matters were worse.

The further development of plastic methods therefore, was continued on the European continent in a few specialised centres. One of these fortunate places was Prague, where Academician Professor Burian, founded a specialised Institute of Plastic Surgery, in the year 1922. This Institute developed all-sided activity with a scope of work, which, for a long time, remained unique on the Continent. Prof. Burian succeeded under unfavourable conditions, often only with irregular support from the public, in continuing the work begun during the First World War and built up in our State peace-time plastic surgery, whose founder and teacher he is.

As a result of the discontinuation of the maxillo-facial centres of the war in many countries, the experiences of the First World War were neither collected and evaluated systematically nor at the right time, to make it possible to lay down the main principles for peace time and war-time surgery. I dare to assert this, even if the books by Davis, Gillies, Ivy, Blair, Smith, Pickerill, Lexer, and essays of Ombredanne, published shortly after the end of the First War, remain the basic textbooks for our generation. The conception of a lasting peace made this evaluation of the war experiences appear unnecessary and the consequences only showed themselves in the Second World War. The menace of war led to the rapid collection of the war experiences, which, however, were old and not influenced by modern techniques and recent knowledge in this field. In most belligerent states the experiences were not published until the last war was in full swing. Proof of this is given by the books by Virenque, Ganzer, Smith and Rauer. The experiences of Soviet plastic surgeons formed the greatest plus for Soviet War Surgery. These were discussed at the nation-wide Surgical Congress in 1937 in Moscow and became the basis for the treatment of war facial and jaw injuries. It was not until the end of the war that the work and the experiences of the different teams for maxillo-facial and plastic surgery accumulated. The work of each bears the seal of the different plastic schools.

The work on the reconstruction of war injuries and mutilations, together with the new branch of surgical treatment of burns during the Second World War is based on the efforts and the results of the peace work and progress between the two wars. The peace time content of plastic surgery was the product of its time, on the one hand the comparative poverty and monotony of the so-called aesthetic or cosmetic surgery, on the other hand the dramatic progress





Fig. 1a



Fig. 1b



Fig. 1c



Fig. 1d





Fig. 2a



Fig. 2b



Fig. 2c



Fig. 2d

in the treatment of accidents and their consequences in the victims of the ever faster tempo of life, transport, and industrial production. Although plastic surgery has grown and has been steadily gaining new fields of occupation, it has achieved its greatest success in the region of the face. Here the fortunate alliance with the stomatologist has given rise to the largest sector of peace-time plastic surgery, together with another branch of stomato-surgery, which without the experiences of plastic surgery would remain a narrowly applied speciality.

In the face, all modern reconstructive methods have been used, from the operative technique to all tissue transfers, plastic corrections and post-treatment methods. It was quite logical therefore that plastic surgery should become engaged in the treatment of congenital deformities and acquire the sovereign domination of cleft deformities in the face. It has proved effective in the treatment of malignant tumours of the face, even if for a short time it was overshadowed by the successes of X-ray therapy.

As I have already mentioned, maxillo-facial surgery was dependent on the experiences of great personalities as well as on the experiences of working teams in the different parts of the world. Unfortunately, however, they were not in contact and often had to rely on themselves and their own experiences acquired through hard work. It is my task to point out the results of this development in our country.

Our plastic surgery is, as I have mentioned the work of one man, who managed to impress his personal character, his skill, knowledge and versatility upon it. For many years he found himself in isolation from the official stream, but developments proved him right in his historical advance, both in the field of operation methods and operative technique, as well as in the social function of plastic surgery. It is his merit that plastic surgery in our country, is today generally recognised as an inseparable part of public health care and surgical treatment.

Professor Burian also started from his experiences of both Balkan wars as well as the First World War. The main task which he set himself was the reconstruction of faces. War-time surgery differs from peace-time surgery by its urgency, the necessity for acquitting oneself of the task more quickly and the application of the simplest methods, often at the cost of sacrificing some esthetic considerations in order to achieve the quickest healing and restoration of function of the damaged parts. Peace-time surgery can afford a slower speed to reach its aims and can take the esthetic results of the treatment into full consideration.

One of the foremost and perhaps one of the basic features of the plastic surgery of Prof. Burian was his endeavour to achieve the best formal results both in the application of complicated and long-term and even quicker and less complicated procedures using local plastics. For this purpose he developed his own characteristic operation technique by which he attempts to achieve a maximal approach to the idea of physiological operation, a conception which is expressed in a continual effort to refine the technique and eliminate gross interference, with the maximal sparing of the tissue. Prof. Burian points out to the surgeon how monstrous an unsparing instrument in the wound would look under the microscope. He carefully places the incision in the natural creases or in

hidden places, often at the cost of making the operation considerably more difficult. He uses mostly local anaesthesia and allows the firmness and the resistance of the infiltrated tissue to guide the knife thereby attaining more exact adaptation of the wound suture. The set of instruments, according to Prof. Burian, has become the standard of his school.

Professor Burian never operates according to some scheme, pattern or stereotype. He has perhaps never performed any operation in the same way as the previous one. He therefore always demands of the junior surgeons an accurate analysis of the deformation, imaginative power, ability to improvise and immediate inventiveness according to the circumstances which may arise in the wound during the operation. Thus, he dislikes the drawing of the incisions in the operation area, which often leads to stereotyped work and does not train the imaginative faculty.

Another characteristic feature of Burian's plastic surgery is the continual evaluation of the operation, as regard the endurance of the operated tissue, as well as the patient himself. Burian understands the connection between the local processes and the reaction of the whole organism. The relation between local irritation and the response in the central nervous system, was a fact to which Prof. Burian drew attention in his book before we became acquainted with the physiological teachings of Pavlov. The human relation between the person operated on and the surgeon and favourable surroundings in hospital are for Prof. Burian factors in treatment of equal importance as expert knowledge, skill and inexhaustible patience on the part of the surgeon.

A third feature, is his desire to improve results. Burian has never been satisfied with the results of his work. Therefore, his school returns many times to operative modelatings and scar-corrections on the same patient.

These principles of Burian's facial operations hold good for all reconstruction procedures and the technique of tissue transplantation. The high demands made on the esthetic result associated with the maximal restoration of function have often led to the modification of the methods of tissue transfer. In only a few cases do we content ourselves with the transfer of thin skin grafts. Already in 1926 Prof. Burian published the work in which he coined the term "skin-inlay", in contrast to Esser's "epithelial-inlay", thus pointing out the high quality of a free skin transfer of the full thickness according to Wolf-Krause, as against the thin grafts which are deficient in a number of qualities.

For the first time he used skin-inlays as a valuable material for a non-contracting lining of the orbital cavity, to cover the raw surface of the Indian frontal flap and for the epithelisation of the tubulated flap, transferred to replace the mucous membrane of the cheek, to create a new nasal cavity and a new auditory duct. Professor Burian, therefore in principle uses the free transfer of the whole skin to the lids and to the skin defects after the extirpation of naevi, flat scars, and malignant growths, and especially after skin TB and lues. The dermatome method of skin grafting meant an undeniable advance in the methods of skin transfers, also in this country. It improved some results and extended the use of the free transfer in the face and in other parts of the body. However, in our centres we mostly give preference to the free full thickness skin grafting taken





Fig. 3 a, d, e



Fig. 4 a



Fig. 4 b



Fig. 4 c



Fig. 5 a



Fig. 5 b



Fig. 5 c



Fig. 5 d



Fig. 6 a



Fig. 6 b



Fig. 6 c

free hand, often for very extensive areas, at the cost of covering the secondary defects by means of further skin transfer.

However, wherever he wants to achieve a more perfect esthetic result Prof. Burian recommends the tubulated flap plastic. We may say that even in Czechoslovakia, plastic surgery has developed under the influence of the discovery of the tubulated flap. The records of same duplicate Italian arm and chest flaps for covering large defects in the face, which Prof. Burian carried out already in the Balkan War of 1913, show that the procedures of Prof. Burian were contemporary with the great discovery of the Fillatov-Gillies flap. In 1921 Burian published a report of the closure of the defect of the upper jaw after a tumour resection, an operation, which until not long ago was certainly unique.

It is characteristic for Burian to prefer the abdominal flap to the arm or neck flap in order to place the scar of the secondary defect in a covered site, and thus to gain sufficient material for subsequent corrections. His anxious endeavour for the best and most permanent cosmetic result has led to an individual modelling technique of the skin material of the tubulated flap transferred from a distant place to the face. The fat tissue of the flap is considered to be the most valuable material, which through repeated modellings makes it possible to reach the required form. Meticulous care, the combating of post-operative sclerosis and the prevention of chronic mild infection leads, after many operations, to a permanent result, a non-contracting and stable repair. In nasal plastics after a period of good Indian and Italian plastics, we tend increasingly to use the abdominal flap according to Burian with the same success as regards the colour and the appearance of the transplant. (Fig. 1. a, b, c, d). Prof. Burian has taught us to place the scars bordering on the adjoining intact skin in such a way that they merge with their surroundings. This may even be done on the lips and other movable parts of the face. It is true that such results can be achieved at the cost of many operations and great demands on the patience of the patient, as well as on that of the surgeon. We, however, believe that this is the only way to reach lasting results. (Fig. 2. a, b, c, d).

Burian's school uses the cartilage of the patients ribs as basic supporting material for the reconstruction of the greatest part of the facial skeleton. He devoted a lot of work to the research and study of cartilage. He developed the method of subperiosteal anchoring of the cartilage graft, which guarantees immobility and a firm union with the surrounding tissue and facilitates further corrections and reduces the risk of the secondary warping of the cartilage. We prefer the autotransplantation of cartilage to homotransplants and reject the heterotransplant altogether. Prof. Burian teaches in principle that the use of the patient's own biological material is the only method of reconstruction, and therefore we use neither hetero nor alloplastic material to replace tissue in the face.

When transferring bone into a defect in the facial skeleton, mainly the lower jaw, Prof. Burian never insisted upon the transfer of any special type of bone tissue. We prefer the cancellous bone. In it we see the building material and we think it most important that the bone transfer should be done under favourable conditions. We therefore avoid all foreign fixing material and try to effect the





Fig. 7 a



Fig. 7 b



Fig. 7 c



Fig. 8 a



Fig. 8 b



Fig. 8 c



Fig. 8 d

elastic wedging of the graft into the bone defect. The inclusion of the transplant into the functional system reduces resorption and excludes subsequent atrophy of the graft. We seldom transfer bone to skull defects, where we always attain good results with cartilage. (Fig. 3. a, b, c, d, e).

As an important supporting material we use the free or the flap transfer of fatty tissue. We use the free transfer of fatty tissue, which has been made safer by the use of antibiotics, in atrophic conditions of the face, especially in progressive facial hemiatrophy, as means of enlivening and revitalizing the skin qualities, a fact which has many times proved effective in practice. When transferring fatty tissue freely, we use the corium as a conductor which is often used as semi-solid resistant filling, instead of cartilage, in saddle noses, bone depressions etc. The fatty tissue of the decorticated tubulated flap is used for filling extensive tissue defects, especially in the contour of the lower jaw and chin. (Fig. 4. a, b, c, d, e).

Prof. Burian was one of the first to use fascial strips for the suspension of transplanted soft parts, as well as of paretic sectors of the face. As early as 1921 he published, in French, a modification of the suspension of the paretic face in paralysis of the facial nerve. He always tries to attain active mobilisation of the face by suspension on the mobile muscles of mastication. (Fig. 5. a, b, c, d).

For local rotation and transfer the Czechoslovak school of plastic surgery often uses flaps suspended on a subcutaneous pedicle, sometimes reduced to the nursing vessels as in the case of an arterial flap. These frequently large flaps, especially angular, frontal and temporal flaps, are used for covering fresh defects following the resection of tumours, and in emergency surgery. On the lips we often use Estlander Abbé flaps more or less changed into arterial orbicular flaps.

The treatment of malignant disease of the face is not the subject of this report. However, we wish to express our viewpoint here. Radical operative treatment must not be influenced by considerations of a later repair. Without the cooperation of the plastic surgeon, however, the lines of the surgical incisions often reduce the prospect of repair. Therefore we stand for close cooperation wherever the plastic surgeon does not feel competent himself to carry out radical extirpation.

In our plastic centres the treatment of the sequelae of the specific inflammations of lupus and lues is also undertaken. We support the idea early surgical treatment, even in processes which have not completely healed. Here Prof. Burian has made full use of favourable influence of the skin transfer on the treatment of basic diseases. The successes in the modern treatment of lupus have removed the uncertainty and the last remains of mistrust of early repair. We consider, however, plastic treatment to be absolutely indicated where the function of vitally important auxiliary organs in the face has been grossly impaired by the process and its treatment. (Fig. 6. a, b, c).

The treatment of congenital naevuses, lymphangiomas and haemangiomas forms a large chapter in the reconstruction of the face. Here also Prof. Burian has achieved the best results by means of the tubulated flap technique, although this laborious procedure is today being increasingly replaced by the technique

of the dermatome. We divide the area into esthetic zones which place the bordering scars of the transplant into favourable sites and the expression lines of the face. (Fig. 7. a, b, c). When treating haemangiomata we choose from conservative up to radical methods. Burian's school makes full use of the methods of successive partial excisions, by which the extensive naevoid areas are gradually removed, with good cosmetic results. (Fig. 8. a, b, c, d).

Here reconstruction links up with the group of congenital deformation due to disturbances in the development of and the pathological basis of the facial tissues, which leads to a stunting of the growth of individual parts. Here we have in mind the group of facial dysostoses, which sometimes require fine corrections and which use the knowledge of all techniques of so-called cosmetic surgery.

In our country cosmetic operations are more and more frequently performed in our Departments of Plastic Surgery, free of charge, as guaranteed by our Constitution and by the National Health Insurance Act, wherever the deformity reduces working capacity.

Prof. Burian applied the progressive principles of health care by demanding that plastic surgeons not only treat the sequelae of facial injuries, but also prevent them by treating fresh injuries. He himself is the author of the principles which, on the basis of his experiences during the war, have become the guides for the treatment of facial wounds in peace as well as in war time. Our Departments of Plastic Surgery today treat all facial injuries occurring in children in their areas.

In conclusion, we may say that facial reconstructive surgery in Czechoslovakia, through the merits of Prof. Burian, has developed in all branches of maxillo-facial surgery. It has its characteristic features, resulting from the conditions of its development, which for a long time took place in isolation, without foreign contact, under the influence however of a great surgical personality, namely its founder. Today when all people desire the renewal of personal and cultural relations between the nations, we hope that the methods of Czechoslovak Plastic Surgery will be more and more confronted with the experience of plastic surgical centres all over the world, and that by mutual recognition it will be able to contribute to the further development and success of our surgical speciality.

#### DESCRIPTION OF ILLUSTRATIONS

1 a b. Deformation after X Rays therapy of haemangioma in childhood. — 1 c d. Correction with abdominal tubed flap. — 2 a. Lupus — cancer of the cheek and defect of the nose. — 2 b. Transfer of an abdominal flap. — 2 c d. After reconstruction. — 3 a. Total defect of the lower jaw after war injury. — 3 b c. X — Rays picture before and after reconstruction. — 3 d e. Alveolar process reconstruction by means of skin-inlay. — 4 a. Defect of lower jaw with excessive contour deformation. — 4 b c. Correction by means of decorticated tubed flap. — 4 d c. Mandibular defect covered by iliac bone graft. — 5 a b c d. Facial paralysis treated by fascia lata suspension on the temporal muscle. — 6 a b c. Lupus deformation treated with abdominal tubed flap. — 7 a b c. Congenital naevus treated with successive free skin grafts. — 8 a b c d. Excessive cavernous haemangioma treated by successive excisions.

(Doc. V. Karfik): Berkova 34, Brno-Královo Pole, Czechoslovakia



Department of Plastic Surgery, Central Hospital, Budapest (Hungary)  
Chief surgeon: Doc. J. Zoltán

## OUR EXPERIENCES AND VIEWS IN THE RECONSTRUCTION OF THE FACE

J. ZOLTÁN

Operations for the reconstruction of the face and for replacing its skin appear as both easy and difficult tasks at the same time. The task is easy, for the blood supply of the face is good, its skin elastic, thus the "fourth dimension" as it is termed by Pick,<sup>1)</sup> is well utilized. Yet it is at the same time difficult, for functional factors must be taken into consideration, such as the function of the eyes, mouth and nose, which must be secured as well as mimetic function and, in addition, esthetic effect, such as the course of the scar lines, the colour of the skin, its consistence, structure, the way fits into the contour of the face, the preserving of natural folds etc.

In no other region of the body is systemic arrangement so difficult as in cases of reconstruction of the face, for the actual solution of the given case depends equally on the characteristics of the case and on the abilities and disposition of the surgeon. In the literature very different methods and results can be found for the solution of similar or almost identical cases, which arise rather from differences in planning the operation and the choice of method, than from differences in surgical skill.

In seeking to carry out his task as well as possible, which is essentially to restore to normal, or as near to normal as possible, both function and appearance, the surgeon judges the characteristics of the defects in his individual way and determines the points of reconstruction accordingly. His work is individual in respect of the planning and not in technical accomplishment, which is today of a fairly standard character.

I should like to make a brief survey of some of our view points, illustrated by some case reports. Let us begin with the replacement of skin defects of greater extent, which cannot be dealt with by the utilization of the neighbouring skin, and therefore need either free grafting or a migrated flap plastic.

The split or full thickness skin graft is only employed where specially indicated, primarily for the replacement of the eyelids, the forehead and the nose. In other parts of the face, in opposition to the opinion of Byars and others,<sup>2)</sup> we find the free grafted skin suitable for replacement only if the subcutaneous

V. Karfík

THE MAIN FEATURES OF FACIAL RECONSTRUCTIVE SURGERY IN CZECHOSLOVAKIA



Fig. 3b



Fig. 3c



Fig. 4d



Fig. 4e

L. Bařinka

CLOSURE OF PALATINE DEFECT WITH TUBE SKIN FLAP AFTER TUMOR RESECTION

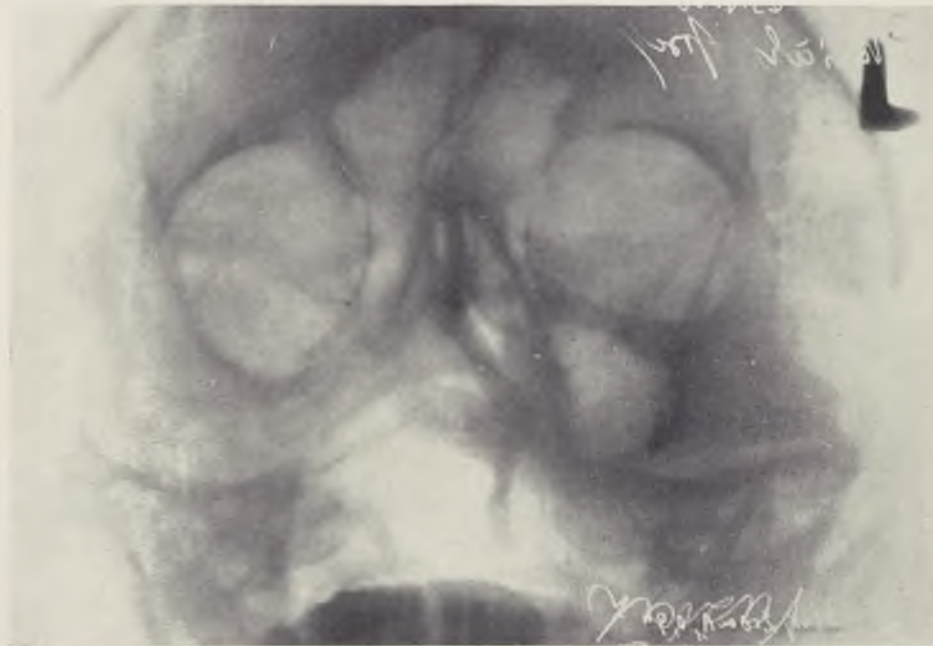


Fig. 3



VESTIBULAR SKIN—INLAY

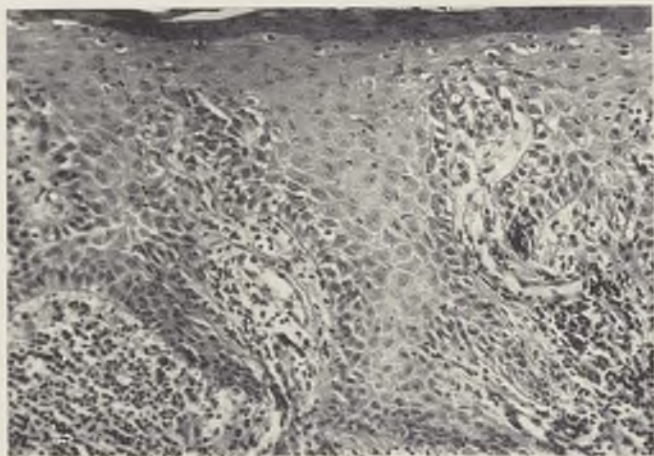


Fig. 6



Fig. 7



Fig. 8

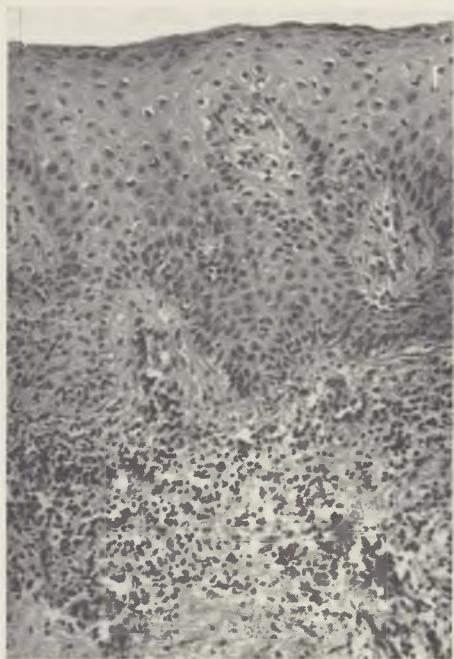


Fig. 9

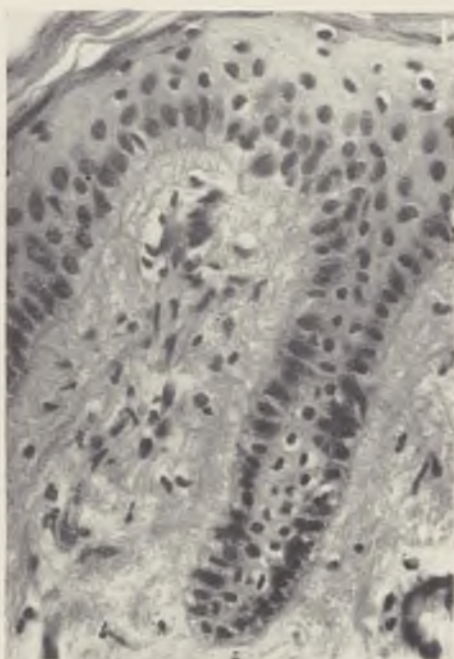


Fig. 10



Fig. 11



V. Kubáček

FREE DERMAL TRANSPLANTATION



Fig. 14



Fig. 15



Fig. 16



Fig. 17



M. Chytilová, V. Kulháněk, V. Horn

EXPERIMENTAL PRODUCTION OF KELOIDS AFTER  
IMMUNIZATION WITH AUTOLOGOUS SKIN



Fig. 1. Experimentally produced keloid after immunization with autologous skin in rabbit No 69.



Fig. 2. Proliferated, cellular tissue of the keloid with inflammatory infiltrates and atrophied skin appendages. (Haematoxylin-eosin 100X.)

fat is completely preserved, whereby the contour of the face guaranteed. It is most frequently used in extensive operations for naevi. Such a case is illustrated in Fig. 1, where a naevus flammeus located on the left side of the face in a 22-year-old woman, extending to the forehead, the bridge of the nose and the upper lip, was extirpated in such way that even the lowermost layer of the cutis was preserved and the defect covered by a dermatome graft cut from the thigh. The skin of the lower lid was replaced with a full thickness free skin graft from the back of the auricle. The result — one year after the operation is shown in Fig. 2.

It should be mentioned as a technical detail that the free graft is always cut with great accuracy, because in our experience whenever grafts overlapping the margins are placed on the wound, the suture-line remains thickly embossed. This can be explained by the fact that some edges of the overlapping skin which does not mummify remains at the margins of the suture-line.

Calnan and Innes<sup>3</sup>) in their paper suggest the unbandaged, open treatment of free grafts. We have also left such grafts exposed several times and they healed uneventfully, with good results. In most cases, however we employ bandages even now. The main point is to be consistent in our proceedings: if once we put a bandage on the free graft it should not be removed before 2—3 weeks, for the difference in pressure will bring untoward consequences to the circulation of the graft.

If the defect is of such a large extent that its replacement needs a transplantation, but free grafting is not indicated (i. e. the subcutaneous fat is missing) peculiarly if deep scarring in the region of the mouth and chin hinders the movements of the lips, narrowing the opening of the mouth etc., only a pedicled flap should be used for replacement, either as a tubed pedicle flap taken from the trunk or a direct flap taken from the upper arm.

We proceeded similarly in the case shown in Fig. 3 where scars removed from the face of a 25-year-old male patient had led to great narrowing of the opening of the mouth. The patient had sustained petrol burns in his face and in the extirpation of the scars brought about by the burns, free grafts were employed which led to the bad results shown in Fig. 3. On the left upper arm we prepared a delayed flap, pedicled at the side and after cutting a longitudinal opening of the same size as the opening of the mouth, used it to replace the skin at the sites of the extirpated scars. The donor site of the flap was covered with a dermatome graft. The movements of the mouth became quite normal (Fig. 4).

Free skin grafting as well as the pedicled flap plastic are procedures of necessity rather than procedures of choice, for though they may produce the desired contour, they leave a great deal to be desired from the esthetic point of view on account of their conspicuous difference in appearance. If possible therefore, skin of the ear or even more distant surroundings should be used for replacement. The question arises as to what are the limitations of this rule? First of all anatomical facts, the amount of available skin, the state of the circulation, the observance of the principle "never do harm" (the avoiding of the distortion of important lines, the prevention of disfiguring scars at the donor site and last but not least, the extent of the surgeons intuition. The two of course go together,



Fig. 1



Fig. 2

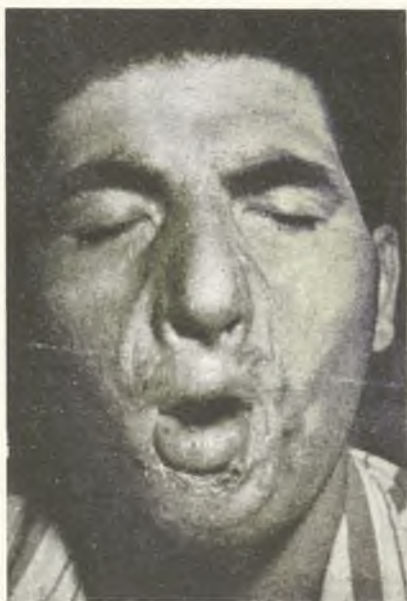


Fig. 3



Fig. 4





Fig. 5



Fig. 6



Fig. 7

for the reckless fancy of the artist must be kept within bounds by considerate and sober medical calculation.

There is another difficult problem, and that is the time factor. It must be taken into consideration, for no patient wishes to spend a score of weeks or even months in hospital and would like to get rid of his disfigurement as soon as possible. We should therefore invariably apply the speediest method that gives a good result. In operations on the face, however, we are always liable to make concessions for the sake of a better result even if it costs time. In this case one should always choose the method giving the best result and if necessary, we should enforce patience upon ourselves as well as upon the patient.

The scar near the corner of the mouth, shown in Fig. 5 seemed to call for extirpation and free grafting as soon as possible. Nevertheless, the local operation, accomplished in two stages gave a far better result, though it needed two operations and between them several months of patient waiting (illustrated in Fig. 6 and schematized in Fig. 7).

In this case the operation was the combination of a multiple excision and an interpolated flap. I must say in passing that as apposed to the opinion of Gillies<sup>4)</sup> according to which: "... it may be, that what can be done by serial excision could be done in one shot" — on the basis of our own experience, we rather side with Davis-Kitlowski<sup>5)</sup> and Ferris Smith<sup>6)</sup> inasmuch as we share their opinion that multiple excision, combined with the Z-procedure, permits complete substitution of the normal without subsequent distortion of the eyelids, nose, angle of mouth or ear, in other words, an end result which approaches the normal and cannot be accomplished in any other way. This, my opinion was corroborated by my experiences at the *Burian-Clinic* in Prague.

In connection with this I would like to point out that we should not go too far in exploiting the elasticity of the skin of the face, and we had better observe the principle of Brown<sup>7)</sup> according to which we must keep in view the fact that "the medium is woody rather than rubbery". Thus, individual parts should be fitted together rather than pulled together, for we not only take the risk that too blank an expression will be produced by stretching the skin covering, that the patient will never recognize as his own, but that tension may also cause dehiscence and hypertrophic scarring, which detracts from if not totally destroying the esthetic effect.

Local methods should be based upon careful planning. Lines of incision should be carefully planned prior to the cutting of the flaps, and the imagination used to determine where the suture lines of the incision will fall. The flaps should be outlined so that the greatest length of the sutured incision will conform as closely as possible to normal skin lines, facial folds or creases.

For bandaging, in addition to the usual vaseline gauze, the cellophane film recommended by Burian<sup>8)</sup> is very suitable even after operation, but particularly after the early removal of the sutures, when it proved superior to collodium. The cellophane film should be removed after two days, since it is not advisable to leave it in place for a longer period.

For donor sites the skin of the pre- and postauricular as well as parotid region is most frequently used either as a sliding flap [Cholnoky<sup>9)</sup>] or as

a rotated flap [K a z a n j i a n<sup>10</sup>]. In the case shown in Fig. 8 the naevus pilosus pigmentosus, located on the left side of the face would at first sight appear to require a free graft on account of its great extent. No doubt, the free graft would have given a relatively good result, particularly on account of the lateral situation of the naevus. But the excision had to be relatively deep for the sake of the reliable removal of the hair roots and that could have brought untoward effects to the contour in addition to the incalculable changes of colour in the transplanted skin.

Therefore, the skin situated between the extirpated naevus and the auricle as well as that behind the auricle was placed on to the defect in the shape of a bi-lobed flap and we succeeded in even covering of the secondary defect in the retroauricular region, after broad preparation using simple knotted sutures. In the lower corner of the suture lines some scallops of course remained, they had to be excised a fortnight later. The effect can be said to be ideal (Fig. 9 and Fig. 10).

Flaps taken from neighbouring sites, can be employed with good results even in the reconstruction of extensive defects of the face, although here we should speak rather of regional than of local methods, since we have to do with neighbouring parts of the body. For this purpose flaps can be cut from the submandibular region, from the neck or the forehead, in extreme cases even from the back or the chest-wall as is elaborated in great detail by G o n z a l e s U l l o a<sup>11</sup>) in his operation for the restoration of the total skin of the face. All of these methods have their advantages as well as their disadvantages. The ideal esthetic effect and the good blood supply are in favour of the use of the skin of the forehead, the variations of which are well illustrated in the paper of C o n w a y, S t a r k and K a v a n a u g h,<sup>12</sup>) but it has a disadvantage that the disfiguration remaining at the donor site is rather striking. Though we do not share the opinion of F e r r i s S m i t h<sup>13 14</sup>) according to which "utilization of flaps from the forehead results in a disability which can never be corrected" — there is no doubt that correction to satisfy our esthetic claims needs a wit like that of G i l l i e s. The lower we go below the jawbone, the more difficulties we have to encounter and the more care must be taken invariably to ensure the blood supply.

The patient shown in Fig. 11 fell upon a petrol cooking range in an epileptic fit and suffered severe burns on the face. Her left hand was completely charred and therefore had to be amputated. After four month's treatment she was brought from a neighbouring country to our department in the state shown in Fig. 11. Both sides of her face as well as the chin were covered with hypertrophied scars, which extended on the right side from the cheekbone, on the left side from the mouth to almost as low as the middle of the neck. The mouth was destroyed on the right side, the remnants, of the upper lip were displaced into the scar, the right side of the lower lip was missing, the remnants of the lips on the left side were swollen, oedematous, embossing like a livid mound from the masses of the scar. In the middle of the scar, on the right side, the denuded and mortified surface of the mandible lay patent. The slobbering caused by the gaping mouth kept up a ceaseless ulceration in the scar on the right.





Fig. 8



Fig. 9



Fig. 10

Fig. 1. Naevus flammeus of great extent on left side of face. — Fig. 2. The patient one year after extirpation of naevus and free grafting. — Fig. 3. Distorting, hypertrophic scar caused by free grafting narrowing the mouth. — Fig. 4. The movements of the mouth rendered free by pedicle flap taken from left upper arm. — Fig. 5. Distorting scar caused by irradiation beside the right corner of the mouth. — Fig. 6. The patient after two local operations. — Fig. 7. The sketch of the operations. Ia, b: first stage IIa, b: second stage. — Fig. 8. Naevus pilosus pigmentosus of great extent on left side of face. — Fig. 9. The patient six months after operation with local method. — Fig. 10. The sketch of the operation.



Fig. 11



Fig. 12



Fig. 13

Fig. 11. Destruction of the face and mouth caused by burn. The right side of jawbone is denuded. — Fig. 12. The incision lines of flaps traced on skin of patient. — Fig. 13. The patient two months after two-stage operation, completely healed.

It is unnecessary to say that the planning of the operation was not an easy task. Because of the lack in material for replacement, we thought first of a migrated flap plastic. But that would have had the great disadvantage — besides the considerable number of operations — that on account of the continuous fixation of the remaining right arm, the patient would have been rendered utterly helpless for a considerable time, at least twice for three weeks. We therefore decided to use large pedicle flaps, taken from both sides of the neck and the chest for covering the defects. On account of the considerable length of the right side flap, delay seemed to be necessary. We began it accordingly by the incision and resuturing of the longitudinal lines of the right flap, but the ceaseless slobbering, which could not be stopped, caused suppuration in the upper suture line.

Therefore we decided to make the operation in a single stage, confident of the help of the rich blood supply, the abundant periarticular network of vessels would convey, as both flaps were situated in the region of the shoulder joints.

All scars were removed under nasotracheal anaesthesia. The mortified bone surface on the right side of the mandible was chiselled down. The upper lip which was distorted into the scar was released so that in connection with it a large piece of mucosa flap was cut, rotated downwards and utilized for the replacing of the inner wall of the cheek. The right side of the lower lip was replaced by the mobilized remnants of the lower lip, which were transferred to the right. Thereafter the flaps shown in Fig. 12 which were traced in advance, were cut, prepared and after rotating upwards, they were sutured on to the face. The secondary defect, at the donor side, was covered with dermatome grafts, taken from the thigh.

Healing was entirely uneventful, not the slightest sign of trouble could be seen in the vascular supply. The effect was slightly spoiled by the reshaped lower lip not being high enough, and the vermilion being turned over. For the correction of this we made a new operation after four weeks: the vermilion was released, replaced and the remaining skin defect covered with a full thickness skin graft, taken from the lower-outer quadrant of the right mamma. At the same time we broke the scar running down vertically from the right side of the point of the chin, which displaced the chin slightly downwards (this was the suture line between the two large collar flaps).

We succeeded in the reconstruction of the severely disfigured face of the patient in practically two stages, omitting the trial of the delay due to the slobbering. (Fig. 13.)

#### SUMMARY

Author gives a brief outline of his experiences in the reconstruction of the face and the replacement of its missing skin from the literature and from his experience. He favours the local or regional methods and takes the pedicled flap or free graft transplanted from distant parts of the body for methods of necessity rather than for methods of choice. The cases described illustrate the effects achieved with different methods.



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## THE USE OF FLAPS IN FACIAL PLASTIC SURGERY

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In plastic surgery of any facial deformity, it is the duty of the surgeon not only to maintain or restore the function of the given part, but also to achieve the best possible aesthetic results.

Experiences show that for other parts of the body, simple transfer of skin often gives satisfactory results. The simpler, flatter relief of other areas of the body and the deep layer of soft muscle tissue over the bones maintain the required contours. The thin layer of soft tissues and almost non-existent layer of fat on the face, the diverse combination of forms and the specific shape of certain organs such as the nose, the ear, the eyelid and the lips often require the transfer of tissue in the form of different flaps, which contain subcutaneous tissue and all accessory elements in addition to skin.

Since the soft tissues of the face have a specific structure, texture and pigmentation, it is obvious that the greatest success is to be anticipated from substitution by facial tissue. When planning a plastic operation of the face, therefore, the possibilities of local transfer from the immediate vicinity are considered first, and afterwards the possibilities of transfer of tissue from more distant parts of the face, in the form of different types of pedicled flaps. The size of the flaps, however, is naturally limited by aesthetic considerations. The replacement of loss at one site of the face should never be allowed to be the cause of new disfigurement at another site.

Only flaps of limited dimensions can therefore be used in facial plastic surgery and the place from which they are taken should be selected so as to permit the resultant defect to be closed directly, if possible, preferably by a linear suture. The best solution is for the scars of secondary defects to be situated in physiological grooves or folds, or at inconspicuous or covered sites. The scars must never be allowed to displace or distort adjacent organs. If these conditions cannot be fulfilled at the first operation, it is best to reduce the size of the original defect by moving the surrounding tissues and by covering the rest of the defect with a free skin graft. The latter sometimes remains noticeable, mainly because of its different coloration. In time, however, both graft and scar tissue soften and the tissues can be loosened by massage. The temporary skin covering can then be removed by repeated partial excision, so that only

linear scars are formed at the site of removal. This removal of a temporary covering is often successful after large-scale plastic operations, e.g. after the Indian type of operation for replacement of the nose.

Where extensive loss of the skin of the face has occurred, there is nothing left but to transfer skin from another part of the body, even at the price of differences in structure and coloration. In such cases the commonest method is the tubed flap. This is not, however, the subject of the present paper, the purpose of which is to draw attention to the types of flaps most frequently used on the face itself.

The great vitality of facial tissues, which is due to their rich supply of blood vessels and nerves, makes it possible to prepare and safely transfer flaps from many different localizations. This is further aided by the convenient situation of the stems of the larger blood vessels, the endings of which can easily be detected in the thin layers of the soft tissues of the face by palpation and are surgically accessible.

Nutrition of a pedicle flap is ensured by providing a sufficiently wide pedicle, which need not contain the ending of a large blood vessel, but contains a plexus of smaller blood vessels in the subcutaneous tissue, which is of primary importance in nutrition. At anatomically suitable sites, where the pedicle contains the stem of a large blood vessel, such as the supraorbital and frontal artery, the temporal artery or the angular artery, the pedicle can be narrow without endangering nutrition of the flap. A tissue flap can be prepared and moved on a very thin pedicle consisting only of the vessels and a very small amount of subcutaneous tissue. These flaps are called island artery flaps (Fig. 1—5). In these, the skin connection is severed for the whole circumference of the flap. This can be done only when an island flap is transferred to the immediate vicinity on a pedicle of subcutaneous tissue. The possibilities of transfer can be greatly increased — as repeatedly demonstrated by Burian — by repeated preparation of the flap. The flap is cut away in a number of operations, thus ensuring good nutrition wherever it may be localized, even if the pedicle does not contain any large blood vessel stems in the subcutaneous tissue.

Flaps on the face are usually prepared and transferred from areas with simple contours and large surfaces, mainly from the forehead and the cheeks, less frequently from the chin, where more noticeable scars are formed. The possibility of the transfer of large flaps is naturally greater in older persons, in whom the flabby, soft tissues are more movable and looser.

Forehead flaps can be variously localized. The most common operation is replacement by flaps of different shapes on the basis of the Indian method of plastic surgery. These flaps are used mainly for loss of part or all of the nose (Fig. 6—12), extending into the orbital region (Fig. 13—14). Horizontal flaps from above the eyebrows can also be moved from the forehead. These are generally used for the eyelids (Fig. 15—19). Flaps prepared unilaterally or bilaterally on the forehead and fed by the temporal artery or its branches, can be transferred to both lips (Fig. 20—22) or to the chin.

The most frequently used cheek flaps are taken from the area adjacent to the side of the nose and the nasofacial groove, so that the resultant scar lies





Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11

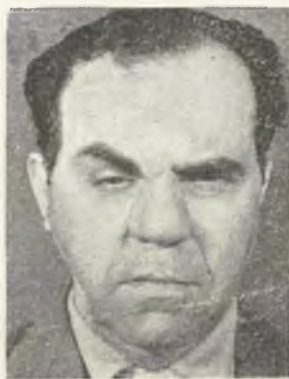


Fig. 12



Fig. 13



Fig. 14



Fig. 15



Fig. 16



Fig. 17



Fig. 18



Fig. 19



Fig. 20



Fig. 21



Fig. 22





Fig. 23



Fig. 24



Fig. 25



Fig. 26



Fig. 27



Fig. 28



Fig. 29



Fig. 30



Fig. 31

Fig. 1. Scarring and tissue defect below eyelid after accident. — Fig. 2. First stage — cutting and raising frontal flap with arterial pedicle. — Fig. 3. Flap drawn through tunnel below skin of temple into defect. — Fig. 4. Post-traumatic defect of nasal apex and septum. — Fig. 5. Replacement of lower part of bridge and apex by artery flap from forehead. — Fig. 6. Severe post-traumatic deformity of root of nose with loss and extensive perforation. — Fig. 7. Rotation of flap from forehead. — Fig. 8. Situation after modelling of the flap, adjustment of the pedicle and implantation of bone. — Fig. 9. Defect after carcinoma. Flap traced on forehead, incision for turning skin under for inner lining traced on nose. — Fig. 10. After healing, showing area on forehead covered with skin graft. — Fig. 11. and Fig. 12. Defect of nose after carcinoma in lupo restored by Indian method. — Fig. 13. Fig. 14. Tissue defect on root of nose and below edge of lower lid replaced by flap from forehead. — Fig. 15. Fig. 16. and Fig. 17. Extirpation of carcinoma of lower lid and replacement by horizontal flap from forehead. — Fig. 18. and Fig. 19. Replacement of loss of part of eyebrows and soft tissue by flap from side of forehead with some of the hair. — Fig. 20. Fig. 21. and Fig. 22. Defect of upper lip after carcinoma. The first illustration shows cutting away of the tissue to form the inner lining of the upper lip. The outer surface of the lip is replaced by a bipedicle flap from a hair-bearing part. — Fig. 23. and Fig. 24. Defect of ala nasi after carcinoma replaced by large flap from cheek, which was folded over and the distal part used to replace the lining of the nose. — Fig. 25. and Fig. 26. Plastic covering of defect after carcinoma of upper and lower lip by flap from cheek. — Fig. 27. and Fig. 28. Formation of scar on lip with partial loss of tissue. Replacement by flaps from nasolabial region. — Fig. 29. Amassing of tissue at site of pedicle after rotation of flap. — Fig. 30. and Fig. 31. First stage — flap on forehead and skin on stump of nose only freed. Second stage — flap rotated on to nose.

in the groove. Cheek flaps are used for defect of the alae nasi (Fig. 23—24) and for the area of the lips and chin (Fig. 25—28). Different types of flaps transferred from one lip to cover losses on the other are based mainly on the principle of the Sabattini-Abbé-Estländer operation, which is discussed in another paper.

The question of the extent to which the prepared flap can be rotated without endangering its nutrition (which would result in partial or complete necrosis) is not the same in every case. On the face, a flap can be turned successfully for as much as 180 degrees. This is possible particularly in the case of flaps with a narrow pedicle, containing a large blood vessel stem or plexus of smaller blood vessels in the subcutaneous tissue. A wider pedicle cannot usually be rotated for more than 90 degrees without endangering its nutrition. In cases in which a wide pedicle has been selected, tissue amasses at the site of the pedicle after the flap has been rotated (Fig. 29); this necessitates secondary adjustment of the pedicle after the flap has taken at the site of the loss and the pedicle must be disconnected and returned to its original site.

Unpleasant episodes such as partial or complete necrosis of the flap after rotation are rare with correct localization and measurement and sparing operative technique.

If, when planning replacement, the surgeon decides to use a flap from the surrounding tissues, it is best, at the operation, to commence with preparation of the flap. If nutrition of the flap is not reliable, it can be resutured in place and the tissue can be transferred some days later (Fig. 30—31). It thus follows that facial flaps are used chiefly for the correction of chronic defects and deformities, where such delay is possible. In fresh loss due to injury, flaps from adjacent parts are used only if the wound is not too badly contaminated, if safe and reliable surgical treatment is possible and if the tissue from which the flap is to be taken has not been contused by the injury. Fresh losses of small dimensions can thus be covered by local flaps if primary rotation of a properly nourished flap is possible. In the case of larger losses and contusion of the surrounding tissue, it is better to cover the defect with a temporary free graft and to postpone final replacement until a later date.

#### SUMMARY

The covering of an extensive facial defect by transfer of a carefully localized flap from another site has many advantages, the most important of which are considered to be

1. the good aesthetic and functional results,
2. rapid healing with consequent shortening of the time spent in hospital,
3. its convenience for the patient,
4. the reliability of the method, which entails no great danger of haemorrhage or necrosis,
5. the relative simplicity of the operative technique, with the possibility of using local anaesthesia.

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## OPERATION OF SABATTINI

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The operation by which a flap from one lip is swung and sewn into the defect of the other lip is usually known in the literature by the name of the American surgeon Abbé. The author of this original method, however, is probably Pietro Sabattini from Italy, who in 1837 used, with good effect, a pedicle graft from the lower lip for a defect in the upper lip caused by a sabre cut.

In 1848, Sophus A. V. Stein, professor at Copenhagen, published his paper on the filling of an extensive defect in the lower lip after excision of an epithelioma by using two wedge-shaped flaps from the upper lip swung into position on medial pedicles. This method is technically complicated and did not gain wider usage.

Twenty eight years after Sabattini, the Finnish surgeon Jacob A. Estlander published a similar method. He asserted that he had performed this operation independently of others already in 1865. He used a flap from the outer margin of the upper lip to cover a lateral defect in the lower lip. The pedicle of the graft thus forms the new commissure of the mouth. In the years 1872 and 1877 Estlander wrote a number of articles in various languages on this operation, where he describes in detail the method and his technique, as no one had done before. Thus it came about that this operation was known for a long time by the name of Estlander. Then, in 1898, the American surgeon Robert Abbé described his operation which Sabattini, Stein and Estlander had described and demonstrated a long time previously. Abbé made a modification by using a flap from the lower lip for the correction of the upper lip, which was too short after repair of a bilateral harelip. Abbé left part of the flap uncovered on both lips, and only in the second phase, after freshening up of the edges, he severed the pedicle and then sutured the adjacent edges.

In the light of these historical facts the author of the already 120-years-old principle of this operation remains Sabattini. To this name may be added the names of those who contributed to it with essential modifications.

### INDICATIONS

Sabattini's operation is a simple and clever method of repairing defects in the upper or lower lip. Such defects arise most frequently after the radical

excision of malignant or extensive benign tumours, after trauma with loss of tissue, e. g. a bite by an animal, after electric burns, and also after the destruction of a lip by noma following a systemic or local infection, resulting in necrosis. The method is also useful in the correction of some secondary deformities after unsuccessful operations for harelip, where the upper lip is left too short and the lower relatively too long and underhanging.



Fig. 1 a

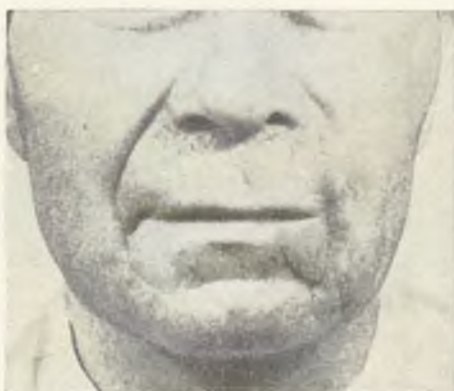


Fig. 1 b

The defect must not be more than half the length of a lip in order to get a mouth aperture which is not too small after reconstruction. This depends on the size of the primary or secondary surgical defect. A loss of less than one half of a lip is always an indication for Sabbatini's operation. In more extensive defects it is necessary to consider other methods.

The indications are not very wide; still, faced with the problem of substituting for the loss of a portion of the upper or lower lip, we always consider in the first place correction by Sabbatini's operation. It is, of course, possible to combine this operation with other local plastic procedures on both lips.

#### METHOD

The principle of Sabbatini's operation lies in the transposition of a flap of different size and shape from one lip into the defect of the other. The flap consists of the full thickness of the lip, i. e. of the skin, the musculature and the mucosa. The superior or the inferior labial artery respectively lies well preserved in a thin muscle-mucosa pedicle, on which the flap is swung by  $180^{\circ}$  so that it can be sutured into the defect in the other lip. The pedicle with the artery is left only temporarily. It supplies the rotated flap for approximately a fortnight and is then severed.

#### PLANNING OF THE OPERATION

As in all plastic operations, in Sabbatini's, too, precise planning is important. At first the size of the defect is drawn, then the length of the lip and of those parts of the damaged lip which remain after deducting the defect, are



Fig. 2a



Fig. 2b



Fig. 2c





Fig. 2 d



Fig. 2 e



Fig. 2 f



Fig. 3 a



Fig. 3 b

Patient before operation



Fig. 3 c



Fig. 3 d

The patient healed



Fig. 3c



Fig. 3g



Fig. 3f

The operative procedure



measured. The half-sum gives the length of each lip which should be approximately equal. Then, on the donor area the flap of a width, corresponding to that of the defect, and of a length which, measured at the very base, should amount to half the length of the defect, is drawn.

When a wedge-shaped flap is used, its pedicle should be in line with the centre of the defect. Both sides of the triangle are planned of equal length so that on suturing the donor area no puckering of the longer edge should take place. This laborious scheme should facilitate planning; however, it is not always possible to keep to it strictly.

The choice of the flap depends on the shape and size of the defect. With regard to this, the operation of Sabattini has a number of modifications. It is possible to use a flap shaped as a triangle, rectangle or quadrangle. The corners may be pointed, rounded or split. The operations according to Stein with triangular flaps is already obsolete. On the other hand the classical operation of Sabattini, which resembles that of Estlander, maintains its indications. So does the modification of Abbé. Finally, it can be used in combination with or as a supplement to local plastic operations on both lips.

#### TECHNIQUE OF THE OPERATION

After excision of an affected portion or the adjustment into the planned shape of a fresh defect in the upper lip we prepare to form the flap. The incision is made at right angles to the surface of the lip. The skin and muscles are cut through with the scalpel, the spurting vessels are then ligated and the remainder, the mucous membrane, is cut with scissors. On one side the red margin of the lip is cut through completely; on the other the cut stops two or three mm. beyond the border of the red margin so as to preserve the labial artery which lies on the posterior border of the orbicularis oris muscle. This is done so as to make the pedicle as thin as possible in order to facilitate the rotation of the flap as well as the proper approximation of wound edges of the red margin. After excision of the flap, the secondary defect on the donor lip is sutured. Care should be taken to assure the accurate apposition of each layer. Only then is the flap swung into the primary defect and suturing is started in the mucous membrane, is continued — with accurate apposition — through the musculature, and finishes in the skin leading from the muco-cutaneous junction towards the apex of the graft.

The operation is performed under local anaesthesia adding adrenalin to the novocaine. Only a light wound dressing is applied. In children a four-tailed sling bandage (funda) or an immobilizing plaster cast is used.

The pedicle of the graft is severed after about a fortnight. The edges of the thus created wound are again accurately approximated and sutured so that there is no difference in level between the skin and the red margin of the lip.

#### CLINICAL MATERIAL

In the course of eight years we used this method in our clinic on thirty patients, of whom 27 were men, 2 women and one a child. The most frequent indication was cancer of the lip — a total of twenty cases. In conditions after



Fig. 4a



Fig. 4b



Fig. 4c



Fig. 5 a



Fig. 5 b



Fig. 5 c



Fig. 5 d



Fig. 5 e



reconstruction of hare-lip six cases were operated on, three times for scars after the X-ray treatment of malignant processes and once after trauma.

The modification of Sabattini-Estlander was used in six patients, that of Sabattini-Abbé in 21 patients, and combined methods in three. The youngest patient was eight years of age, the oldest 85.

The results, immediate or late, were good in all patients. Only in three cases slight gaping of the wound edges occurred after severing of the pedicle, but this had no influence on the final result. Out of the twenty cases operated on for carcinoma only one developed a local recurrence of the malignant process, and in the following reconstruction a flap graft had to be used. Fourteen patients had X-ray treatment for tumours previous to the operation.

#### ADVANTAGES OF THE OPERATION

The operation of Sabattini has many advantages. In the first place it results in a complete physiological and anatomical replacement. Since the flap does not contract it is unnecessary to cut it bigger than the defect, as must be done in other one-stage flap graft operations where primary contraction has to be taken into consideration. The simple technique allows the use of local anaesthesia and makes the operation shorter, which is particularly beneficial for the patient. The inter-operational stage can be shortened to ten days, because the blood supply of the flap is always good. The operation, therefore, demands only a short stay in hospital. The after-treatment and rehabilitation can be carried out in the out-patients department.

The secondary deformity of the donor lip is very slight indeed. The coordination of muscle movement is disturbed and the face altered much less than after correction of similar defects by other plastic operations. The only drawback of this method is the circumstance that between the two stages of the operation the patient has his mouth partly closed by suture, and can neither talk nor take other than liquid food through a tube. Therefore, the first stage requires good cooperation on the part of the patient which cannot always be expected in children.

In conclusion it can be ascertained that the operation of Sabattini with its various modifications is a simple, useful and little demanding procedure. We recommend that every general surgeon should be acquainted with this principle so that he may be ready to repair a defect immediately after operation or trauma.

#### SUMMARY

In the introduction it is suggested that the so-called operation of Abbé be named after P. Sabattini according to historical data. The indications for the operation, its method, planning and a description of its technique are then given. It is stressed that the pedicle of the rotated flap should be as thin as possible so as to include only the labial artery. Clinical experience shows the great advantage of Sabattini's operation in the correction of a loss up to two thirds of the length of a lip.

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## CLOSURE OF PALATINE DEFECT WITH TUBE SKIN FLAP AFTER TUMOUR RESECTION

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Closure of defects of the palate with skin flaps is becoming a common operative procedure in present-day plastic surgery. Knowledge of the physiological and biological properties of the tube flap combined with refinement of operative technique makes it possible to perform these delicate reconstruction operations. Antibiotics are a valuable and often indispensable aid.

The most frequent injuries of the palate with loss of tissues occur in war. Entin, in his war statistics, presents a figure of 9—11% of the total number of injuries to the upper jaw. In war injuries there is not only an isolated injury of the palate but also devastation of the surrounding tissues of the face.

In peacetime defects of the palate are seen in cases of attempted suicide or, very rarely today, of lues. The plastic surgeon encounters palatine defects more commonly after unsuccessful operations for harelip and cleft palate. In this case the defects are smaller, usually located in the anterior field, and a thin flap from the arm is sufficient to close them. Gillies in some cases uses a tube flap from the abdomen to effect a primary closure of the cleft palate.

Partial or complete resection of the upper jaw for malignant tumours is seen much less frequently in spite of the most modern clinical and histological diagnostic advances. Hence the even rare use of flap closure for such defects. The patient dies from the progressive course of the neoplasm before a plastic repair of the jaw can be attempted, either following an operation which was not radical enough or an operation undertaken too late.

In the Czechoslovak literature there is only one such case published by Burian in 1919 in which after resection of the left half of the upper jaw for malignant tumour by means of a Diefenbach-Weber incision the loss of the palate was primarily repaired. Burian used a flap from the left sternocleidomastoideal region with a pedicle for nourishment in the mastoid area. The flap was inserted into the defect through an incision in the cheek, the skin placed nasally and the bleeding surface orally. The latter was epithelized with a folded mucous flap from the buccal region.

In 1954 Professor Khytrov in the Soviet Union published a case in which he closed half of the palate by means of a Filatov flap from the abdomen. The right





Fig. 1



Fig. 2



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9



Fig. 10



Fig. 11



Fig. 12



Fig. 13



Fig. 14



Fig. 15

half of the palate was resected for sarcoma and the plastic reconstruction was performed six years later with permanent functional as well as cosmetically satisfactory result.

Closure of the defect with a prosthesis, either of artificial resin or rubber, is used more frequently. This type of mechanical closure does not meet all the physiological and hygienic requirements. A large prosthesis replacing the upper jaw is a source of continual discomfort for the wearer — the oozing and decomposition of food, the flowing of saliva into the mouth, not to mention the necessity for frequent adjustment of the prosthesis. Its advantage lies in that it is simply produced in an average dental laboratory and in its fixation on to the remaining teeth of the upper jaw.

Because of the variety of these cases a report is presented of one of our patients in whom we performed closure of half of the upper jaw which had been resected for sarcoma thirty years previously (Fig. 1, 2). The patient came to the clinic with a request that only the deformed cheek be repaired. He was persuaded that it was necessary to reconstruct the depression of the cheek simultaneously with a closure of the palatine defect. Among his other subjective complaints, the patient reported reduced hearing on the left side and a chronically recurring erysipeloid infection on the cheek. Neurological examination revealed a neurasthenic syndrome.

Status localis: Total resection of the right upper jaw. Nasal mucous membrane polypous, swollen and congested. The remaining part of the soft palate was replaced by scar tissue and pulled to the right. The right nostril and upper lip were deformed. The lower eyelid was ectropic from scar formation and permanently oedematous. Resection of the right maxilla with deviation of the septum to the left was seen in the x-ray plates taken in the two classic projections (Fig. 3). The contours of the surgical defect, insofar as they are evident, were smooth. Slight mucous changes in the left maxillary sinus. *Strept. alfa haem.*, *Strept. beta haem.*, *Staph. aureus haem.*, *Neiseria* and *Escherichia coli* were present in the bacteriological swabs. Otorhinolaryngical examination revealed a dry inflammation of the open paranasal sinuses. From a functional point of view their communication with the nasal and pharyngeal cavity was adequate. Spa therapy was indicated for the patient.

The patient had been under treatment since the fall of 1956 and a total of 10 operations were performed. The entire surgical treatment was carried out according to a previously determined plan. After the plaster casts were made, the extent of the defect was ascertained and the site of the future implantation of the flap was decided (Fig. 4). In order to insure the successful closure of the palate and replacement of the tissue defect around the resected zygomatic bone, it was necessary to mobilize a large tube flap on the arm (Fig. 5). This was then transferred and implanted, in stages, into the preauricular region. After 5 weeks the arm pedicle was severed, and the flap implanted in the buccal mucosa through a large incision in the cheek. The healing was complicated by infection of the flap which had to be pulled out of the mouth and shortened by 1.5 cm. on the 10th day (Fig. 6). After the oral pedicle of the flap had been pulled out of the mouth, it was fixed with bandages to the head.



After healing, the free end of the flap was implanted under the old incision into the cheek (Fig. 7). A month later the operation was continued by the cutting and, after a week, by shifting of the cranial pedicle. The flap was placed in the oral cavity through a wide incision in the cheek which cut across the entire upper lip and implanted into the bleeding surface of the septum and of the left half of the palate (Fig. 8). The size of the rotated flap is marked by the dotted



Fig. 16



Fig. 17



Fig. 17 a

line; a sufficiently large bleeding surface was obtained by turning the flap through 180°. The lip was sutured. The flap healed without serious complications and remained soft and well nourished (Fig. 9, 10, 11, 12). The patient was able to take food without difficulty. Since the flap was insensitive, it was necessary to protect it against hot foods. Seven weeks later we continued the closure of the defect by undermining the skin flap along the periphery of the defect and suturing it to the oral mucosa and the skin of the cheek and lower eyelid (Fig. 13, 14). The narrow band of soft palate which was retained during the original resection was sutured to the flap, under considerable tension with pulling of the uvula to one side. During healing dehiscence occurred in the entire soft

palate. Consequently, this operation was not definitive. In the subsequent operations in the oral cavity we dissected the remainder of the vellum and a wedge of skin was sutured. The bleeding surface was covered orally by means of a Rosenthal flap which, however, became necrotic in its entirety (Fig. 15). The size of the wedge flap, which was rotated 180°, and the point of severance are marked by dotted lines on the plaster cast. Healing took place per secundam from the



Fig. 18

edge of the wound. The flap remained soft even after secondary healing and continually retained the character of oral mucosa. By slight modelling of the cheek it was possible to eliminate the ectropium of the lower eyelid and also the chronic oedema (Fig. 16, 17). The individual phases of the closure of the palate are indicated in Fig. 18. The present state of the patient is represented in the last cast. The flap closure of the defect eliminated the escape of food into the nasal cavities which were chronically inflamed. Furthermore, speech was improved, and the appearance of the patient was partly improved by correction of the facial asymmetry which resulted from the resection of the zygomatic bone during the initial operation.

#### DISCUSSION

Knowledge of the physiological and biological properties of the tube flap makes it possible to perform the most complicated plastic operations. On the basis of experiences thus far with flaps in the oral cavity, the plastic surgeon recommends the use of Filatov's flap to a greater extent. Its advantage in contrast to the usage of unsuitable obturators is beyond doubt.

Rare use of flaps is seen in defects of the palate after tumour resection. In the literature accessible to us only two cases were found. In one patient the resected upper jaw was repaired primarily with a cervical flap. In the other, a Filatov flap from the abdomen was used. In our case an arm tube flap was used for the closure of the palatine defect. Its considerable size was sufficient to close the quite large defect of the right half of the palate. Implantation of the flap into the defect was not performed through

the mouth but through a wide incision in the cheek. This method was less troublesome for the patient and he was able to take food without great difficulties. The condition of the patient after operation is satisfactory.

1. Functionally, speech was improved, the escape of food into the nose was eliminated, and the ectropium of the lower eyelid which caused chronic inflammation of the conjunctiva was repaired.

2. Cosmetically, the asymmetry of the face and deformation of the nose were improved.

By presenting our patient we wished to point to several important facts:

A) It is possible to close even a large defect of the palate by means of an arm flap and thereby shorten the time staged reconstruction with a caterpillar flap from the abdomen.

B) It is better to give preference to the Filatov flap rather than the various obturators which by their continuous irritation can, needed in a stigmatized terrain, cause malignant growth, in addition to inflammation and decubitus ulcer.

C) We believe that similar cases would be much more numerous than hitherto with the establishment of good cooperation with the oncological centres. By more radical and early operation at the first sign of tumour it would be possible to prevent the sad fate of such patients. Permanent plastic replacement of the palatine defect substantially reduces the suffering of the patient and enables him to return to his former social life.

#### SUMMARY

Postoperation defect of the upper jaw resected for malignant tumour can, with advantage, be closed with a Filatov flap from the abdomen or arm. The superiority of this method consists in its more physiological return of normal function (speech, deglutition) than by the use of obturators. An additional advantage of the flap procedure is the better cosmetic result in repairing the asymmetry of the face resulting from the resection of the palate. Acquaintance of the surgeon with the plastic technique of closure of palatine defects can favourably affect the radical and early operation of malignant tumours of the palate, even at the first signs.

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## VESTIBULAR SKIN-INLAY

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The application of skin grafts may be regarded as a new era in reconstructive facial surgery. It has also opened new vistas in stomatoprosthetics and in facial prosthetics. Though stomatoprosthetics has made great progress in the past ten years as a result of careful studies of the anatomy and physiology of the orofacial system and of the use of new materials, conditions still exist, where the surgical repair of the oral cavity must be undertaken in order to secure the retention or adhesion of an artificial denture.

One of the methods used is the application of a free skin-transplantation in the shape of skin-inlay. It is commonly used in the case of a very atrophic alveolar process in an edentulous jaw, with muscle insertion placed under the body of the denture. It is used further, in the edentulous maxilla with atrophic tubers where the edge of the maxilla is continuous with the velum and plica pterygomadibularis where it interferes with the function of the marginal closure of the denture. Finally, in cases of loss of soft tissues and of scar processes in the region of the oral vestibulum, rarely also in fractures with loss of bone tissue and after jaw resections.

Reports on the covering of the raw surfaces of the oral cavity go back as far as 1886 (quoted by Limberg). The first failures, caused by insufficient fixation and failure to prevent infection of the skin graft, resulted in the rare use of this method. The poor success was attributed to the uneven thickness of the graft cut with a scalpel and to unequal pressure of the surrounding tissues in the course of the healing.

In 1916 Moskowicz proposed the creation of a cavity for the skin inlay through an external incision in order to prevent the infection of the transplanted skin. In the same year, Esser decided to use a stent mold of the cavity instead of the tamponade of Moskowicz and he thus attained an even pressure on the grafted skin.

After complete healing he opened the epithelized cavity into the mouth. Esser used a thin dermoepidermal Thiersch graft for epithelization of the cavity and thus became the author of the epithelial-inlay method. The thin Ollier-Thiersch graft is subject to shrinkage under the influence of changes in the





Fig. 1



Fig. 2



Fig. 3

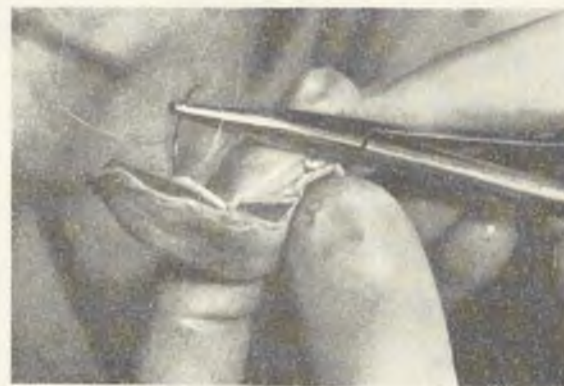


Fig. 4

transplanted area, which is the greater, the thinner the graft. As late as in 1932 R a u e r spoke sceptically about Esser's method on account of the considerable retraction of the graft which often destroyed the whole initial success of the operation. If the skin is split in the lower dermal layers it prevents shrinkage and it gives a better cover than a thin dermoepidermal membrane. B u r i a n, therefore, as early as 1920 proposed the use of full thickness skin grafts for the epithelization of the cavity.

We prefer a half-thickness skin graft and have never observed any substantial changes in the volume of the newly formed cavity, not even after a lapse of some years. The main condition of success is the immediate use of the denture after the opening of the epithelized cavity. The prosthesis produces desirable pressure and massage and this prevents the retraction of the skin-inlay.

Our operative procedure is as follows: an vestibular incision is made about 3 mm. from the insertion of the mucous membrane on the alveolar process. We penetrate as far as the periosteum and push down the soft tissues to to a desirable depth while the periosteal covering is left on the jaw. An impression of the created cavity is made with stent sterilized by boiling. The surface of the impression is transferred on to linen and in this way we obtain the size of the surface to be covered. The outlines of the area obtained on linen are drawn with a scalpel on the site from which the graft is to be taken. The donor site (the anterior region of thigh, the inner surface of the upper arm, the abdomen, the gluteal region) is cleansed only with ether and alcohol and infiltrated with  $\frac{1}{4}$  percent novocain solution. When using the Humby knife the thickness of the skin graft can be easily adjusted according to the quality of the skin (Fig. 1—4). The transplanted graft with the epithelial surface downwards is sutured to the stent so that after its introduction into the created cavity the stitches lie under the suture of the mucous membrane (Fig. 5). The cavity is closed with catgut sutures. After seven to eight days the sutures in the mucous membrane of the skin-inlay are released and the stent removed. The cavity is usually completely epithelized and can hold the denture at once.

In our patients we were interested in changes occurring in the transplanted grafts in the new site. The transplanted tissue is often grafted in a chronically inflamed area often encountered in edentulous patients using prostheses with a gingival transfer of masticatory pressure. The graft is constantly moistened by the saliva. Finally, the prosthesis causes certain changes in the skin graft due to pressure and chemical irritation of the material from which the prosthesis is made and by a thin layer formed from the remains of food and dead epithelial cells from the mucous membrane.

Our report is based on observations on 14 patients, seven of them were followed up 2—8 months after operation, the rest after 1—3 years. In these patients we used a middle-sized graft taken from the anterior part of the thigh.

In four patients we took samples of the transplanted skin. The biopsy excisions were taken from the buccal side not subjected to the pressure of the prosthesis, and from the alveolar side, which was subjected to it. As control material we used the skin from the donor area.

Immediately after the extraction of the stent-carrier considerable desquamation of the macerated superficial layers can be seen macroscopically on the transplanted skin. The healed graft is oedematous for a certain time and at the beginning it has a skin-like character with a tougher consistency and lighter colour than the surrounding mucous membrane. Later an increased pigmentation



Fig. 5

can be observed. If the cavity is not tamponaded immediately after the opening of the inlay or what is even better if it is not filled out by the prosthesis, rebased according to the new anatomical circumstances, after a few weeks considerable retraction and stiffening of the graft occurs. The pressure of the prosthesis prevents not only shrinking, but it also flattens the swollen edges between the mucous membrane and the graft to the level of the surroundings. In the majority of cases this zone remains thicker, but by its adhesion to the vestibular surface of the prosthesis it forms a sort of physiological retention thus complementing the function of the muscoli buccinatorii and the circular muscles of the mouth.

If we cut a thicker graft including sweat and sebaceous glands and hairs, these skin adnexa mostly undergo degenerative changes and destruction. Nevertheless, we have seen some hairs growing in this environment, but not often. This is an unwelcome complication, which has made the use of thinner grafts necessary, and the taking of hairless skin from above the hair zone of the thigh, and other regions. The advantage of a thicker graft in the reconstruction of the oral vestibular cavity is its higher resiliency when compressed by the prostheses. The original mucous membrane on the alveolar process is thin, however, and strongly adherent to the periosteum, the fibres of which run immediately into the papillae of the mucous membrane. It is therefore not necessary to transplant more tissues on to the alveoli, than were formerly present, by using a thicker graft.

A thinner graft more easily changes to become adapted to the environment as may be seen macroscopically in the colour changes of the graft which sometimes does not differ from the surrounding mucosa.

Microscopically on the buccal side the graft is covered by high pavement



epithelium, the superficial layers of which have only slight marks of keratinisation, as in the pavement epithelium of the oral cavity. The epithelium has lost all the signs of the original epidermal graft. All components of the stratum corneum (granulosum, lucidum, corneum) are absent. Against the lower part of the epithelium the mucous membrane tissue (the original corium) juts out in the form of slender, tall and differentiated papillae, the surface of which is often covered by a few layers of epithelial cells only (Fig. 6). The fibrous tissue of the papillae is richly vascularized and infiltrated by a great number of lymphocytes, plasma cells and fibroblasts (Fig. 7—8). These free cells penetrate into the epithelium, partly dissolving its lower layers, destroying the basal membrane the lower strata of the epithelium. This sectional demolishing of the lower epithelial layers gives rise to new fibrous burgeons. Into the spaces which have arisen by the destruction of the lower epithelial layers fine capillaries penetrate and newly formed fibrous tissue, which pushes the epithelium sideways and the lower strata upwards. In the lower layers of the former corium the ducts of the sweat glands may occasionally be discerned in the form of epithelial strips.

A temporary small-cell infiltration is a common phenomenon during the healing of the grafted skin elsewhere on the surface of the human body and it is therefore not specific for oral skin-inlays. Influenced by changes in the milieu of the mouth this reaction persists for more than one year, as we observed in our cases.

The thicker grafts preserve the original structure of the epidermal layer to a higher degree. The stratum granulosum and the stratum corneum proprium may be discerned in the epithelium (Fig. 9). The cylindrical cells of the stratum basale contain a great number of fine melanin grains in their cytoplasm (Fig. 10). The corium shows a normal configuration, is richly vascularized and only infiltrated by cells to a small degree (Fig. 11). Histiocytic and fibroblastic cell-elements are grouped in larger numbers around the disappearing sweat glands.

#### SUMMARY

From these histological findings the following may be deduced: Under the influence of the environment and the pressure of the prostheses thin skin grafts undergo substantial structural changes, which are manifested by marked desquamation and a reduction of the epidermal layer. The small cell infiltration which is a sign of an inflammatory reaction may cause the penetration of granulation tissue into the basal membrane of the epithelium and the forming of fibrous burgeons on the surface of the graft. The reduction of the epithelial layer is evident in changes in the colour of the graft and in the macroscopic loss of the character of skin. The colour and the glossy surface in the moist environment gives a false impression of a transformation into mucosa.

In thicker skin grafts and in whole thickness skin grafts all these changes are less marked. There is no doubt that the surface of the skin desquamates and becomes macerated, but it is more resistant to pressure and to inflammatory reactions. The degenerative changes are sometimes characterized by a greater production of pigment, which causes a colour-contrast against the surround

ing tissue. Deleterious pressure by a bad prosthesis may cause papillomatous growth, acanthosis and hyperkeratosis in thick grafts.

As with grafts to other places, cold and pain sensation are renewed after some period in vestibular skin-inlays. The renewal of sensation is influenced by the preservation of the innervation, which may easily be destroyed in the lower jaw by dissection of the mental nerve.

The following conclusions can be drawn from the histological findings and clinical observations of the changes in the oral skin grafts:

1. Oral inlay by skin graft represents the ideal material for covering defects in the oral mucous membrane.

2. The healing of the graft as a skin inlay on a submerged stent carrier introduced intraorally is a reliable method which reduces the process of healing to a week.

3. The best results have been attained by skin grafts of medium thickness, taken from the hairless part of the thigh by a Humby knife. The result is ensured by the immediate use of a rebased prostheses after the extraction of the stent carrier.

4. The tougher margin of the border of the graft and the buccal mucous membrane supports the retention of the prosthesis.

I would like to express my thanks to Doc. Mazanec, Director of the Histological and Embryological Institute, Brno University for his kind cooperation in the histological parts of this paper.

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## FREE DERMAL TRANSPLANTATION

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Free transplantation of fatty tissue with a layer of dermis from the adjacent skin is well known and widely used in plastic surgery. It acts as a base for a skin covering, where there is a deep defect in various parts of the body. The layer of dermis serves three purposes. It acts as a conductor in implanting fatty tissue into a cavity, helps to maintain the necessary shape of the grafted fatty tissue, and, in many cases, improves the quality of the skin covering at the site of implantation.

However, free transplantation of dermis alone or with a thin layer of fat has begun to be used in plastic surgery only recently, and rather rarely for the replacement of lost skin. It arose out of the efforts which are being expended to improve the results of free skin grafts, particularly in nonhealing chronic granulating surfaces and chronic ulcers (Hynes and others). These chronic conditions were hitherto treated satisfactorily only by highly intricate and, for the patient, incapacitating pedicle flap transfers, whether from the immediate vicinity or from a distant site. Use of skin grafts, particularly thin grafts, is rarely successful in chronic ulcers and granulations and, according to the extensive statistics of Conway, is permanent only in about 10% of the cases. If, therefore, flap technique, i.e., suitable skin with subcutaneous tissue, satisfactorily serves to cover chronic granulating surfaces and ulcers, the improvement of free skin grafts would mean attaining a quality closely resembling that of flap skin; in other words, to transplant the thickest and the most resistant grafts. On the basis of our experiences we believe that a small step in this direction is represented by the free transplantation of dermis. Certain facts and experiences which we acquired with this type of grafting and which Karfík referred to in part, are reported in this preliminary communication.

By dermal graft is meant the bottom layer of skin free of epidermis and containing an adequate source of epithelium around the hair follicles, the excretory ducts and the remains of the interpapillary calyces which form the epithelial islets in the dermis. Dermis in this form was first grafted by Harkins and Morel Fatio in 1943 for strengthening the abdominal wall in the repair of large abdominal hernias. The dermis was obtained by separating the whole skin dermatome graft into epidermal and dermal layers. We used their methods and



experiences for the epithelization of large surfaces in cases of burns, being forced to this measure by the lack of skin material, and also in the repair of large abdominal hernias, as reported from this clinic by Chytilová in 1951 and 1953. It was only in 1949—54 that the English plastic surgeon Hynes put forward the idea of free transplantation of the corium — representing the most resistant part of the skin which from its own sources is able to produce a more suitable and lasting skin covering than epidermal grafts.

#### METHOD OF DERMAL TRANSPLANTATION

We had the opportunity in 1954 and subsequently of observing that the dermis is the most resistant part of the skin. At that time we used skin homotransplants in covering large granulating surfaces in a severely burned boy. The epidermal layer rapidly became separated and sloughed off while the corium survived for a long time and in some places had to be surgically removed (Fig. 1, 2, 3). Following this observation which we repeatedly confirmed and after learning of the studies by Hynes, we began to use free grafting of the dermis in the treatment of chronic granulations and ulcers.

The defect, that is, the chronic granulation tissue or chronic ulcer, is always prepared by radical excision of the entire poorly nourished area as well as the sclerosed tissue, and the surface is left under moist aseptic dressings to regranulate. Under these conditions the granulating tissue is formed slowly and therefore we have attempted recently to hasten this process by an immediate provisional epithelization with skin homografts. The homograft is removed at the latest in 10 days. For the time being it seems that this is one of the ways of hastening the formation of granulation tissue.

The dermis is obtained by first cutting thin epidermal grafts with the Humby knife and then in the same spot cutting thick dermal grafts down to the fatty layer. The epidermal layer is in continuity with the donor bed at one end and sutured back and the defect is thus closed (Fig. 4).

Recently, dermal grafts have been prepared according to Hynes by leaving them, after excision, on the donor bed for 24 hours under a light compression dressing so that they are supplied with as much nutrient material by osmotic action as possible before they are grafted. Even in this case the epidermal layer is sutured back into the secondary defect.

The dermal graft is fixed by compression as in free skin transplantation; prolonged compression is avoided, the compression being removed in 48 hours.

#### CLINICAL OBSERVATIONS

Of the number of problems which will have to be more thoroughly studied we can, for the time being, report in detail on the clinical observations of the fate of freely transplanted dermis, on the changes which take place during healing and final epithelization from inherent sources, and on the histological study of these changes, as well as objective confirmation of the clinical impressions. Furthermore, mention will be made of the knowledge obtained in experi-

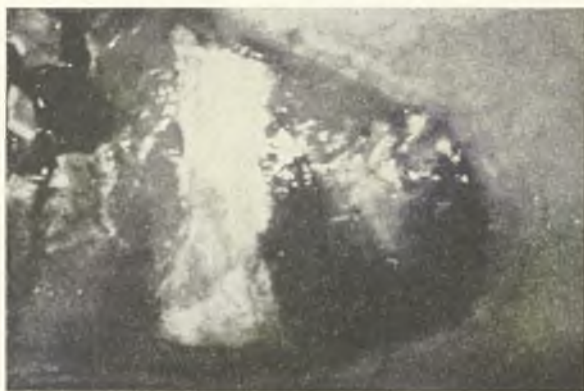


Fig. 1



Fig. 2

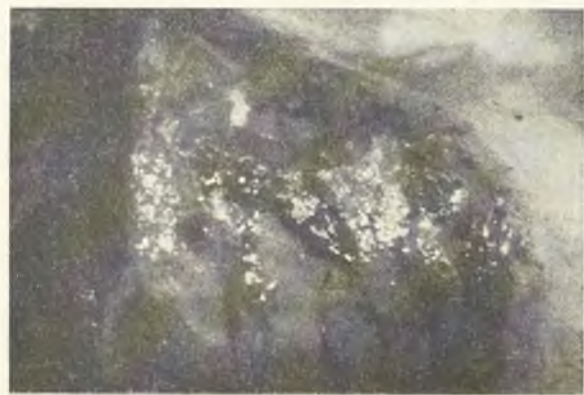


Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



mental studies, using the dye method, of the direction of osmotic flow from the bottom of the defect and surroundings into the grafted dermis.

After removal of the compression in 48 hours, it is possible to observe macroscopically fine, regularly disseminated red islets in the form of small spots, in the dermal stroma. They represent migrated erythrocytes and the vessels of the dermis filled with them. These spots grow from day to day and



Fig. 9



Fig. 10

change into small granulating islets; simultaneously with this process the dermal structures around the islets disappear until only a fine network remains around the 10—15th day. At times the erroneous impression is gained that we have before us only granulation tissue just as prior to transplantation. Foci of epithelium begin to appear in the midst of the islets of granulation tissue which quickly grow and spontaneously epithelize the defect in a few days (Fig. 5, 6, 7, 8). The newly formed skin has the solid character of firm hard skin which is more resistant to trauma than skin resulting from the epithelization of dermo-epidermal grafts. It is not so dry, is more moist and mobile. The surface is finely granular, and the pits and projections are very uniformly distributed next to each other in the same manner as the epithelial centres, from which the new epidermis is formed in the final stage of healing (Fig. 9, 10). The hardness and resistance of the epithelized dermis was especially marked in one patient in whom a melanotic granuloma resulting from an accident was excised from the sole of the foot and the defect covered with a dermal graft. The defect healed, and the patient is without complaints for the second year despite the fact that the dermal graft on the sole of the foot is subject to considerable functional strain (Fig. 11, 12, 13).



Fig. 11

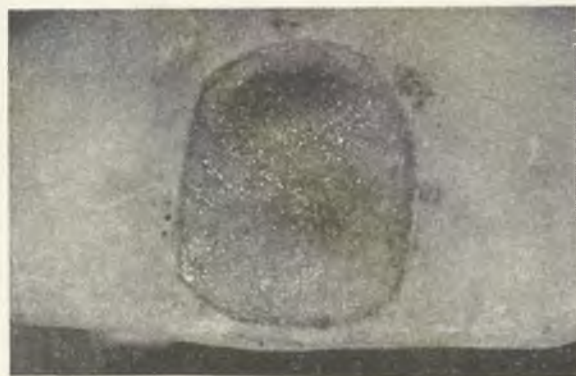


Fig. 12



Fig. 13

## HISTOLOGICAL FINDINGS

The clinical observations on the transformation of the dermis into granulating tissue with subsequent spontaneous epithelization and formation of normal skin were fully confirmed by histological study. In Fig. 14 the corium is without epidermis, only with the remnants of the ducts of skin glands. Fig. 15 shows



Fig. 18

the corium where for comparison the epidermis is retained in the vicinity; the adnexa and epithelial islets are well illustrated in the dermis. Fig. 16 is the state nine days after operation. There is marked exudation with numerous newly formed vessels and round cell infiltration characteristic for granulating tissue, into which the surface of the transplanted dermis is for the most part, transformed. Fig. 17 is the histological picture four weeks after operation. New skin with epidermis has been formed, the stratum papillare having disappeared, and in the dermis there are traces of the cellular infiltration and a large number of vessels and connective tissue fibres.

## EXPERIMENTAL OBSERVATIONS

In order to determine the direction of osmotic flow of tissue fluid in the skin defect and thereby the direction of the probable nourishment of the graft in the first 48 hours, we used intradermal and then subcutaneous injection of 2% sterilised methylene blue in physiological saline. After intradermal injections at several points close to the grafted dermis the dye did not appear in or under the dermis in 24 hours, it appeared clearly in the dermis, however, six hours after subcutaneous injection beneath it.

In an additional experiment we compared the seepage of dye from the subcutaneous tissues and from the epidermis into free skin grafts in their entire thickness and also into dermal grafts. Both grafts were reimplanted into the donor bed next to each other (Fig. 18). After removal of the compression dressing 24 hours later, the dermis was thoroughly soaked with the dye, the dressing over it also being intensely coloured. The skin graft did not show any



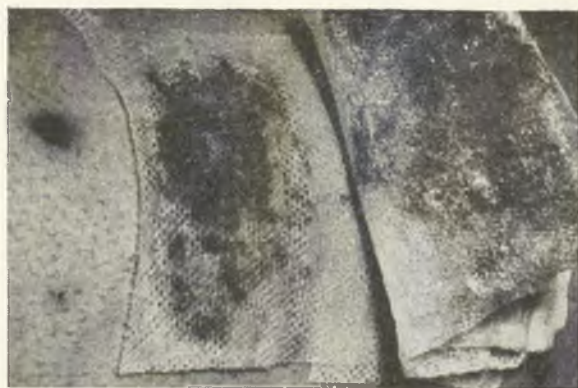


Fig. 19



Fig. 20



Fig. 21



Fig. 22

traces of the dye in its entire thickness and the dressing was white and clean. At two sites the full skin graft was raised by small hematomas which were slightly coloured blue and which were emptied (Fig. 19, 20, 21, 22).

## DISCUSSION

One of the essential features of dermal autografts and homografts is their high resistance and extremely good ability to heal. The process of healing of full-thickness skin auto-and homografts is always accompanied by early desquamation of the epidermis. The desquamation affects the epidermis to varying depths, at times the entire epidermis. In homografts the entire epidermis is always desquamated and the dermis sometimes survives it three times longer. If the entire epidermis is desquamated in autografts, it means that the graft has not taken. Even in this case, however, the dermis survives for a long time and sometimes must be surgically removed before a new transplantation is attempted. In deep second degree burns where there is a loss of the entire epidermis, only the deep layers remaining untouched, the white dermal network survives a long time and disappears very slowly when there is either a spontaneous epithelization from the dermal sources or the formation of granulation tissue. It is known from normal histology that, after development of the skin is complete the dermis is its firmest layer and is composed of collagen and elastic fibres and the so-called cement substance which is made up, for the most part, of mucopolysaccharides. The cellular elements are scanty in the dermis. This fact also explains its firmness and resistance. It is of paramount importance for the healing of grafted skin that the vascular network be located only in the dermis and that the epidermis be devoid of its own vessels, being nourished solely by the circulation of tissue fluid in its intercellular spaces. Vascular connection of the graft with the bed can take place as early as 48 hours in the dermis but the epidermis still remains dependent on osmotic nourishment, which in the thicker grafts is inadequate over an extended period of time. Consequently, desquamation in the upper layers of the epidermis results, and, in the presence of impaired healing, also deep desquamation and necrosis.

It appears that early desquamation of the epidermis in homografts also has a deeper cause. It is perhaps due to the fact that the immune reaction in the epidermis is much more violent than in the dermis. The epidermis is always sloughed off in its entire thickness, and there remains only a dermal network. It is possible that this phenomenon is related to the fact that the epidermis is of ectodermal and the dermis of mesenchymal origin.

In addition to great resistance dermal grafts also have extremely good healing capacity and practically all of them take. This is explainable by the more vigorous and greater gradient of so-called plasmatic nourishment in the graft. The graft is nourished in the first 48 hours partly from its own sources and partly by osmosis from the bed. Osmosis, furthermore, maintains a moist environment in the graft which is not of less importance for its vitality. As was shown by the experiments with subcutaneous injections of dye, the osmotic gradient in dermal grafts is much greater since there is no impermeable dermal layer obstructing its path. The flow of plasmatic nourishment is less retarded in the dermis.

The experiments with intradermal injection showed that the principal and essential means of nourishment is by osmotic supply from the bed and not from the edges of the graft.

Equally true is the fact that excessive and prolonged compression dressings must not be allowed to inhibit the adequate flow of plasmatic nourishment. For this reason

the dermis is compressed only with an elastic dressing which is removed at the end of 48 hours. Early removal of the compression is also a preventive measure against complications in healing, particularly the formation of seroms and hematomas which can be emptied in time.

Dermal grafting led us to certain changes in surgical technique in the preparation of the transplantation site. Dermal grafting is used only for the treatment of chronic diseases (chronic granulation and chronic ulcer). It is precisely in these cases that we see a great advantage in radically excising the lesion, deeply and widely. Chronic processes always mean sclerosis of the affected tissues and, therefore, inadequate vascular nourishment. A graft would definitely heal badly in a sclerotic terrain. Hence, we radically cut into the healthy tissue, preferably up to the loose connective tissue, which according to Bartoš represents the best source of blastema for the formation of granulation tissue. Grafting, then, is performed on well formed and sterilely maintained granulation tissue which appears on an average in 14 days and represents highly vascular tissue capable of providing nourishment for the dermis. Finally, as was shown by histological study, the granulation tissue is changed into connective tissue and contributes substantially toward the firmness and thickness of the new skin. The skin is more permanent, resistant and mobile than that of dermoepidermal grafts. It differs from normal skin in its finely granular surface and lesser mobility, for it lacks the stratum papillare, which has disappeared.

#### CONCLUSION

Our experiences thus far with free dermal transplantation in 17 patients who were treated for chronic residual granulation or chronic ulcers, indicate that the method is a definite improvement leading to safer and better results in the treatment of these diseases. We believe that in the future it will become the method of choice in a number of surgical conditions. This is justified by our clinical and experimental observations and also by the fact that in practise the skin resulting from dermal grafts proved to be more permanent and resistant to trauma than the skin of dermoepidermal grafts. Flap technique with full-thickness skin is certainly superior in quality to dermal grafting, but chronic granulations and ulcers occurring mainly in the lower limbs generally require distant transplanted tissue which is much more time consuming than dermal grafts. In a certain sense dermal grafting resembles healing of pinch grafts especially in its epithelization. A large quantity of epithelial elements which are ideally distributed and abundant is grafted with the dermis into the granulating surface. It is also known that previously healing of infected chronic granulations was successful only with Braun grafts. But this does not mean that we wish to advocate the use of dermal grafting to the exclusion of full-thickness skin. The latter has its full justification and exact indications, but we feel that it is sometimes less suitable for the treatment of chronic diseases.

Our study of dermal grafting also led us to re-evaluate our ideas on certain questions of operative technique and tactics in free skin grafting generally, especially in relation to the preparation of the graft. Our observations are not always new, they being at times a return to older methods used in another form, the essence of which, however, takes on added importance.

In our future studies we wish to determine the extent to which free dermal grafts represent a distinct improvement in the treatment of nonhealing gra-



nulating surfaces and ulcers. We also wish to follow the fate of dermis grafted with a thin layer of fat and attempt to solve the question of free skin transplantation which would qualitatively approach procedures with skin flaps.

#### SUMMARY

1. Chronic granulating surfaces and chronic ulcers were hitherto successfully treated only by means of pedicle flap transplantation of skin. Treatment with dermoepidermal free grafts was rarely successful and was permanent in only about 10% of the cases. New methods were therefore sought which would qualitatively approach flap techniques and which would not be so time consuming. One of these methods is free dermal grafting.

2. The dermis is a very resistant part of the skin containing a sufficient amount of epithelial elements capable of forming normal skin. In addition, the dermis heals well, for the gradient of plasmatic nourishment is much greater than in dermoepidermal grafts since there is no epidermal layer in the way to impede the flow of nourishment. Good plasmatic nourishment is of decisive importance for the healing of grafts in the first 48 hours. This was shown in experiments with dyes. It was found that only osmotic nourishment from the bed and not from the edges of the graft is important.

3. In operative technique and tactics the necessity is emphasized for the radical excision of all sclerotic, poorly nourished tissue and the grafting of dermis into healthy, vascular and sterilely maintained granulation tissue which is newly formed in the defect. On the basis of experiments to determine the direction, velocity and vigour of plasmatic nourishment the former view of prolonged compression was also modified. It is possible to remove the compression by the end of the first 48 hours without endangering the graft. After this time the dermis is in contact with the vascular supply. It is not necessary to compress it any longer on the bed. On the contrary, excessive and long pressure can impair the newly formed vascular circulation. In addition, early removal of compression is a preventive measure against complications of healing, for it makes it possible to remove any coagulum under the graft and empty the hematomas which are usually the cause of complications.

4. Histological study confirmed the clinical observation of apparent transformation of the dermis into granulation tissue during healing and of the subsequent epithelization from the numerous epithelial islets in the dermis. In the final stage of healing the granulation tissue is changed into a strong layer of connective tissue covered by a newly formed epidermal layer which is lacking only in the stratum papillare. The newly formed skin is sufficiently mobile, strong, permanent and more resistant to trauma than skin from dermoepidermal split grafts.

5. Experiences thus far with free dermal grafting in the treatment of chronic granulating surfaces and chronic ulcers in 17 patients showed better and more permanent results than with dermoepidermal grafts. As opposed to pedicle flap technique dermal grafting is less time consuming and less incapacitating for the patient. The free transplantation of the whole skin is in our opinion not

suitable in chronic infected conditions. It appears that in the treatment of many chronic granulations and ulcers free dermal transplantation will become the method of choice.

6. In this study preliminary results of dermal grafting with a thin layer of fat are presented and the direction of further study and improvement indicated.

The histological study was kindly performed by MUDr Konrad Bohuslav, M.D. assistant, Laboratory for Dermatological Biochemistry, Skin Clinic, Director: Prof. Horáček. Thanks are expressed to Dr. Konrad on this occasion.

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## EXPERIMENTAL PRODUCTION OF KELOIDS AFTER IMMUNIZATION WITH AUTOLOGOUS SKIN

M. CHYTILOVÁ, V. KULHÁNEK, V. HORN

In the course of experiments in rabbits, in which the healing of autotransplants during autoimmunization disease produced by injections of autologous skin was studied, among other signs, keloids were found in the scars after autotransplantation. The production of keloids is seen very rarely in veterinary pathology, mainly in dogs and horses, whereas in rabbits it is practically never found [according to consultation with Dr. Vendulka, Clinic of Pathological Veterinary Medical College, Brno].

In the present experiments 14 rabbits were immunized and keloids appeared in four.

### 1. METHODS

#### a) Method of Immunization

A total of 18 rabbits average weight 2.5 kg., 10 females and 8 males, were used. Active immunization was performed in 12, passive in 2, with 4 rabbits serving as controls.

At the beginning of the experiment a piece of skin, 10×4 cm., was taken from the shaved back of each animal under local anaesthesia with 0.5% novocain supplemented by an intramuscular injection of Pentothal (0.2—0.25 g. according to the weight of the animal). The skin was lyophilized and homogenized under sterile conditions. The instrument made by Zdr. Blažek was used as the homogenizer based on the principle of a grater. The blades, finely set next to each other, are located on the upper surface with sharpened grooves cutting across them. With this instrument it is possible to grind the lyophilized skin into a fine powder, whose particles up to 0.2  $\mu$  are retained in aqueous solution. The particles of such homogenized skin contain all the components of skin tissue, including elastic fibres which, during homogenization of fresh skin in the usual glass homogenizer, are obtained only in traces.

The autologous homogenized skin was injected, in increasing doses from 10 mg. up to 40 mg. in the Freund adjuvant, into the femoral muscle of each



rabbit once a week for a period of 5 weeks. After a pause of 4 weeks the entire immunization procedure was again repeated for 5 weeks.

#### b) Transplantation Technique

A week before the beginning of immunization an autograft was grafted on the ear lobe of each rabbit. The skin graft was excised with a circular knife 2.5 cm. in diameter. The skin was raised from the bed and turned 90 to 180° and sutured back into place. The graft was fixed simply with a spray of plastic material. Only two rabbits of the total number scratched off the grafts after operation. In the remaining animals the grafts healed by first intention and in the 3rd week the growth of fur was evident. The scar was linear, scarcely palpable, and only from the reversed growth of fur was the site of transplantation evident. In the 2 rabbits which threw off the graft the wound was allowed to heal by spontaneous epithelization. In the 3rd week the wound was healed with a transparent, level scar.

#### c) Serological Method of Examination

A modified consumption technique with AGC serum was used (serum anti globulinum cuniculosum — guinea pig serum against rabbit globulin). AGC serum was prepared by immunization of guinea pigs with rabbit globulins which were salted out of mixed rabbit sera by saturating with a 50% buffered solution of ammonium sulphate. The globulins were washed, dialysed against running water and lyophilized. The immunization was performed intramuscularly once a week for 5 weeks, the first and last immunization being supplemented with an intracardial injection. The separated serum was inactivated, saturated with rabbit erythrocytes and preserved with merthiolate.

The indirect titre of antibodies against skin in the serum of rabbits with keloids  
(29. 12. 1958).

$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{128}$	$\frac{1}{256}$	$\frac{1}{1024}$	$\frac{1}{2048}$	$\frac{1}{4096}$	$\frac{1}{8192}$	$\frac{1}{16384}$	$\frac{1}{32768}$	Serum of rabbit No
+	+	+	+	+	+	—	—	—	—	—	69
+	+	+	+	+	—	—	—	—	—	—	77
+	+	+	+	+	+	—	—	—	—	—	98
+	+	+	+	+	+	—	—	—	—	—	100
+	+	+	+	+	+	+	+	—	—	—	control

The AGC serum was titrated against tannic acid-coated-erythrocytes sensitized with rabbit globulins and immediately diluted so that it gave positive results up to the tenth degree of dilution in the new titration. A weighed amount of lyophilized homogenized substrate was then sensitized with the test serum, washed, and the consumption of AGC serum estimated. Reduction of titre was determined against tannic acid-coated-erythrocytes sensitized with rabbit globulins. The exact description of the method is presented elsewhere.<sup>12 14)</sup>

## 2. RESULTS

### a) Clinical and Serological Observations

The autoantibodies against skin were then tested at three week intervals and were found only in the third week after the second immunization, that is, 16 weeks after the start. Autoantibodies were found in all immunized animals, but in varying titres.

In the 19th week after the start of immunization the scars on the ear began to change in 4 animals (No. 77, 100, 98 and 69). At first they became swollen, and in a week a ridge was formed rising to 4 mm. above the surroundings, glistening, pink-coloured (Fig. 1), smooth-surfaced, devoid of fur and extremely hard on palpation. In rabbits No. 77, 100 and 98 typical keloid nodules appeared. The keloid mass was the largest and formed typical keloid projections in rabbit No. 99 (which was passively immunized intraperitoneally with a homogenate of spleen cells). Auto-antibodies against skin were found serologically in all the animals. It was interesting that in none of the rabbits was a keloid swelling seen in the scar after excision of the skin on the back.

### b) Histological Findings

Examination of the keloid after autotransplantation of the ear skin was conducted by a histological study of the cross section of the entire ear lobe at the site of transplantation. In addition to haematoxylin-eosin, the staining method after Mallory, the Weigert method for fibrin, Congo red, orcein and colloidal iron after Halle were used for detailed differentiation of the tissue changes.

In the first rabbit (No. 77—187 H) the autograft was well healed, but a marked keloid proliferation of connective tissue occurred in the dermis and subcutaneous region. In the superficial layers close to the epidermis the proliferated connective tissue was quite cellular and contained numerous hair follicles, around which chronic inflammatory infiltration was found. In the deeper layers the connective tissue underwent hyaline degeneration. The cartilage of the ear lobe was unaltered. The walls of the arteries, whether located within or outside the keloid, were thickened, often homogeneous and showed necrosis of the fibrinoid type. The small capillaries also had thickened walls which, however, were swollen and contained mucous substances of a mucopolysaccharide character. The collagen fibres in the entire lobe were considerably damaged. The collagen fibres were split, there was fragmentation, uneven staining and sometimes also disintegration. Even though the severest damage to the collagen was found in the proliferated connective tissue of the keloid, there were also severe changes in

the collagen fibrils in the other subcutaneous tissues of the ear lobe. In the superficial layers of the keloid there was a predominance of swelling of the elastic fibre fragments which in the deeper layers were generally dissolved. Also the elastica of the subcutaneous tissue beyond the keloid as well as the elastica of the skin adnexa was fragmented and usually disintegrated. The lamina elastica interna of the arterial walls was swollen in places with the beginnings of longitudinal splitting; generally, however, it was dissolved in the necrotic mass. In addition to fibrinoid necrosis of the arterial walls, substances similar to fibrin were found in the collagen fibres of the subcutaneous connective tissue, and, hence, it is possible to speak of a fibrinoid degeneration of the collagen. These substances were not found in the connective tissue of the keloid. Staining for amyloid substances was negative, apart from certain artificial findings in the hyalinised connective tissue. (Fig. 2.)

The second rabbit (No. 98—188 H) also had a well healed skin autograft. The subcutaneous tissue proliferated just as profusely as in the first animal. The changes in the subcutaneous tissue, keloid, blood vessels and the other tissues of the ear were similar to the changes in the previous animal. The only difference was that eosinophil leucocytes were found in the inflammatory infiltration around the hair follicles.

In the third rabbit (No. 100—189 H) a marked production of thin as well as thick lamellae of cartilage arising from the subcutaneous tissue were seen at the site of transplantation. The cartilaginous lamellae resulted from the metaplasia of fibroblasts in the subcutaneous connective tissue, and transitional forms between fibroblasts and cartilage cells were seen in the periphery. While elastic fibres were clearly demonstrable in the normal cartilage of the ear, none were found in the intracellular substance, which showed considerable degeneration, or in the newly formed cartilage, indicating that the latter is membranous cartilage. Only in the centre of the larger lamellae of newly formed cartilage did the elastica begin to stain in small areas. The original cartilage of the ear lobe was swollen at these sites, projections into the surrounding tissue were formed, and the cells were degenerated. There were foci of more or less cellular connective tissue between the lamellae of cartilaginous tissue. The ectasia of veins and mainly of lymphatic vessels in the connective tissue was marked, probably resulting from their blockage by the newly formed cartilage. A relatively narrow layer of cellular connective tissue, in which numerous newly formed capillaries and proliferated histiocytes were found, was seen between the lamellae of new cartilage and epidermis. The skin adnexa were found to be missing at these sites in the subcutaneous tissue. The changes in the collagenous fibres in this case were even more severe than in the previous animals. Particularly in the proliferating connective tissue of the autograft fibrinoid substances were found in the collagen fibrils which were often dissolved. The ground interstitial substance was increased at these sites, and mucous substances of the character of mucopolysaccharides were demonstrated in them. The changes in the vessels and elastica of the entire ear lobe were much more extensive than in the preceding case. The intima of the larger arteries proliferated into the lumen of the vessels



and this proliferation was accompanied by splitting of the lamina elastica interna insofar as it was not dissolved.

In the fourth rabbit (No. 69—190 H) extensive newly formed cartilage tissue was seen in the skin autograft. The cartilage was of the same character as in the previous case. Lamellae were found which were sometimes in continuity with the original cartilage of the ear lobe, at other times they were directly in the subcutaneous tissue completely deprived of contact with the original cartilage. In contrast to the previous cases the newly formed cartilage was located in a thick layer of proliferating connective tissue which in places was highly cellular, in other places hyalinised. Hair follicles were not found in the subcutaneous tissue above the new cartilage, and the epidermis in these places was atrophic. Ectasia of the lymphatic vessels, although of lesser degree than in the preceding case, was likewise found in the connective tissue between the lamellae of cartilage. On the periphery of the graft in the proliferating connective tissue an extensive granuloma was found surrounding the remains of the suture material and containing giant cells of the same kind as seen around foreign matter. The changes in the vessels, collagen and elastic fibres, and in the ground substance of the connective tissue within and outside the keloid were similar to those of the previous case.

Severe degenerative changes in the collagen and elastic fibres of the connective tissue, often including disintegration, were seen in the ear lobe of autoimmunized rabbits. Similarly, the changes in the interfibrillary ground substance of the connective tissue as well as the changes in the arterial walls were identical with the findings described in the sensitized animals. Even though it healed per primam before autoimmunization, the autograft behaved quite differently from the other connective tissue of the body. There was a marked proliferation of the subcutaneous tissue in the graft, being of keloid character. While regressive degenerative changes — hyaline transformation with loss of cellular elements — occurred in the older parts of the keloid, the younger areas were highly cellular. The fibroblasts showed marked proliferation and very often they developed into biologically more differentiated chondrocytes which produce the intracellular substance of fibrous cartilage. The non-cellular components of the keloid, the collagen and elastic fibres, as well as the interfibrillary ground substance underwent the same changes as the other connective tissues of the autoimmunized organism, at times to a much greater extent. The hyalinization of the older parts of the keloid is in our opinion a non-specific change dependent on the inadequate vascular supply in the hyperplastic tissue, to which the specific damage of the arterial walls in autoimmunization also contributes.

### 3. DISCUSSION

According to the present state of research on keloids we may say with certainty that though they always appear when the connective tissue is traumatically injured (Largrot et al.),<sup>26</sup> they are a systemic disease in which the local factors, although still unknown today, play their part. It is interesting in our present experiments that keloids did not appear in any rabbit in the scar on the back, occurring only in the transplantation scar in the ear.

The structural changes in the connective tissue which are observed in keloids place this disease in the group of collagen diseases, whose unifying feature is the systemic damage of the connective tissue, especially of its non-cellular components. The basis for this concept was given by Klinge,<sup>16)</sup> and the common term "collagenosa", by Klemperer.<sup>15)</sup> This group includes all diseases in which changes i. e. fibrinoid necrosis and degeneration, are found in the collagen fibres. On the whole they are diseases of unknown etiology which essentially differ from each other in the clinical picture.

During the last 10 years the structure of fibrinoid substance was subject to careful study, histochemically and biochemically. The problem was whether fibrinoid is degenerated collagen of the ground substance of the connective tissue or whether it is deposited material with character of blood fibrin [Gitlin].<sup>8)</sup> New facts have accumulated and it was discovered that the fibrinoid substance is not a chemically homogenous substance but that it is composed of several substances which are deposited, in part, in the vascular wall and, in part, in the connective tissue and which differ from each other in their staining properties [de Brux].<sup>3)</sup> Furthermore, it was found [Vasquez and Dixon]<sup>26)</sup> that fibrinoid of the so-called collagenosa is richer in gamma globulin than fibrinoid of inflammatory effusions which contains more albumins. Further studies confirmed [de Brux]<sup>3)</sup> that fibrinoid is a substance which is deposited between and on the collagen fibres but which can be separated from the fibres by the action of trypsin, revealing collagen fibres. The original concept of Klemperer was thereby considerably altered.

More recently, using fluorescent technique, a number of investigators such as Craig, Gitlin, Coons, Kaplan and others<sup>8, 5)</sup> have shown that fibrinoid in the so-called collagenosis is a precipitate of alpha and gamma globulin with fibrinogen and that it represents the morphological evidence of a previous antigen-antibody reaction. The whole field of research was then shifted into immunology and the so-called collagen diseases into the group of autoimmunization diseases. It appears that the production of keloids will be based on an endogenous immunological conflict. This concept is also confirmed by our experiments where the keloids appeared in rabbits in scars almost 5 months old only when clinical, serological and histological signs of autoimmunization disease were evident. This idea is supported by the findings of other workers. Winkler<sup>2, 7)</sup> produced an allergic response by intracutaneous injections of keloid eluate in patients with keloid disease. The response was not obtained when an eluate of hypertrophic scar was used.

The Third Congress of Plastic Surgery in Paris in 1955, which had as one of its main themes "The Biological and Therapeutic Study of Keloids", had some interesting, though not fully formulated, facts to report which can only now be interpreted immunologically. Morel-Fatio and Pales<sup>22)</sup> observed that production of keloids occurred in a large percentage of Negros suffering from goitre. Today the most recent studies by Blizard et al.<sup>2)</sup> have shown that auto-antibodies were found against thyroglobulin not only in chronic Hashimoto thyroiditis but also in certain cases of myxoedema, cretinism and thyrotoxicosis. Here then is a general disorder of reactivity and adaptation, the result of which can also be keloid formation, indicating an immune reaction as well as auto-aggression in the thyroid. Ducourtioux also reported<sup>7)</sup> that familiar keloids were related to the incidence of goitre in countries where the latter is endemic. If keloids are regarded as an expression of auto-antigen — auto-antibody reaction, it will be necessary to alter some of the therapeutic methods recommended by certain workers, such as the local injection of hyaluronidase into the keloid. By increasing permeability, hyaluronidase can also increase the penetration of antibodies into the vascular walls and tissue fluid and thereby aggravate the condition of the non-cellular components of the connective tissue as a result of the immune reactions, as was clinically confirmed by Krenar.<sup>18)</sup>

Insofar as the use of ACTH and cortisone therapy for keloids is concerned, the reports of various workers differ. Some see distinct improvement in the disease and recommend their administration, especially as a preventive measure in burns (Largot).<sup>19)</sup> According to others the production of keloids is unaffected by cortisone. Clarkson<sup>4)</sup> observed recurrence of keloids after cortisone. Both workers are probably correct. According to the latest studies by Scheiffarth<sup>23)</sup> the production of antibodies is not influenced by ACTH or cortisone. The hormones act on the cellular level of metabolism and through the proteolytic products in the connective tissue. They can, however, at times cause the disintegration of plasma cells in which the antibodies are formed (Ortega, Mellors),<sup>22a)</sup> thus releasing a large amount of antibodies into the circulation and thereby promoting the formation of keloids.

From a therapeutic point of view it will be necessary to revert to substances which inhibit the antigen-antibody reaction and to test them to see whether or not they can, especially in the first stages, affect the formation of keloids. Just as in other auto-immunization diseases, there are also in this field a number of problems to be studied before it will be possible to treat keloids, the Gordian plastic surgeons effectively.

#### S U M M A R Y

In experiments on rabbits the healing of autografts was investigated in the course of autoimmunization disease produced by the repeated injection of lyophilized autologous skin in Freund's adjuvant. In four of 14 rabbits a keloid appeared in the scar after autografting. In all four cases the keloid tissue was demonstrated both clinically and histologically.

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