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# ACTA CHIRURGIAE PLASTICAE

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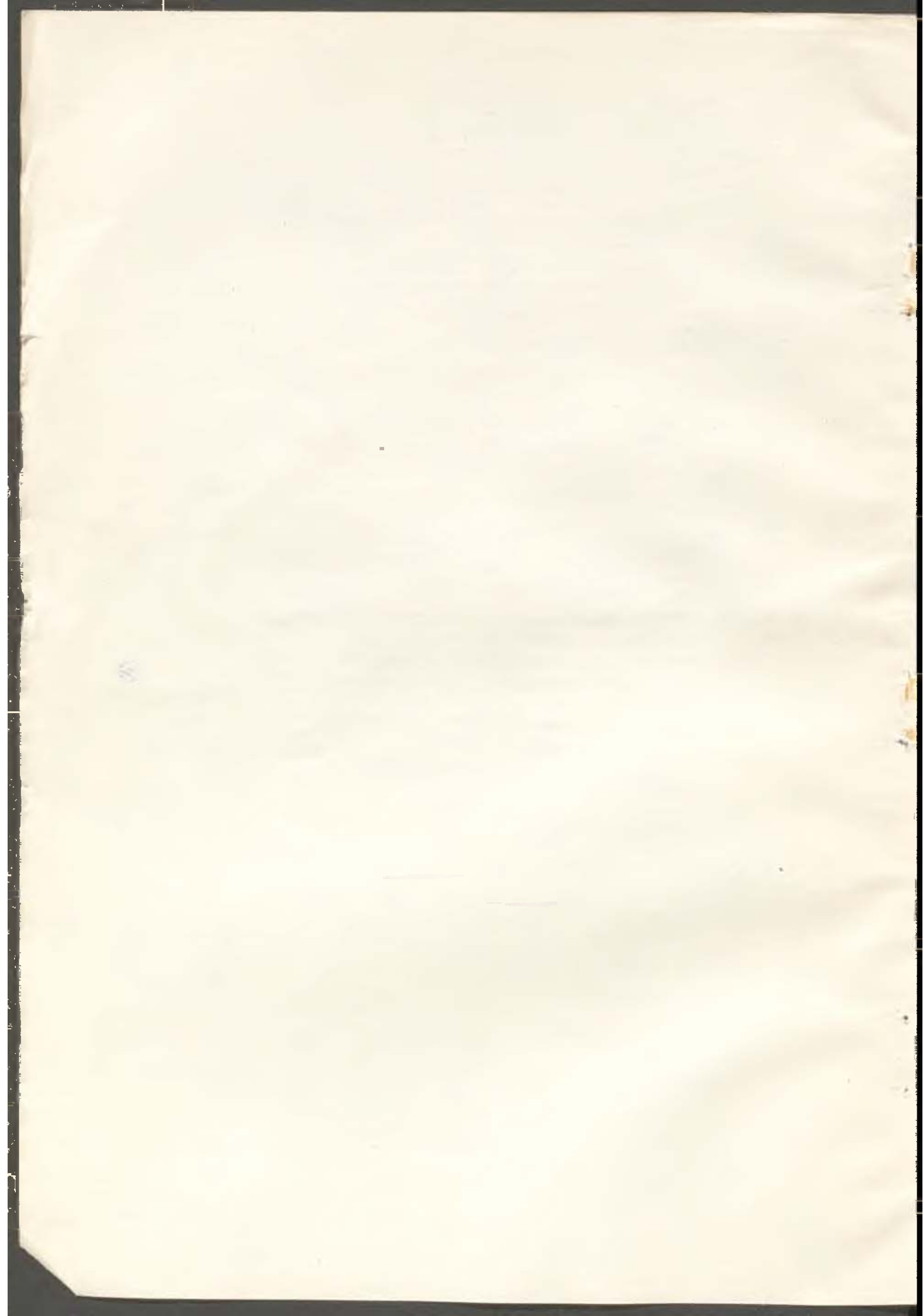
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VOLUME III

1961

CZECHOSLOVAKIA — PRAGUE — SZDN





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## EDITORIAL

### The progress of Tissue Transplantation in Czechoslovakia\*)

Before the First World War in our country as in the majority of countries abroad, transplantation was performed only occasionally in the different branches of surgery. The transplant consisted mainly of small pieces of skin such as Reverdin's grafts or thin dermo-epidermal Ollier-Thiersch grafts. On rare occasions bone grafts were even used either human from a donor or animal bone grafts. As in other countries the results of these operations were but little criticized.

When Orthopaedic Surgery became a separate surgical speciality orthopaedic surgeons started to be more interested in transplants. The true and systematic application of tissue-grafting started after the First World War with the development of plastic surgery. As early as during the First World War and in the treatment of the war wounded, transplantation of skin, bone, cartilage, fat, corium and fascia became a part of routine surgical treatment. Quite soon it became evident that the results of grafting are deeply influenced by numerous factors. Of these the most important are the following: the correct choice of the graft according to the clinical indications of the tissue defect, delicate treatment of both the transplanted tissue and the recipient area during the operation and careful nursing following operation.

We were soon convinced that as far as skin is concerned the best substitute is a full thickness graft.

The quality of such a graft depends on the biological properties of the skin.

Even so perfect, biologically ideal coverage was not achieved for many reasons. First of all the "full thickness" skin graft is not really complete, because the sweat glands are almost completely cut off with the subcutaneous fat as well as a greater part of the sebaceous glands and almost all hair follicles, the tactile endings of the nerves and both, circulatory and nervous connections of the subcorial networks. The subcutaneous tissue, which represents the natural environment of the skin is not transplanted.

The graft further undergoes a very radical change, many of its elements decay and only a part of these regenerates. The graft gets sodden with protein

\*) Delivered as the introductory paper at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.



transudate, the organisation of which causes fibrosis, which in turn leads to permanent changes of the consistency of the graft. Biological reaction of the recipient area also brings some fibrosis and sclerosis depriving the graft of a normal base. The thinner the corium of the graft the more pronounced will be the unfavourable effects of the transplantation (most unfavourable in thin Ollier-Thiersch epithelial grafts).

The clinician meets with still more difficulties in skin grafting, with unsolved problems, such as colour changes and the unfavourable effects of the anatomical and biological incompleteness of the somatic cover provided by the graft as already mentioned above. These facts have great importance in the treatment of severe burns, which sometimes necessitate coverage of 50—60 per cent of body surface mostly by thin-split-skin grafts. The problem of adaptation of the human organism to this state of the skin organ is a subject of research for many of our specialists devoted to the treatment of burns. This problem is also studied by the research laboratory established at the Burns Unit of our clinic in Prague. The increased application of transplantation in clinical treatment led many of our specialists to microanatomical and experimental studies. Early results describing reactive changes in the new bed confirmed that these changes were brought about by the preparation of the bed itself, and are basically of an inflammatory nature; their intensity depends on the surgical trauma during the operation and on the type of graft. The changes are least pronounced in auto-, more in homo-, and reach their maximum in heterotransplantation.

The complex physical, biochemical, hormonal and immunobiological processes are subject of intense research work in our country. Hašek (1953) attained an important fundamental results by successfully inducing some degree of immunological tolerance by connecting the circulatory systems of different chicken embryos. Hašek and the members of his institute have been contributing a constant flow of further experimental studies on immunological tolerance and are already known on an international scale.

The results of other authors seem to indicate that there is no basic difference in the nature of the reactions caused in the recipient by different kinds of grafts. Even auto-grafts can act as antigens and provoke the production of antibodies (Chytilová — 1959).

Autoantibodies were detected by the collodion agglutination method in diseases in which destruction of tissues occurred (Brod - Pávková — 1958); employing the same method Pávková has detected autoantigens to skin in burned patients. Under certain circumstances the reactions in homografts are quite intense; a pathological state of the bed-tissues develops, from which there flows a constant stream of unfavourable irritating impulses to the central nervous system, which return and reach the bed in a form of neurovegetative disturbances.

A "circulus vitiosus" thus develops which terminates with the rejection of the graft. The same effects — but still more pronounced — occur in hetero-grafts. The changes in the bed are of a more intense inflammatory nature (similar to the foreign body reaction) resulting in most of the cases in rejection of the graft

or its gradual disintegration and resorption. As a successful result also we can consider the capsularisation of the "foreign body" that can serve as an "inlay".

Great attention was always paid to bone grafting. In 1930 one of our foremost surgeons J. Knobloch published a clinical and experimental study with an explanation of the processes in the graft and its bed. Many different recent studies have confirmed Knobloch's findings. Bone homografting in carefully selected cases meets with good results in clinical treatment. Orthopaedic surgeons give preference to this method. Cartilage autoplasty is a very profitable sort of tissue for deep transplantation.

Histological and experimental studies confirm the fact that changes in the cartilage graft consist only in an acceleration of its ageing processes (these were found and described by J. Wolf in 1926) i. e. circumscribed asbestosis and calcinosis. The cartilage transplanted with his own perichondrium has a better take than without it (Burian and Soraluce — 1937). In homotransplantation the same basic changes occur, only to a much greater extent than in autotransplantation. Unfavourable results are frequent (30 per cent of the grafts are resorbed). We had no success with heterotransplantation.

Fat tissue graft retains its value as filling material. Experiences we have made led us to prefer a composite fat-corial graft, the best proportions being 5 or 6 : 1 in the thickness.

More solid, fine granulated fat tissue with more fibrous elements (from the buttocks) give far better results and does not shrink with loss in volume in the way that the grossly granulated fat of the abdomen does.

Aponeurosis and tendons are inert tissues with a very small participation of cellular elements and are thus well fitted for transplantation. Their macroscopic appearance remains unchanged following transplantation and their fibrils adapt and orient themselves according to the direction and intensity of traction within the new environment. In hand surgery we use duplicated strips of femoral aponeurosis with a thin layer of fat coverage as very valuable substitution if palmaris tendon is not available. The gliding of the new tendon is thus facilitated.

Only thin tendons are suitable for transplantation, e. g. the tendon of the palmaris longus or part of the extensor of the lower extremity. In thick tendon-grafts central circumscribed necrosis occurs which may inhibit or even prevent a good functional result.

As early as during the First World War I used strips cut out of the femoral aponeurosis for the suspension of the newly formed parts of the face, e. g. the lower lip and chin. These strips were attached to the mimical and chewing muscles which transferred their movements to the newly formed parts.

At the same time I have also used such strips in the treatment of the facial nerve palsy to mobilise the eyelids, cheeks and the lips. I attach these strips to the temporal muscle after having inserted them through both the eyelids. For the mobilisation of the corner of the mouth I sometimes use a combination with the masseter (Burian — 1921).

*All that has been mentioned here shows the general development of tissue transplantation in our country: it shows the progress from early empirical work to basic and experimental research with the clinical application of the results constantly in view.*

*Our final aim it is to resolve the problems of homotransplantation. From the rapid progress of the results achieved it looks as though our aim will be attained. The resolving of this task will lead to immense progres and will act as a strong factor in our efforts to tackle problems of surgical treatment which were hitherto beyond our grasp.*

*F. B.*



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## MORTALITY IN A BURNS UNIT, WITH REFERENCE TO ANTIBIOTICS\*)

T. L. BARCLAY, D. J. CROCKETT, E. WARSHAVSKI

### INTRODUCTION

In the years 1954—1959 inclusive, 862 patients with burns were admitted to the Special Burns Centre at Northwood, Middlesex. Of these, 335 patients had burns of more than 10% of the body surface, and many of these required resuscitation. A total of 168 patients with burns of more than 10% of the body surface were received in the Burns Centre within four hours of the accident and these were resuscitated in the Centre; 167 patients with more than 10% burns were resuscitated elsewhere and transferred to the Burns Centre later, the period elapsing before admission varying from two to twenty-four days, the majority at about seven days. In the whole series of patients there were 104 deaths, i. e. a 16.5% mortality (Fig. 1).

### ANALYSIS OF DEATHS

It is possible to classify the deaths as either unavoidable or theoretically avoidable (Bull and Fisher 1954). Without raising our expectations too high, we can say that death was unavoidable if —

1. There was over 50% whole thickness skin loss.
2. There was over 30% whole thickness skin loss and the patient was aged more than 40 years.
3. There was over 20% whole thickness skin loss and the patient was aged more than 60 years.
4. The patient was aged more than 70 years.

While it is true that occasionally survival of a larger injury than the above has occurred, in our experience it is extremely uncommon.

As regards assessing the probable mortality in partial skin destruction, we have followed Bull and Fisher and given the partial skin loss a value of  $\frac{1}{4}$  of the total skin loss.

Applying these standards, 66 of the 104 deaths were assessed as unavoidable by extent or by age of the patient, and we shall not consider these further. This

\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

leaves 38 deaths (4.4% of the whole) which were theoretically avoidable and these will now be analysed (Fig. 2).

Half of these deaths were due to miscellaneous causes and the other half were due to septicaemia, as proved by the finding of multiple scattered abscesses at autopsy. It is possible that several of the miscellaneous deaths e. g. those due to pulmonary embolus, were also directly due to sepsis.

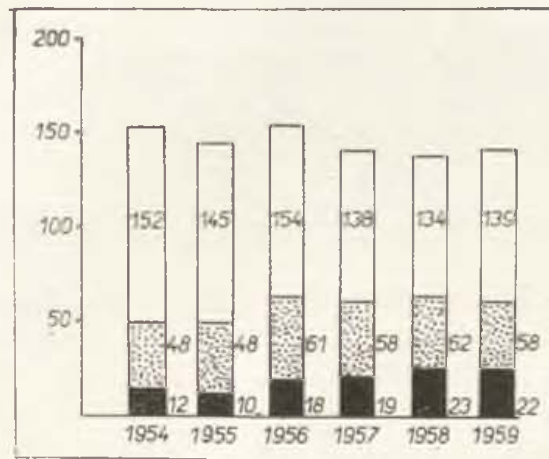


Fig. 1.

It is instructive to make a table of the deaths year by year (Fig. 3). It seems probable that until 1956 sepsis was present but seldom lethal; at some time during 1956 a lethal organism entered the ward and has never been eradicated in spite of closure and repainting, and latterly total cubicalization; we believe this organism to be a type of *Ps. Pyocyaneus*, and this has frequently been cultured from the abscesses found at autopsy, sometimes alone, but often in association with a staphylococcus organism.

Fig. 2.  
Cause of death.

Coronary thrombosis . . . . .	2
Pulmonary burn . . . . .	2
Liver failure . . . . .	3
Anuria (Renal failure) . . . . .	2
Bronchopneumonia . . . . .	3
Pulmonary embolus . . . . .	2
Cerebral glioma . . . . .	1
Disseminated sclerosis . . . . .	1
"No cause found" . . . . .	3
Staphylococcal enteritis . . . . .	1
	<hr/> 20
Septicemia . . . . .	18
	<hr/> 38

## EXPERIENCE WITH ANTIBIOTICS

The average number of antibiotics administered to patients who died of sepsis has been steadily rising over the six year period. It is clear from Figure 4 that in spite of an increasing death rate, the frantic administration of more and more antibiotics to patients who are clinically developing a fatal septicaemia has had no effect at all on the mortality. Indeed, one may suspect that the administra-

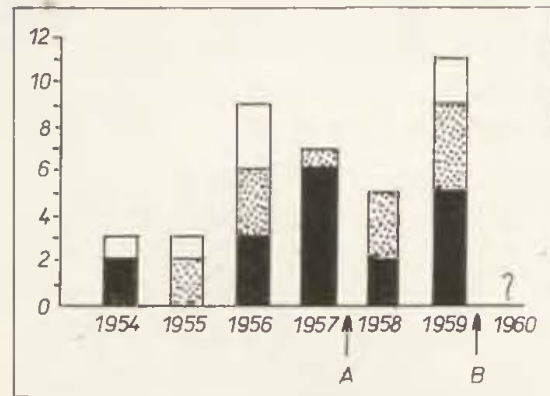


Fig. 3.

tion of high doses of many antibiotics serially and even simultaneously may possibly reduce the patients resistance to his infection, while having no effect on the septicaemia.

We personally incline to the opinion that the pyocyaneus organism has changed its character, and is now more malignant than it used to be. The altered behaviour of the organism may be due to the reduction in the gram positive bacteria on the surface of the patient, consequent on the administration of powerful bacterical antibiotics (erythromycin, terramycin, etc.).

Fig. 4.

Year	Died of proved septicemia		Comparable survivors	
	average % burn	average different antibiotics tried	average % burn	average different antibiotics tried
1954	30%	3 . 5	30%	0 . 75
1955				
1956	33%	2 . 3	24%	1 . 3
1957	39%	2 . 3	28%	1 . 5
1958	38%	5	25%	2
1959	33%	4 . 25	22%	2 . 1

No antibiotics that we have tried have had any measurable success against established gram-negative infection. Neomycin was given intramuscularly to two patients; both these patients subsequently died, with renal failure, but whether this was cause and effect is debatable, as late renal failure does occur in severe burns in some cases. It seems possible that neomycin does affect the pyocyaneus in the blood stream, but has no effect in eradicating the reservoir established in the raw area; this seems probable, because neomycin is uniformly successful in dealing with pyocyaneus in vitro. It is of interest to note that this experience is similar to that of the M.R.C. Burns Research Unit at Birmingham.

It might be emphasised here that all the usual recommended measures are adopted for our burns cases; we give them

Extra vitamins in large amounts, and high calorie diets. They get intensive physiotherapy. We excise full thickness burns whenever possible (up to about 15—20%). We employ homografts as temporary skin cover for very ill patients.

We have highly trained staff in the proportion of one nurse to every two patients. The dressing station is air-conditioned, and full aseptic technique is employed when doing burns dressings.

#### DISCUSSION

This gloomy experience of six years of unselected admissions to a ward of twenty beds set aside solely for burns gives rise to concern. What has our burns unit achieved? It has provided excellent treatment during the early shock phase — there has only been one death as a result of mismanagement of the shock phase in six years. It has provided good care and a reduction of morbidity for the smaller full thickness burns, with early skin cover achieved. It has provided material for research into the physio-pathology of burns, especially a much better understanding of the red cell destruction pattern (this research being directed by I. F. K. Muir, using radioactive isotopes). What has it not achieved? It has not achieved a reduction in mortality; and it has proved to our satisfaction that antibiotics so far in clinical use are no answer to cross-infection in places where burns cases are gathered together. What then is to be done if mortality in burns is to be reduced?

1. The patients can be treated a long way apart. This would either entail a very large scattered burns unit, like a Tuberculosis sanatorium with a very large staff; or the creation of mobile burns teams to tour the country, dressing and operating on cases of burns in the hospitals to which they were originally admitted. Both these solutions would provide administrative problems of great difficulty, and research would be almost impossible.
2. The patients to be treated in Burns Units specifically designed (and staffed) to prevent cross-infection. This is the solution advocated by Dr. E. J. Lowbury in Birmingham. It is not clear just what sort of construction this would entail.

3. The discovery of a safe and effective antibiotic to control gram-negative septicaemia would certainly reduce the mortality. It is almost certain however, that this would provide only a temporary solution, owing to the development of resistance.
4. It is urgently desirable that research should be directed to the discovery of a potent, quick-acting, non-surgical slough remover, which would remove all dead tissue from the surface of the burned patient within a few days (five at the most) and leave a surface suitable for skin grafting. It is also desirable to find a solution to the impermanency of the take of homografts; but in our submission a safe, quick-acting slough remover would achieve our aim, and if all the research now in progress on homografts were switched to the discovery of such a therapeutic agent, the tragic toll of life, especially of previously healthy children, would fall much quicker.

#### SUMMARY

The mortality figures of six years experience of a Burns Centre are analysed.

Antibiotics so far have failed to influence the mortality.

The discovery of a safe, quick-acting, non-surgical, slough remover would be a very great advance in the therapy of burns.

#### ВЫВОДЫ

##### Смертность в станции лечения ожогов, главным образом, при применении антибиотиков

T. L. Barclay, D. J. Crockett, E. Warshawski

Был произведен анализ смертности за 6 лет на основании опыта станций лечения ожогов.

Антибиотики не оказались эффективными в отношении благоприятного воздействия на смертность.

Открытие надежного, быстро действующего нехирургического средства для устранения некроза было бы большим успехом в лечении ожогов.

#### RÉSUMÉ

##### La mortalité par suite des brûlures en rapport avec les antibiotiques

T. L. Barclay, D. J. Crockett, E. Warshawski

Au cours des années 1954—59, 864 malades ont été acceptés dans le service spécial pour les brûlés, dont chez 336 plus de 10 % de la surface du corps était brûlée. Des 103 brûlés qui ont succombés, la mort était inévitable pour 71, et ceci à cause de la grande étendue des brûlures ou bien à cause de l'âge des malades. Chez 33 des succombés, un espoir théorique de survie avait existé (46 %).

On discute les causes de ces issues fatales, dont la plus fréquente est la septicémie, et un rapport sur l'effet presque nul des antibiotiques sur la mortalité est présenté.



## ZUSAMMENFASSUNG

### Mortalität bei Verbrennungen in Beziehung zu Antibiotika

T. L. Barclay, D. J. Crockett, E. Warshawski

In einer Spezialanstalt für Verbrennungen wurden in den Jahren 1954—1959 864 Kranke aufgenommen, von denen bei 336 mehr als 10% der Körperoberfläche betroffen waren. Von 103 verstorbenen Patienten war bei 71 der Tod unausweichlich u. zw. wegen des grossen Umfangs der Verbrennung oder wegen des Alters der Patienten. Theoretisch bestand bei 33 dieser Patienten (46 %) Hoffnung auf Überleben.

In der Publikation werden die Ursachen dieser Todesfälle erörtert, von denen Septikämie die häufigste war. Antibiotika erwiesen sich hier als fest völlig erfolglos in der Beeinflussung der Mortalität.

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## INFLAMMATORY CHANGES IN BURNED SKIN\*)

S. SEVITT

The most important effect of heat inflammation is the excessive permeability of capillaries which allows a protein-rich fluid to exude into the tissue spaces. This communication is concerned with studies on increased capillary permeability, the subsequent local oedema and stasis in the dermal capillary blood in experimental burns.

Circular burns of known temperature and duration were made with a constant temperature burning-iron usually on the shaven abdomen of albino guinea pigs. Capillary permeability and stasis were studied by dyeing the animal's plasma by an intracardiac injection of Evans blue or Brilliant Vital Red. Coloration of the burned skin is due to leakage of plasma albumin with which the dye combines, and indicates an increase of capillary permeability in the dermis (Fig. 1b). The demonstration of capillary stasis is referred to later. Full details of the technique have been given elsewhere (Sevitt 1949 a, b).

### SUBDERMAL TEMPERATURES AND TEMPERATURE GRADIENTS IN THE SKIN DURING BURNING

Before discussing the permeability change a word is needed on the vertical gradient of temperature *within* the skin during burning (see Mendelssohn and Rossiter 1944, Henriques and Moritz 1947, Sevitt 1957).

Subdermal temperature was measured by inserting an hypodermic needle with a thermocouple at its tip into the subdermis. Application of the burning iron to the skin surface is immediately followed by a rapid increase in subdermal temperature (Fig. 2); this is called the unsteady state. The temperature reaches a maximum and is then maintained in equilibrium, the steady state. The difference between the subdermal temperature and the burning (surface) temperature is the temperature gradient. During the early unsteady state the temperature at any level in the dermis rapidly rises as heat is absorbed and transferred to deeper layers. The final steady state indicates equilibrium between gain and loss of heat-saturation.

The nature and duration of the vertical temperature gradient during burning determines the subsequent physiological (and histological) changes at the different levels in the skin.

\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

# MINIMAL PERMEABILITY-PRODUCING BURNS

Various combinations of temperature and duration of burning which just produce an increase of permeability in the dermal vessels are shown in Fig. 3, curve PP. This degree of burning produces only a slight but definite appearance of dye in the burned skin. Coloration is quicker and more intense with more



Fig. 1a.



Fig. 1b.

Fig. 1 a, b. Reactions of increased capillary permeability and capillary stasis and their relation to oedema. Burns at  $62^{\circ}$  for  $\frac{10}{30} \mid \frac{20}{60}$  seconds were made on the guinea pig's abdomen. Fig. 1a shows that gross oedema developed in the lower two burns but was slight in the upper two. — Evans-blue solution was injected 1 hour after burning and figure 1b was photographed 20 minutes later. Dye has coloured the skin of the upper 2 burns which indicates continuation of dermal blood flow through capillaries of increased permeability. The lower burns show narrow coloured rings due to graded vascular damage at the edge of the burned areas which remain erythematous; this indicates that stasis has occurred. Note the association of clinical oedema with subsequent stasis.

severe burns (top 2 burns in Fig. 1b). The minimal permeability response occurred after burning at  $58^{\circ}$  C for 5 seconds,  $54^{\circ}$  for 30 seconds,  $52^{\circ}$  for 60 seconds,  $50^{\circ}$  for 3 minutes and so on. At and below the curve EE, erythema was the only visible evidence of burning. By extending PP to the right to obtain an infinitely prolonged burn, the lowest theoretical burning temperature which produces an increase of permeability is about  $45^{\circ}$  C.

#### THRESHOLD TEMPERATURE FOR PERMEABILITY

The maximal temperature recorded in the subdermis during different burns just producing an increase of permeability are similar. Thus, subdermal temperature between  $41^{\circ}$  and  $45^{\circ}$  C are produced 30 seconds after applying the burning iron at  $54^{\circ}$ , and 60 seconds after application at  $52^{\circ}$ ; whilst the equilibrium sub-

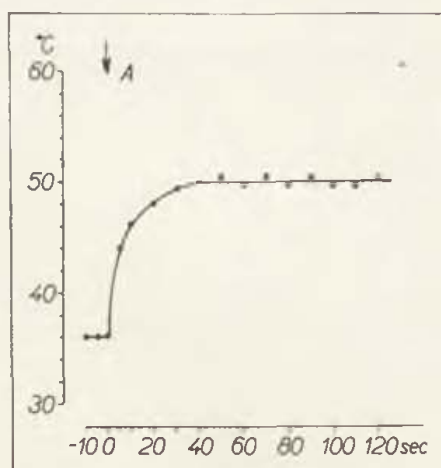


Fig. 2. Serial subdermal temperatures found after applying a burning iron at  $60^{\circ}$  C onto the shaved abdomen of a guineapig. A rapid rise of temperature is followed by a slower rise (unsteady state) and finally a constant temperature of about  $50^{\circ}$  C is reached (steady state).

dermal temperature is  $41^{\circ}$  to  $42^{\circ}$  with very prolonged burns at  $45^{\circ}$  C. This suggests that a threshold temperature between  $41^{\circ}$  and  $45^{\circ}$  C exists to which the dermal capillaries need be heated before they leak abnormally.

#### TIME-TEMPERATURE RELATIONSHIPS FOR MINIMAL PERMEABILITY BURNS

Fig. 3 (PP) shows an almost linear relationship between temperature and duration of burning below  $51^{\circ}$  C and a steep deviation to the temperature axis above  $52^{\circ}$  C. The shape of PP is due partly to the physics of heat transfer through the skin from the heated surface (heat capacity, heat conductivity, heat gain versus heat loss) and partly to the rates of injury and recovery of heat-injured cells. In prolonged "low" temperature burns the temperature of the sub-epidermal capillaries reaches a steady maximum but the time required to increase capillary permeability is much greater than the duration of the unsteady temperature state. This accounts for the almost linear relationship with burning temperatures below  $51^{\circ}$  C. Below about  $49^{\circ}$  C injury to the capillaries depends considerably on time; injury is produced so slowly that the rate of cellular recovery becomes significant and very prolonged heating is needed to produce an increase of permeability.

With burning-iron temperatures above  $52^{\circ}$  C the temperature of the subdermis rises steeply after the burning-iron is applied. The burning period required to attain steady maximum temperatures in the dermis becomes shorter and shorter

as the burning temperature rises. At the higher burning temperatures, the rise of temperature within the skin (unsteady state) is quick whilst injury can be produced by burning periods too short to produce a steady temperature state within the dermis. The period needed to produce a permeability change in the capillaries is now often less than that of the duration of the unsteady state or if not, the latter is a large fraction of the whole burning period. As the

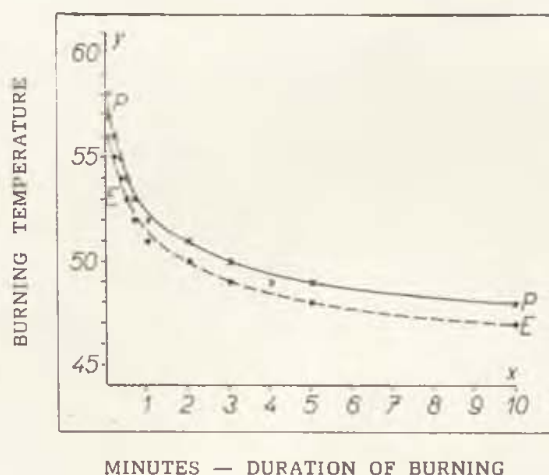


Fig. 3. The minimal temperatures and periods of application of the burning iron which just produce in guinea pigs an increase of permeability in dermal capillaries (PP). At and below EE erythema was the only visible evidence of burning.

burning temperature rises the curve PP therefore deviates more and more from its relationship at lower temperatures and rises sharply towards the temperature axis. This is accentuated by the fact that at these temperatures the rate of production of injury to cells more and more exceeds their rate of recovery.

#### EARLY AND DELAYED INCREASE OF PERMEABILITY

Increase of capillary permeability is of two kinds, *early* and *delayed* according to the time of onset after burning. The skin usually becomes coloured within a few minutes of burning — early permeability — when dye is injected before burning. However in less severe burns the dye may not appear in the skin for 30 to 60 minutes or longer. Experiments involving a delayed injection of dye after burning have reduced or abolished this delayed appearance of the dye and have shown that the delay is due to a retarded leakage from the capillaries (Sevitt 1954, 1958). Both the early and delayed kinds of permeability change usually occur in the same burn, the later change merging into and supplementing the early effect. The delayed effect can be separately demonstrated in the dermal capillaries of skin subjected to minor burns and in the subcutaneous tissue after more severe burns. Experiments in guinea pigs have shown that the permeability change after severe burns first affects the dermal and subdermal vessels and later extends to the capillaries of the panniculus carnosus and then to the sub-pannicular fat. In general, the delayed permeability effect extends more deeply



the more severe the burning. The superficial capillaries may also be affected unless they are already maximally permeable from the early increase of permeability. The delayed effect is also manifest at the edge of the burn; the dye-stained area is at first localised to the site of application of the burning iron but within an hour or two it extends peripherally for 1—3 mm. and more in severe burns. This explains the enlargement of burns with time, seen in clinical practice.

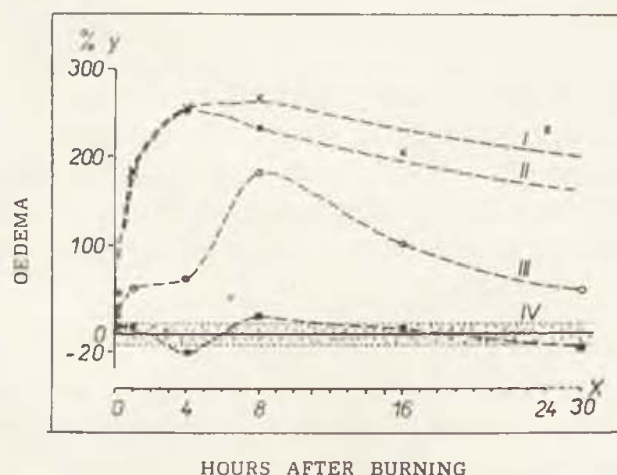


Fig. 4. Rate of formation of oedema in experimental guinea pig burns at 60°C for 5, 10, 30 and 60 seconds. These are curves IV, III, II and I respectively. Degree of oedema or added-water is given as the percentage of the mean water content of normal guinea pig skin. Each point is the mean of observations on excised portions of 12 to 18 burns. The horizontal shaded area is the standard deviation of the water content of normal skin.

#### EARLY AND DELAYED OEDEMA

Oedema may also occur in 2 stages, early and later. This was demonstrated by measuring the degree of oedema in standard burns on a series of animals at different times after burning using the wet-weight: dry weight method. The animals were killed at various intervals after burning (0 to 30 hours) by exsanguination under anaesthesia. Known areas of burned skin were excised by cutting close to the sides of a square of plastic applied to surface of the burn whilst the depth of the excision was standardized by cutting down to and through the panniculus carnosus. The excised tissue consisted of dermis, subdermis and panniculus carnosus. Desiccation to constant weight was done over phosphorus pentoxide. The degree of oedema was calculated from the water content per cm.<sup>2</sup> of excised skin. For further details of the method see Sevitt, 1958.

The evolution of oedema in burns of increasing severity is shown in Fig. 4. The four curves (I to IV) represent changes in the water content of the skin and subdermal tissue after burning at 60°C for 5, 10, 30 and 60 seconds. Oedema or added water is expressed as a percentage of the mean water content of normal skin which is placed at zero.

The burn at 60° for 5 seconds (curve IV) showed little or no oedema at any time, perhaps a slight amount developed at between 4 and 8 hours after burning. Experiments with Evans-blue injected into the blood stream showed that capillary

permeability had increased and therefore the fluid leaking into the dermis must have been removed about as quickly as it appeared.

The burn at 60° for 10 seconds (curve III) is of special interest. It showed an early increase of water content (50% to 60% above normal) at 1 hour with little further change at 4 hours; then there was a considerable increase of oedema water amounting to 180% above normal at 8 hours. In this burn the oedema is evidently of two kinds, *early* and *delayed*. The delayed or later oedema is of special interest and is consistent with the later onset of capillary leakage as detected by the dye-technique.

The burns at 60° for 30 seconds (curve II) and 60 seconds (curve I) showed a rapid onset of considerable oedema which was maintained for a considerable time. In burns of this severity it is difficult to distinguish the early oedema from that developing later since they merge into each other. It is likely however that part of the later oedema had developed from newly permeable capillaries and part from those affected earlier.

#### CAPILLARY STASIS

After severe burning (short of heat necrosis) many capillaries become freely permeable and exude fluid rapidly. The erythrocytes which flow along the minute vessels become more and more concentrated and, as the capillary resistance increases, the local blood flow becomes grossly retarded. This commonly ends in cessation or *stasis* of the flow associated with blockage of the capillaries and venules by tightly packed masses of red cells.

In experimental animals continuation of the dermal blood flow or the development of stasis can be demonstrated by injecting Evans blue or other dyes at different times *after* burning. When blood continues to flow through excessively permeable capillaries the whole burned area becomes coloured by the dye. If stasis has occurred dye cannot enter the burned erythematous area but a narrow coloured rim due to graded vascular damage appears around the edge of the burn (lower burns in Fig. 1 b). The changes in the same burn at different times were studied by first injecting the red dye and later the blue dye. The times of onset of stasis were evaluated in burns of differing severity. Stasis may set in hours, minutes or seconds after burning the interval decreasing as the severity of burning increases until it develops within the burning period.

#### STASIS AND OEDEMA

Correlation of the evolution of burns oedema with the state of the dermal circulation has shown that oedema is related to retardation of the capillary blood flow and to the rapidity of the development of capillary stasis. Oedema is absent, minimal or considerably delayed when stagnation and stasis do not occur; but it develops rapidly and abundantly when the capillary blood flow becomes retarded, then stagnant and finally static.

The results of a series of experiments are shown diagrammatically in Fig. 5. The evolution of oedema in burns of increasing severity is correlated with the state of the local dermal circulation as found by the dye-technique. Burning temperatures ranged from 53° to 61° C and each burn lasted 1 minute.



Burning at 53° C for 1 minute increased capillary permeability but neither oedema nor capillary stasis were detectable and the local capillary circulation remained intact.

With burns at 55° C for 1 minute capillary permeability was increased and a little oedema developed between 1 and 2 hours after burning but it lasted only

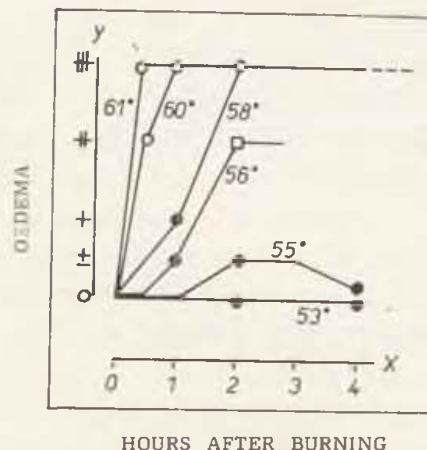


Fig. 5. Evolution of oedema in experimental burns on the guinea pig. The diagram summarizes the results of a series of experiments. The burns were standardized but varied from minor ones at 53° C just capable of producing capillary permeability to severe ones at 61° C short of producing quick heat coagulation. All burns lasted 1 minute.

● = increased permeability without stagnation or stasis on capillary flow of the skin  
 □ = stagnation of capillary flow in the skin — ○ = stasis of capillary flow in the skin.

a short time. Cyanosis developed in the burn erythema and indicated some slowing of the dermal capillary blood flow but neither stagnation nor stasis were detectable.

After burning at 56° for 1 minute, early oedema was absent and oedema was not detectable until about an hour after burning; at this time cyanosis of the burn erythema indicated some slowing of the capillary flow but the local circulation continued. During the next hour, oedema rapidly increased (delayed oedema). The dermal capillary circulation was now found to be slowed (stagnant) but this had not involved the deeper vessels which had become excessively permeable.

With burns at 58° for 1 minute, both early and delayed oedema were more prominent, the delayed form merging somewhat with the early kind; stasis had occurred between 1 and 2 hours after burning but not earlier.

With burning temperatures at 60° and 61° for 1 minute there was a very quick onset of considerable oedema which reached its maximum within ½ to 1 hour of burning; stasis developed within the first hour after burning.

#### DISCUSSION

The local effects of burning especially increased capillary permeability and capillary stasis are closely related to the duration and nature of the vertical gradient of temperature in the skin during burning. In other words the nature

of the inflammatory reaction and its depth within the skin are determined by the temperature attained at the various horizontal levels within the skin during burning and the time to which each level of skin is exposed to the temperature reached. Other local effects including the protein concentration in the exudate, the depth of dermal necrosis and the subsequent mode of healing are also determined in this way, but these aspects cannot be considered here. This does not mean that the various effects cannot be influenced by subsequent events including therapy.

The critical temperatures at which cell-injury like increased permeability occurs, depends on the exposure time; and the exposure time depends on temperature but the correlation between these is not simple.

Time of heating is particularly important with minor burns at lower temperatures even if the complicating effect due to the skin gradient of temperature during burning is neglected. This is probably because injury to protoplasm is slow and is opposed by recovery of cellular metabolism. The net effect is determined by the balance between the rate of cellular injury and the rate of recovery. The exposed cells are not necessarily equally affected. There is evidence (Moritz 1947) that a proportion of the cells are first affected, the remainder being normal. The proportion increases with an increase in the severity of the insult. In these "low temperature" burns the temperature gradient during burning determines the depth of skin affected by an increase of capillary permeability. The more prolonged the burn the deeper the effect; but depth of effect is limited by the poor heat conductivity of skin which prevents the threshold temperature for permeability change being reached deep to a certain level.

With burns of higher temperature the time of exposure needed to produce superficial skin changes is less important. Injury is now so quick that all recovery during burning is impossible. Increasing the time of burning increases the severity of superficial skin changes and determines the depth to which these and lesser changes occur deeper within the skin. This is because small increases in the duration of burning now considerably increase the temperature at the different levels within the skin.

The development of capillary stasis in a burn is also closely related to the time and temperature of burning but this is a more severe injury and is usually irreversible. The critical or threshold temperature to which the dermis must be heated before stasis can occur is several degrees higher than that needed to just produce an increase of permeability; the shape of the curves of the time-temperature relationship are similar though that for stasis is at a higher level.

Increase of capillary permeability and development of vascular stasis may develop either soon after injury or may be delayed. Delayed permeability is not related to delayed capillary stasis. On the contrary, stasis whether early or delayed depends on severe heat damage to capillary endothelium and is preceded by an early onset of capillary permeability. It is always preceded by a period of excessive capillary permeability during which oedema accumulates (Fig. 1 a, b). The speed of onset of stasis is directly related to the severity of burning; stasis sets in sooner after more severe burns and later after less severe burns. When

stasis does not occur the excessive endothelial permeability passes off within hours and the capillaries return to normal. Thus the reversibility or otherwise of capillary damage depends to a large extent on whether or not capillary stasis sets in, since this is generally irreversible and leads to ischaemic necrosis of the skin.

Although the early and delayed increases in capillary permeability have similar effects they are likely to be mediated in different ways. The early permeability change must be the result of a direct physical or physicochemical effect of heat on capillary endothelium possibility involving surface lipids and lipo-proteins. It is analogous to other cellular effects produced directly by heat (see Sevitt 1957). Its reversibility or otherwise as noted above largely depends on the absence or development of capillary stasis. The delayed effect may be quite different in pathogenesis because it could be provoked by chemical or neurochemical intermediaries released by heat-damaged epithelial or other cells. This lays the theoretical basis for ameliorating the inflammation of burns by chemical means. The discovery of chemical agents which could antagonise or neutralise the substance(s) provoking delayed permeability might be of clinical value. The delayed and often prolonged capillary leakage might be prevented or reversed and the oedema of burns reduced.

Finally the biphasic nature of inflammation found with burns has also been shown to occur in other forms of acute inflammation so that chemical intermediaries in inflammation are likely to be a general phenomenon and their antagonism a general advantage.

#### SUMMARY

Capillary permeability, capillary stasis and oedema have been studied in depilated skin of guinea pigs subjected to burns of known temperature and duration. Permeability was indicated by coloration of the burn after injecting into the blood Evan's blue or brilliant vital red dyes. Burns were produced in which increased capillary permeability just appeared and a curve relating time and temperature of the burns was established. A comparison of the subdermal temperatures measured in the course of exposure to heat showed that a minimal or threshold temperature was necessary for increased capillary permeability. Capillary stasis was also demonstrated by the dye technique (uncolored but erythematous burnt surface surrounded by a narrow colored zone). Capillary stasis was found in more severe burns and made its appearance several hours to several minutes after burning. The interval is shorter the more severe the burn. The threshold temperature above which capillary stasis appears was calculated. Burns accompanied by much oedema are those in which capillary stasis develops. Early and late forms of oedema were distinguished by measuring the amount of oedema in the skin of standard burns at different times after injury. The dye technique showed that both types of oedema and capillary stasis, which also appears early or late, are inter-related.

It is concluded that the two forms of permeability and oedema have a different genesis. The late form may be produced by chemical products which form in the burnt skin or exudate.



## ВЫВОДЫ

### Воспалительные изменения в коже после ожога

S. Sevvitt

Изучались изменения проницаемости капилляров, далее вопросы, касающиеся застоя в капиллярах и отека при небольших ожогах, вызванных на коже морских свинок, после предварительной депиляции, при известной температуре и продолжительности. Проникновение белков плазмы из капилляров определялось прижизненной окраской (синь Эванса и бриллиантовый красный). Были вызваны именно такие ожоги, при которых только появилась или еще не появилась повышенная проницаемость капилляров и были построены кривые зависимости от времени и температуры образования такого состояния. При сравнении с данными подкожной температуры, измеряемой во время ожога, оказалось, что для повышения проницаемости капилляров требуется минимальная, иначе говоря, пороговая температура. При помощи окраски была также выявлена фаза застоя в капиллярах (неокрашенный, но покрасневший очаг обожженной поверхности, окруженный узкой окрашенной полоской). Застой в капиллярах был установлен при более тяжелых ожогах и он может возникнуть через несколько часов или минут после травмы. Интервал тем короче, чем более серьезным является ожог. Была вычислена температура, которая представляет собой порог, при котором начинается застой в капиллярах. Ожоги, сопровождающиеся значительным отеком, представляют собой такие ожоги, при которых наступил застой в капиллярах. Были распознаны быстрая и запоздалая формы отека путем измерения количества отечной жидкости в коже при стандартном ожоге. При помощи метода окраски было установлено, что быстрая и запоздалая формы отека и проницаемость капилляров, возникающая быстро или с запозданием, находятся во взаимной связи.

Из вышеприведенного можно сделать выводы, что обе формы отека имеют разный патогенез; форма, возникающая с опозданием, может быть обусловлена химическими продуктами, которые в течение этого времени образуются в обожженной коже или в экссудате.

## R É S U M É

### Recherches sur les altérations inflammatoires des brûlures cutanées

S. Sevvitt

Les changements de la perméabilité capillaire, de la stase capillaire et l'oedème ont été étudiés au cours de petites brûlures, effectuées sur la peau du cobaye, la température et la durée étant connues. La pénétration des protéines plasmatiques des capillaires a été étudiée à l'aide des colorants vitaux (Bleu d'Evans et Rouge Brillant). Il y avait formation de brûlures où une augmentation de la perméabilité commençait à peine à se manifester, ou bien ne s'était pas encore développée, et la courbe des corrélations du temps et de la température nécessaires pour la formation de cet état a été construite. La comparaison des températures subdermiques, déterminées au cours de l'effectueement des brûlures, a démontré le fait qu'une température minimum ou de seuil est nécessaire pour augmenter la perméabilité capillaire. La stase capillaire elle-aussi a été mise en évidence à l'aide d'une technique de coloration (des foyers non-colorés, mais érythémateux de la surface brûlée, entourés d'une brodure colorée étroite). La stase capillaire a été constatée lors des brûlures plus graves et peut débiter des heures ou des minutes après l'accident. Au fur et à mesure que la brûlure s'avère plus grave, l'intervalle est plus courte. La température du seuil pour le développement de la stase capillaire a été calculée. Des brûlures accompagnées d'une oedème considérable sont de telles brûlures où une stase capillaire

s'était développée. Une différenciation des formes rapides et retardées de l'oedème a été obtenue à l'aide des déterminations de l'importance de l'oedème cutané, lors des brûlures standards. On a pu démontrer, par la méthode de coloration, que les formes de l'oedème rapide et tardive et la perméabilité capillaire prenant naissance rapidement ou lentement, présentent des rapports réciproques.

On peut donc déduire de ce qui vient d'être exposé que ces deux formes d'oedème présentent une pathogénese différente; la forme tardive peut être déclenchée par des produits chimiques qui se sont formés entre-temps au niveau de la peau brûlée ou dans l'exsudat.

## ZUSAMMENFASSUNG

### Das Studium entzündlicher Veränderungen in der verbrannten Haut

S. Sevvitt

Es wurden die Veränderungen der Kapillardurchlässigkeit, kapillare Stase und das Oedem bei kleinen, auf der epilierten Haut des Meerschweinchens bei bekannter Temperatur und Dauer hervorgerufenen Verbrennungen verfolgt. Der Austritt von Plasmaeweißkörpern aus den Kapillaren wurde durch Färbung mittels vitaler Farbstoffe (Evans-Blau, Brillant-Rot) festgestellt. Es wurden Verbrennungen hervorgerufen, bei denen sich gerade eine erhöhte Kapillardurchlässigkeit zeigte oder noch nicht auftrat. Es wurde eine Kurve der Abhängigkeit dieser Phänomene von Zeit und Temperatur dargestellt. Der Vergleich von subdermalen, im Verlaufe der Verbrennung gemessenen Temperaturen zeigte, dass zur Steigerung der Kapillardurchlässigkeit eine minimale oder Schwellentemperatur notwendig ist. Die Kapillarstase wurde ebenfalls mittels einer Farbtechnik festgehalten (ungefärbter, jedoch erythematöser Verbrennungsherd, umgeben von einem schmalen gefärbten Saum). Kapillarstase wurde bei schweren Verbrennungen vorgefunden und kann innerhalb Stunden oder Minuten nach dem Unfall eintreten. Das Intervall ist desto kürzer, je schwerer die Verbrennung ist. Es wurde der Temperaturschwellenwert errechnet, bei dem die Kapillarstase beginnt. Verbrennungen, die von einem bedeutenden Oedem begleitet sind, sind Verbrennungen, bei denen es zu einer kapillaren Stase kam. Eine Unterscheidung einer raschen und einer verspäteten Oedemform wurde durch Messung der Oedemflüssigkeit in der verbrannten Haut bei Standardverbrennungen durchgeführt. Die Färbmethode erwies, dass die rasche und die verspätete Oedemform, sowie die rasch oder verzögert eintretende Kapillardurchlässigkeit in gegenseitiger Beziehung stehen.

Aus diesen Ausführungen kann geschlossen werden, dass beide Oedemarten eine unterschiedliche Pathogenese haben; die spät eintretende Art kann durch chemische Produkte hervorgerufen werden, die sich inzwischen in der verbrannten Haut oder im Exsudat gebildet haben.

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## THE TREATMENT OF BURNS IN YOUNG CHILDREN\*)

D. N. MATTHEWS

This paper is based on two hundred and fifty cases of burns treated in twelve years at the Hospital for Sick Children. About half were admitted direct from the scene of the accident and the rest were transferred from local hospitals between one and five days afterwards. The problems in these are often very different from those received at once. The commonest causes of burning were flame and scalding with water or fat. Other children received contact burns from hot objects and a few were burnt by electric current. Their ages ranged from one day to thirteen years.

To deal first with those received direct from the accident. The first requirement is to deal with shock and in my experience this is easier in children than in adults. Analgesics and sedatives must be given at once since fright and fear are powerful adjuncts to pain in causing deterioration. In young babies nepenthe by injection is ideal. In older children heroin is in my opinion best but morphia is a good substitute provided it is given in large enough doses and often enough, and it is not dangerous if the respiration rate is not allowed to fall below 14 per minute. Later phenobarbitone can be substituted in all ages and is very well tolerated.

For intravenous fluids I start with a polysaccharide (dextravan) and change over to blood as soon as it has been matched. The need for intravenous feeding is not so great as in adults since the child nearly always clamours for fluids by mouth and tolerates them well. The surface area burnt is the most reliable guide to the amount needed and the table introduced by Wallace for the calculation of the percentage of the surface burnt makes this easy to estimate. Children rarely need intravenous feeding if less than 15% of the body surface is damaged despite a high initial haemoconcentration. I calculate the total fluid requirement for the first twenty-four hours on the formula 2 ml. per kilo body weight per percentage burnt. For the second twenty-four hours the formula is 1.5 ml/kilo body wt./percentage burnt. I agree with Wallace that when intravenous feeding is required half the total requirement of the first twenty-four hours should be given in the first eight hours.

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\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.



In burns which are mostly, if not all, obviously superficial, I give one quarter of the intravenous requirement for the first twenty-four hours as whole blood and no blood on the second day. In obviously deep burns half the requirement of the first twenty-four hours is whole blood and sometimes a quarter of that for the second twenty-four hours too. I never continue with intravenous feeding in order to bring the haemoconcentration or the haematocrit right back to normal since to do so inevitably means giving too much. I use these tests merely to gain information as to whether haemodilution has started to occur. The decision about discontinuing intravenous feeding should, in my opinion, always be a clinical one in which the return of urinary secretion, the lowering of the pulse rate and the elevation of the blood pressure are the most valuable clinical signs. In my opinion oxygen is not required in the treatment of burn shock in children unless there is inhalation of flame or smoke or unless the child was in bed suffering from a respiratory infection at the time of the accident. This is not infrequently the case.

Similarly, cortisone has no place in the treatment of burn shock in children and can be harmful, though it is sometimes very valuable later in the management of extensive cases as will be discussed.

I believe that infection is a much more serious hazard to life in extensive burns in children than shock. It is a killer. I believe, therefore, that every possible step should be taken from the start to avoid it. This means the commencement of parenteral chemotherapy as soon as possible. I avoid needle pricks and rely on the oral route usually giving tetracycline as an elixir, but penicillin by mouth can be equally satisfactory.

In order to avoid infection, and for other reasons besides, I use the exposure method of treatment whenever possible and it has very few limitations in children. The child must be nursed in a room at 74° Fahrenheit, and in a single room until the coagulum has formed. This may take up to thirty-six hours. The child is placed on a clean sheet and a sheet is suspended over it like a tunnel, being open top and bottom. Even young children object to lying naked and ask to be covered. The child is positioned so that there is no pressure on the burnt surfaces. This may necessitate the ingenious suspension of limbs from a Balkan beam or the cot sides and in burns of perineum, buttocks and back a gallows splint is ideal and very well tolerated. The advantages of securing a coagulum are so great that I attempt it and almost always succeed even in circumferential burns of the trunk. For these I use a Streicher turning frame, moving the child every few hours. Burns of the neck sometimes present difficulties of positioning, but they can usually be handled by extending the child's neck over a pillow. Once the coagulum has formed the child can be allowed to move freely; it can sit out of bed or walk about. It is no longer in pain or in negative nitrogen balance; it does not lose weight and above all it does not lose skin from superadded infection.

During the time the coagulum is forming the whole success of the technique is dependent upon the skill of the nurse in comforting, diverting and amusing the child whilst at the same time maintaining its posture. This is arduous work

and if the child demonstrates its confidence in one particular girl she must serve it as long as is necessary no matter how tired she is. It often happens that the child's choice falls on the junior nurse, perhaps because she is not so much older than the child itself. Once the coagulum has formed the nursing is easy and not time consuming.

I find it impossible to treat the burnt hand of an infant by exposure as I have been unable to devise a satisfactory means of doing so without the child being able to suck the fingers. Older children will co-operate. In infants, therefore, I enclose the hand in a bulky boxing glove dressing with interdigital pads. This is left in place for about ten days when it is taken down under anaesthetic and dealt with surgically as is appropriate to its depth.

If the epithelium is only partly destroyed by the burn the coagulum peels between the tenth and fifteenth day and the area is found to be healed. If the coagulum has showed no sign of peeling by this time it is safe to assume that the full thickness of the epithelium has been destroyed. The child is then anaesthetised and the coagulum removed and replaced by skin grafts. For this purpose the electric dermatome is supremely valuable. Set at its maximum opening it will remove the coagulum at an even depth rapidly and with little loss of serum or blood. The grafts are cut equally quickly with the same instrument and the whole procedure is so rapid that the child stands it well.

When the extent of the burn is very great it may be impracticable to deal with it all at one operation, and in some even partial replacement has to be supplemented with homografts from the skin bank. In such cases autogenous and homografts are applied alternately to provide the maximum number of permanently surviving islands of skin scattered as widely as possible over the denuded surface.

Children admitted between one and five days after burning have usually had shock therapy locally and some are in good condition, requiring no special measures. Others, however, are admitted dehydrated and vomiting. These have usually passed into a state of severe acidosis and if this has been allowed to persist are uraemic. They then rapidly become delirious and comatose. The anuria may lead the inexperienced to persist with intravenous shock remedies when the blood urea very quickly rises to an enormous concentration and the child will die. If the condition is recognised and correct treatment initiated, however, even apparently hopeless cases can survive. Intravenous therapy must be discontinued and a continuous intragastric drip feed be started, feeding through a polythene tube passed via the nose. The amount of fluid given is only sufficient to replace the extra renal loss and the calorific intake is secured by carbohydrate and fat. Biochemical assay of the electrolytes determines how much of these is needed. Once their levels have been restored to normal no more is needed since the continuing loss of electrolytes is minimal in this condition unless the child vomits. In this case the vomit can be filtered and fed back via the tube.

This regime may have to be continued for as long as three weeks before the kidneys recover. Incidentally, if the onset of the acidosis had been recognised by the stertorous breathing and confirmed by estimating the alkali reserve, the

subsequent catastrophe might well have been avoided by giving the child  $\frac{1}{6}$  molecular sodium lactate intravenously. So great is the tendency for young burnt children to go into a state of acidosis that it is my routine practice to have a drachm of bicarbonate of soda added to every glass of fluid they drink during the first forty-eight hours.

Children who are transferred to a children's hospital in a uraemic state are usually found to be covered in tight soggy bandages and are always infected. Removal of these bandages is an urgency and it is pleasing to see how often a satisfactory coagulum can be formed despite this unfavourable start. It is always worth trying and it is justifiable in such circumstances to use antibiotics locally as well as parenterally. If the attempt fails non-adhesive dressings and bandages, changed as often as the conditions demand, are the best alternative. I always use rectal pentothal for these dressings, the dosage being one gramme/fifty pounds body weight. The theoretical possibility that the pentothal may have an adverse effect on the liver in the burnt child does not take place.

By the time the infection has been controlled and the sloughs are away the granulations are slow to form and the child exhausted, lethargic and anaemic. Transfusions of packed red cells are very valuable, but despite them the condition of the child may be critical. It is suffering from adrenal exhaustion and it is at this stage that cortisone has an effect which is little short of miraculous. It is needed for only a few days when the child can be weaned from it, substituting A.C.T.H. pro tem. Within two weeks the child is usually quite fit enough to have the areas grafted and the short course of cortisone has not, in my experience, any adverse effect on the take of the grafts.

With regard to rehabilitation and subsequent plastic repair, there are a few special points in the treatment of children which merit mention.

The first is that when exposure is used there is no reason why the child should not start to move as soon as the coagulum has formed. Occasionally a small crack appears in the coagulum over a joint which necessitates immobilisation for twenty-four hours until it is sealed again, but this is rare. An experienced physiotherapist is therefore an essential member of the team from the start. The child's confidence in her is a most important factor in its ultimate recovery. First attempts at movement must be painless and small regular dosage of the child with phenobarbitone often helps the physiotherapist in the early days.

The second important point is that the powers of functional recovery in children are limitless, provided enough time and trouble are taken. There should not, therefore, be any hurry to start definitive plastic repair with its inevitable restrictions of the child's activities. Time is not so important as in an adult and the advantages to be gained by delay are much greater. I therefore advocate that the child should be given a long convalescent holiday as soon as the burns are healed and it is well enough to enjoy it. During the holiday it must, however, have uninterrupted skilled physiotherapeutic direction and should be encouraged to follow its normal pursuits including sea bathing. If this is done it will be surprising how much less definitive repair is ultimately needed than was first feared. When definitive repair is planned it is well to remember that split skin



grafts often do well in children in situations where, in adults, there would be no escaping more tedious repairs with pedicle flaps.

Finally, I have not found the immediate excision of a burn in a child to be practical except in the small deep lesions which are sometimes seen following contact with hot objects, or from the short circuiting of an electric fitting. In these it is highly satisfactory. The surface area burnt is so small that shock is not a problem, and the operation can safely be carried out as an emergency upon admission to hospital.

#### S U M M A R Y

The author deals with the treatment of 250 children with burns in the London Hospital for Sick Children. He is specially concerned with the problem of dealing with shock in burns and with the choice of methods for local treatment. The survey also gives the author's observations from many years of experience in reconstructive surgery and rehabilitation of children with burns.

#### ВЫВОДЫ

##### **Лечение пострадавших от ожога детей младшего возраста**

D. N. Matthews

Автор разбирает лечение 250 пострадавших от ожога детей в педиатрической больнице в Лондоне. Обсуждает специальную проблему лечения ожогового шока и выбор метода локального лечения. В статье сообщен опыт долговременной реконструктивной хирургии и восстановительной терапии детей пострадавших от ожога.

#### R É S U M É

##### **Le thérapie des brûlures graves chez les enfants**

D. N. Matthews

L'auteur analyse les résultats thérapeutiques obtenus à „Hospital for Sick Children“ à Londres sur 250 enfants brûlés. Il s'occupe surtout du problème spécial qui consiste à surmonter le choc de la brûlure et de celui du choix des méthodes de thérapie locale. Il passe en revue les expériences faites dans le domaine de la chirurgie réparatrice de longue durée et de la rééducation des enfants brûlés.

#### Z U S A M M E N F A S S U N G

##### **Behandlung von schweren Verbrennungen im Kindesalter**

D. N. Matthews

Der Autor bespricht die Behandlung von 250 Kindern mit Verbrennungen in einem Kinderkrankenhaus in London. Das spezielle Problem der Meisterung des Verbrennungsschocks, sowie die Wahl der Methode der Lokalbehandlung wird besprochen. Die Übersicht enthält Erkenntnisse über langfristige Rekonstruktionschirurgie und Rehabilitation von Kindern mit Verbrennungen.

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## HOMOPLASTY IN THE TREATMENT OF EXTENSIVE BURNS\*)

R. L. GINZBURG

The treatment of extensive and severe burns is one of the most important questions of modern surgery.

The systemic factors operative in patients after burns (shock, toxæmia, infection, disturbance of all metabolic functions) require not only immediate comprehensive therapy, but simultaneously applied local treatment as well, since local damage is the source of the generalised reaction.

The general view of converting open wounds caused by an injury into closed, is of particular importance in the treatment of burns, with reference to their size and the immediate effect of the burn on a wide area of nerve endings, producing pain and other stimulation of peripheral receptors. This stimulation is a constant source of afferent pathological impulses to the CNS, which produce a number of pathological changes in the entire organism and in its individual systems.

The American surgeon B.B.Kay (1956), and many other foreign investigators, maintain that a critical state results from burns of 30% of the surface area of the body. They believe that a 40—45% surface area burn in 60-year-old patients and in children is inevitably fatal. This view can and must be overcome. The covering of extensive wounds resulting from burns in the first stage of treatment can be carried out using biological materials, conserved homo- or heterografts (bovine peritoneum, fibrin membranes, etc.).

Due to the serious condition of the patient and the extent of damage in severe burns, autoplasty cannot be carried out in the early stages.

The covering of the wound, however, in the first hours, days or weeks, with biological material, is a lifesaving measure and shortens treatment time, decreases plasma, protein and electrolyte loss, helps to prevent shock, prevents the occurrence of secondary shock, quickly stops pain, improves the general condition of the patient and prevents infection.

In the later stages, the closing up of the wound effects a rapid elimination of necrotic tissue, the cleaning of the wound followed by granulation, and the stimulation of epithelialization.

Most reports maintain that homoplastic repair in the period from 1 to 3 weeks results in absorption of the transplant.

A number of hypotheses exist as to the cause of the sloughing of homografts.

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\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

The transplant separates and sloughs. This period corresponds approximately to the average period during which the organism builds up sufficient antibodies to foreign antigens.

The recipient reacts to antigens of the cells of the homogenous skin graft much in the same way as to bacteria.

Immunological studies have also confirmed the changes observed with a second transplantation to the same recipient from the same donor. With the second homograft, tissue death occurs more rapidly than in the first. This can be explained by immunity acquired by the recipient after the primary transplantation.

We therefore believe that the problem of homogenous grafts should be assessed from the immunological point of view.

Clarification of the character of this immunological reaction is one of the main problems in homoplasty.

Our goal is to find an explanation of this immunological reaction and to study its characteristics. We must learn to prevent this reaction, change it, paralyse it or suppress it by whatever method needed and in this way achieve a permanent or longterm take of homografts.

Healing of homografts is possible if "immunological paralysis" is evoked, i. e. desensitization of the organism to homotransplantation.

Experiments of the American investigators R. A. Good and R. L. Varco (1956) have shown that when there is a deficiency of gamma-globulin in the blood, antibody formation is not observed even with the most active antigenic stimulation. From this observation has arisen the assumption that homografts might survive in man if immunological reactions were prevented.

The authors have tested this assumption in two children with congenital agammaglobulinaemia, in whom homografts survived for 2 years.

In adults, acquired agammaglobulinaemia and immunological "paresis" were associated with successful survival of the graft for a longer period.

According to data available at present, specific circulating antibodies against specific skin antigens have not been detected in the blood.

Although most authors claim that tolerance of blood groups does not affect the taking of homografts, we believe that the use of the finest techniques of determining blood groups and subgroups will reveal new, hitherto little known, factors. This may serve as an example for determining skin groups. It is interesting that inter-twin skin grafts show a permanent take.

In analogy with the blood groups in human blood transfusion it is possible to imagine that there are antigenic types bound to skin cells. In this way it is perhaps possible to clarify the fact that we rarely meet with the same combination of specific antigens in the skin of two individuals.

With reference to the above, the case of the patient P., who fell into a vat of molten metal, is interesting. The burn involved 80% of the body surface, mainly third degree. Dr. Poliakov (director of the surgical Department in Chelyabinsk) carried out skin grafting from five different donors.

This 19-year-old patient was admitted to the Central Institute of Traumatology and Orthopaedics for consultation on keloid formation 1 1/2 years, after he

had recovered. The entire surface had healed. The surprising thing was that despite the huge surface area burn of 80%, the patient had recovered by homografting. Furthermore, the patient was blood group 4, i. e. he was a universal recipient. Thirdly, he received grafts from five different donors. Fourthly, the grafts were applied immediately after removal from the donor, and lastly, the homografts took permanently.

Dempster and Lennox, on the basis of experimental observation, also stress the importance of using homogenous grafts from several donors: this gave a better take. Clinically, this observation is very promising.

On the basis of our own observations in covering large burn areas, we used this method of grafts from several donors with repeated grafting, each operation with a different donor.

At present it is very difficult to tell what can be considered to be a permanent take. During absorption of homogenous skin transplants the inert dermal corium remains, covered with epithelium, growing in from the edges. These cases can be explained sometimes as a permanent take of the graft.

We made use of this fact and in some cases applied auto- and homogenous grafts alternately in a checkerboard fashion. After destruction of the epithelium of the homografts, the autoepithelium replaces it growing over the fibrous remnants of the homograft.

With extensive burns and a severe condition of the patient, autoplasmic repair is not possible in the first stages of treatment.

Even if we admit that resorption of the homograft occurs, this still does not negate the advantage and even the necessity for homotransplantation. We have observed rapid improvement in the general condition of the patient, the disappearance of pain and a fall in temperature to the point that the patient can tolerate autografting.

Even authors who do not believe that it is possible to find a method of attaining a permanent take of homografts, themselves emphasize the usefulness of cadaver skin as a biological covering in extensive burns.

Observations have shown that the resorption of homografts acts as a stimulus to epithelialisation which brings about healing. In the U.S.S.R. work on homotransplantation has been reported by Yelansky, Vishnievsky, Vaynshtain, Kolokoltsev, Akulova, Ishchenko, Ivanienko, Rutkievich and others, who have shown its value and that, not only in the treatment of burns.

The time of survival homografts may be prolonged by influencing the organism of the recipient and the skin of the donor.

Experimental work has been reported in which survival of skin homografts was prolonged beyond the usual time by previous transfusion of white blood cells or red blood cells to the recipient, from the donor of the graft.

Allen, Williams et al. have used the theory of immunity to explain the failure of homografts to take, and have attempted to change the reaction of the recipient by a series of injections of skin antigen from the donor, previous to grafting.

The factor of the age of the recipient and of the donor has an undeniable significance, but this point requires further confirmation on a larger series of cases.



May (1953) and other authors have recorded that ACTH and cortisone block or weaken the antigen-antibody reaction, and in this way may secure a permanent take of the graft, or at least the prolongation of its useful life.

The use of ACTH and cortisone (May, Billingham, Morgan) has increased the number of successful takes from 6 to 20%.

X-irradiation of the recipient (Aklbekova) will also prolong the life of the graft.

In our experience of severe burns of the extremities, we perform a ring block with novocaine and inject 1% novocaine intravenously in homoplasty.

The Vishnievsky clinic has demonstrated the role of the nervous system and of novocaine in immunological reactions.

It, therefore, seemed to us that the influencing of the centre in the cerebral cortex for the organ where transplantation was being carried out, by an interruption of or a marked change in the neural reflex connexions of the individual organs with the higher nervous centres by a ring block with novocaine would have a positive effect in homoplasty.

The methods of skin conservation also affect the take.

In the Central Institute for Traumatology and Orthopaedics, Povelnyenko has experimentally subjected donor skin to X-irradiation during conservation, and injected Ethysine into the recipient before grafting. This resulted in a better take.

All of this demonstrates that prolongation of the time of survival can be, and already has been, accomplished.

Our clinical observation of severe, extensive burns has shown the undoubted clinical success of homografts.

The prolonged survival time of grafts of up to 3—6 months was sufficient time for the general conditions of the patient to improve and for the surface area of the burn to decrease markedly. It is difficult to say if this occurred due to a partial take of the transplant, or to the stimulation of the epithelial cells or glands.

It is possible to consider that a "crawling" replacement occurred from the remnants of epithelial glands or hair follicles, but not a true take, as often claimed.

There are advocates of primary excision of third degree burns, followed by the immediate use of skin autografts (Kolesnikov in Leningrad, and Petrov). It is possible that this would be an ideal method in cases of not very large extent if there were a safe method for determining the depth and extent of fresh burns. With 35—40% burns one must also take 35—40% of the patients own skin to cover the wound, which gives a total skin defect of 70—80%. Skin is an organ with a variety of functions, and it is questionable if life is possible if 80% of the body surface is eliminated. In addition, with early surgical excision of the entire burn area, it is possible that glandular epithelium capable of survival is also removed and such islets are useful in healing. In such a case we may create a large open surface wound which will not take a skin transplant.

We have carried out such excisions after electrocautery burns where the burn was of small extent and its delimitation clear.



In 2½ years (1955—1957) 214 cases of burns were treated at the Central Institute for Traumatology and Orthopaedics.

There were 182 cases of electric flash burns (actually, these are thermal burns), and 3 cases of chemical burns.

We shall concentrate only on 27 cases with 35—70% body-surface burns, i. e. patients who according to most foreign experts have a fatal prognosis.

These patients were admitted at various stages: on the 1<sup>st</sup>, 3<sup>rd</sup> and 5<sup>th</sup> day and 3, 6 and 9 months after injury. Some arrived with areas of granulation already established, some came in a state of complete exhaustion of the organism.

We shall record only that in all cases there were severe burns, mainly second and third degree, and all received the same initial treatment: blood transfusion, serum, Polyglukin, novocaine blocks, antibiotics and local treatment, consisting of: covering up the burn with homografts, heterografts (bovine peritoneum), fibrin layers and then autografts if possible.

Of these 27 severely ill patients, one died after 5 months as an inpatient, when we already believed in success.

Patient B., a 27-year-old male, was admitted on January 5, 1957, having sustained burns by a 6.6 kV cable.

On the third day after the accident he was referred to the Central Institute of Traumatology and Orthopaedics in a critical condition. Third degree burns of the back, circular burns of both legs and calves (up to the middle third), second and third degree burns of both hands and forearms, face, penis and scrotum were present. The surface area involved was 65—70% according to Postnikov. The patient received five homografts of skin from various donors, along with 25 transfusions of blood, plasma, hydrolysates, Polyglukin, etc. He received a high protein diet, with a high vitamin content. After grafting the wounds healed well. In 4 months there were small areas of granulation which were covered with homografts five times. The patient started to get up and felt well. Ten days before his death he began to complain of pain in the lower extremities and his general condition deteriorated.

It was found on dressing that grafts which had previously taken well had been resorbed, as if dissolved. The condition of the patient deteriorated further and he died within a week (on June 5, 1957, 5 months after admission).

We have presented this case because the mechanism of death has remained unclear. Careful daily observation (blood, urine, biochemical and bacteriological tests) gave no warning of catastrophe. Post mortem also gave no answer as to the cause of death. Of the other 26 patients with severe and extensive burns, in excess of 25—30% of the body surface, all recovered. We present the typical case history of the patient K., treated at the Institute from the first days of the accident.

Patient A. S. Kravtsova, 46-year-old woman engineer.

On March 6, 1958 she was burned with boiling NaS (temp. 120° C) on both legs and one arm during work.

The patient was admitted three days after the accident in a serious condition

— disturbed, restless, complaining of pain with superficial respiration, pulse 110, with burns involving 45% body surface, 25% third degree.

Blood account showed 60% Hb, 18,000 leucocytes, ESR 67, lymphocytes 5, thrombocytes 15, segm. 68.

Serum proteins were decreased to 6%. Bacterial flora from the burned arm showed strains resistant to penicillin, streptomycin, biomycin, levomycetin, and sensitive only to a combination of penicillin and streptomycin.

Active general therapy was started from the first day: paranephral novocaine block, blood transfusion and infusion of blood substitutes, penicillin and streptomycin therapy, ascorbic acid, vitamins B<sub>1</sub>, B<sub>6</sub>, B<sub>12</sub> and BP and cardiotonics.

The whole burned area was immediately covered with conserved homografts from three donors. After transplantation the condition of the patient improved and pain decreased.

Within 12 days necrotic tissue had almost completely disappeared and pink granulations appeared. On March 28, the entire area was recovered with conserved homografts from two donors. Part of the grafts took, around which epithelialization commenced. The denuded part of the wound area was recovered with homografts twice. After grafting the extent of the wound markedly decreased and the general condition improved.

On April 15, 1958, 35 days after admission, auto- and homo-grafting was carried out.

After this the patient improved and pain in the legs almost disappeared.

On April 16, 1958, a mouth swab, and stool and urine cultures showed occasional colonies of budding and nonbudding yeasts.

The patient received Nistatin and antibiotic therapy was discontinued.

All autografts took and active epithelialization began at the periphery.

At the site of the sloughed grafts new homotransplants were grafted (5 in number). The condition of the patient improved.

Wound flora showed streptococci, staphylococci and Friedlaender bac., sensitive to Terramycin, which was administered.

May 8, 1958 — autograft to the left leg.

May 23, 1958 — analogous graft to the right leg.

The temperature became normal, patient began to be active, with excellent appetite.

On both calves small areas of the size of a small coin remained which did not heal. Patient began remedial exercises and rehabilitation.

In all, the patient received 28 transfusions of blood, plasma, packed erythrocytes and blood substitutes.

On changing dressings, the patient regularly received 10 ml. of 1% novocaine i. v.

On September 10, 1958, the patient was discharged in good general condition, with complete regeneration of function at the hips, knees and ankle joints and with healed wounds.

All the therapeutic measures, with early homoplastic and later autoplastic repair, saved the patient from what would have earlier been considered to be a fatal prognosis.

It is necessary to have a supply of conserved cadaver skin available for immediate surgical use.

Collaboration of the surgeon, immunologist, immunohaematologist, biochemist and bacteriologist enables us to solve biological problems of tremendous scope in the treatment of severe burns.

#### SUMMARY

The development of new branches of industry, the growth of electrification, new forms of waging war, the use of atomic energy for purposes of peace and war have produced new types of burns different as to their extent in area and depth as well as to the number of people afflicted.

Shock, toxæmia, infection, septic toxæmia, cachexia — these are the most frequent complications of such burns.

Present countermeasures against shock have greatly lowered the mortality due to this factor. The prevention and treatment of toxæmia, septic toxæmia and cachexia remain as yet unsatisfactory.

Long term treatment of burns adds to the complications, so that it is necessary to heal up the burned surface as soon as possible, in order to limit the source of absorption of toxic substances into the blood.

Necrotic tissue must be removed as soon as possible, and the wound covered with homo-, hetero- or autografts.

Our efforts must be oriented to the improvement of treatment results in patients with third degree burns of 25 to 60% extent, which may save patients previously considered as hopeless.

#### ВЫВОДЫ

##### Гомопластика при лечении обширных ожогов

Р. Л. Гинзбург

Развитие новых видов промышленности, развитие электрификации, новые формы ведения войн, использование атомной энергии в мирных и военных целях вызвали и новые виды ожогов, отличные по своей протяженности, глубине и массовости поражения.

Шок, токсемия, инфекция, септико-токсемия, истощение — наиболее частое осложнение этих ожогов.

Современные методы по борьбе с шоком резко понизили % смертности от шока. Предупреждение и лечение токсемии, септико-токсемии, истощения остается еще далеко от совершенства.

Длительное течение ожога способствует этим осложнениям, в силу чего необходимо быстрее заживление раны, как очага, из которого всасываются токсические вещества проникающие в кровь.

Требуется наиболее быстрое удаление некротической ткани и закрытие раневой поверхности гомо, гетеро, аутопластикой.

Основные наши усилия должны быть направлены на улучшение результатов лечения группы больных с площадью ожога III степени от 25 % до 60 % поверхности тела, что может спасти больных, прежде считавшихся безнадежными.

## R É S U M É

### Le Rôle de l'Homoplastie au Cours du Traitement des Grandes Brûlures

R. L. Ginzburg

La naissance de nouvelles branches industrielles, le progrès de l'électrification, les nouvelles formes de la guerre, l'application de l'énergie atomique à l'usage de la paix ainsi qu'à la guerre, ont causé de nouvelles formes des brûlures, se distinguant par son étendue, sa profondeur et le nombre des blessés.

Le choc, la toxaémie, l'infection, la septicaémie et la cachexie représentent les complications les plus fréquentes de ces brûlures.

Le traitement contemporain du choc a fait bien abaisser le pour-cent des morts en choc. La prophylaxie et le traitement de la toxaémie, de la septicaémie et de la cachexie ne seront pas encore à jour quand à l'avenir le plus proche.

Le traitement à la longue des brûlures donne naissance à de maintes complications, si bien qu'il faut à tout prix obtenir la guérison de la plaie représentant le siège de la résorption des produits toxiques dans le sang, nécessitant l'ablation précoce des tissus nécrotiques, si bien que la fermeture de la plaie à l'aide de l'homoplastie, l'hétéroplastie ou l'autoplasie.

Tous nos efforts doivent se fixer au même sujet: celui d'améliorer les résultats du traitement des malades souffrants des brûlures du troisième degré de 25—60 pour-cent ce qui peut, à l'avenir, aboutir à la guérison des brûlures jusqu'alors regardées comme fatales.

## Z U S A M M E N F A S S U N G

### Homoplastische Behandlung ausgedehnter Verbrennungen

R. L. Ginzburg

Die Entfaltung neuer Industriezweige, die Entwicklung der Elektrifikation, neuartige Formen der Kriegsführung, die Verwendung der Atomenergie zu friedlichen und zu militärischen Zwecken - dies alles hat neue Arten von Verbrennungen hervorgerufen, die sich durch ihre Ausdehnung, Tiefe und ihr massenhaftes Auftreten von den klassischen Verbrennungen unterscheiden.

Die häufigsten Komplikationen dieser Verbrennungen stellen Schock, Toxaemie, Infektion, septische Toxaemie und Kachexie dar.

Die gegenwärtigen Methoden der Schockbekämpfung haben den Prozentsatz der Sterblichkeit an Schock in bedeutendem Masse verringert. Die Prophylaxe und Behandlung der Toxaemie, der septischen Toxaemie, der Kachexie sind jedoch noch sehr weit von Vollkommenheit entfernt.

Eine langwierige Behandlung der Verbrennungen trägt zum Auftreten von Komplikationen bei, sodass sich die Notwendigkeit geltend macht, eine schnellere Verheilung der Wunde, die doch einen Herd für die Resorption toxischer Stoffe in die Blutbahn darstellt, zu erzielen.

Es besteht die Notwendigkeit, nekrotische Gewebsteile so schnell wie möglich zu entfernen und die Wundfläche durch Homoplastik, Heteroplastik oder Autoplastik zu decken.

Unser hauptsächliches Bestreben muss daraufhin abzielen, die Behandlungsergebnisse bei Patienten mit Verbrennungen dritten Grades, deren Verbrennungsfläche 25 bis 60 Prozent der Körperoberfläche betrifft, zu verbessern, wodurch auch solche Patienten gerettet werden können, die bisher als hoffnungslose Fälle betrachtet worden sind.

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## SIGNIFICANCE OF THE ORGANISM'S REACTION TO BURNS AND THE POSSIBILITY OF INFLUENCING IT\*)

R. DOLEČEK, J. KALINA, L. KLABUSAY, L. ENDRYÁŠ

Apart from specific changes a multitude of more or less non-specific changes occur after burns which, however, are very important with regard to the course and prognosis of the burns disease. These more or less non-specific reactions may cause great harm to the patient, and may even be fatal. Burns are no local matter. The defensive reactions of the organism evoked by stress (e. g. functional hypercorticalism) are certainly of value, they may, however, "overshoot the mark" in various ways and thus become harmful to the organism.<sup>9 17)</sup>

In this report the authors intend to point out some basic problems and show their possible solution.

1. The reaction of the suprarenal cortex and the behaviour of the antidiuretic hormone after burns.
2. The possibility of influencing the reactions of the burned organism by neuroplegics.
3. The correct indications for hormones in the therapy of burns.
4. The possibility of grave metabolic and energy problems arising after burns.

### METHODS

Apart from the current laboratory examinations and careful clinical observations (general condition, blood pressure, temperature, diuresis, etc.) the authors registered in their patients regularly, and sometimes for many months: the absolute values of eosinophils, 17-ketosteroids (17 KS),<sup>1)</sup> 17-hydroxycorticoids (17 OH),<sup>2 3)</sup> sodium, potassium, calcium and phosphorus in the urine, and last year, also repeatedly the values of aldosterone [ALDO]<sup>4)</sup> and 17-ketogenic steroids [17 KGS]<sup>5)</sup> in the urine as well as the antidiuretic hormone (ADH) in the serum during the first weeks after burns. The values of ADH were determined by a modification of the method of Jeffers et al.<sup>6 7)</sup>

\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

The following shows the normal values as found with the methods used by the authors:

17 KS in the urine in men . . . . . 15±5 mg. per day,  
 17 KS in the urine in women . . . . . 10±5 mg. per day,  
 17 OH in the urine up to 10 to 12 mg. per day, average 5 to 6 mg. per day,

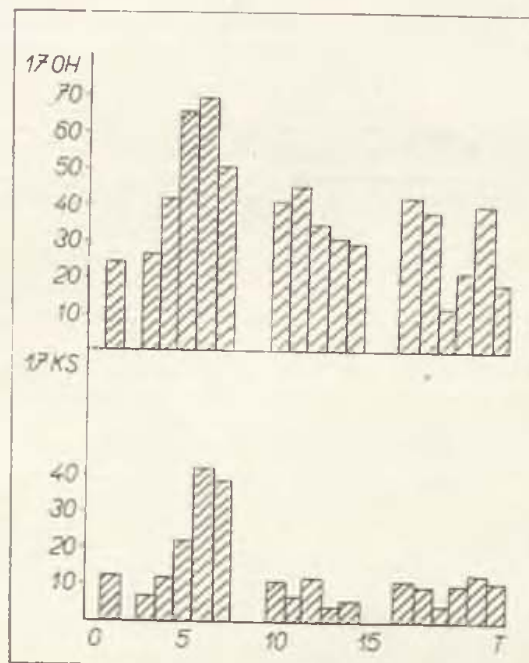


Fig. 1. Patient Š. O., aged 20, burned on 60% of body surface, mostly the 3rd degree  
 Striking are the very high values of 17 OH excreted in the urine.

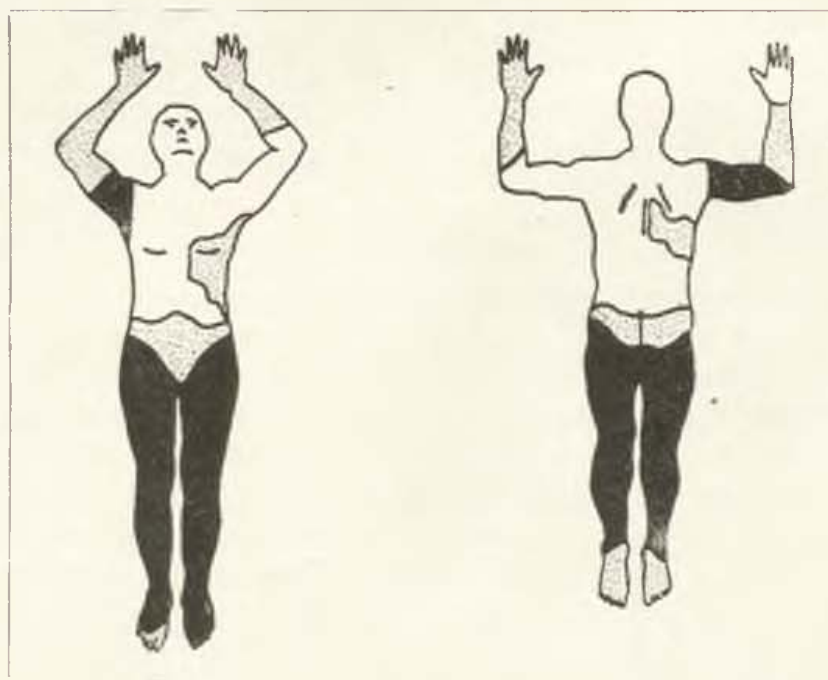


Fig. 2. Patient Š. O., — see Fig. 1.

17 KGS average 6 to 7 mg. per day,

ALDO in men 5.5 to 13 gamma per day, average 8 gamma per day,

ALDO in women 2.5 to 8 gamma per day, average 4.5 gamma per day.

ADH in the serum on fasting in people without apparent endocrinological disorder, neither obese nor asthenic, not exposed to stress is usually below

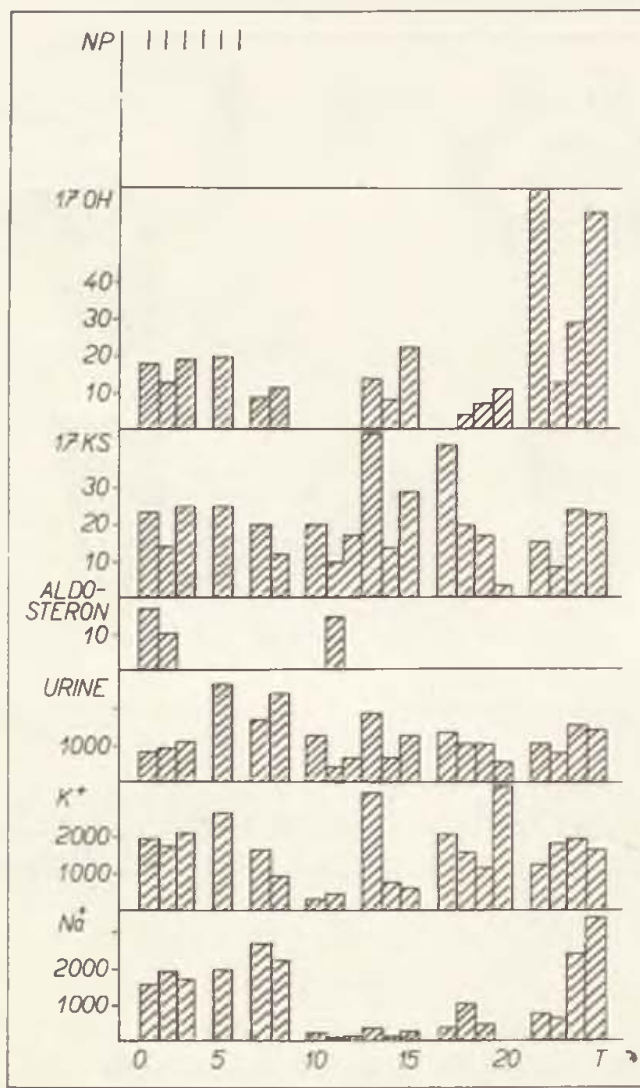


Fig. 3. Patient B. O., aged 18, burned on 60% of body surface mostly the 3rd degree. Received neuroplegics during the first six days. Comparison with Fig. 1 shows markedly lower values of 17 OH in the urine. Considerable retention of sodium only appeared from the tenth day after injury. The values of aldosterone were increased. NP = neuroplegia.

The hatched area on the face marks burns of 2nd and 3rd degree.

15 micro-units in 1 ml. of serum. After an osmotic load (20 ml. of 10% NaCl i. v.) the values of ADH in normal people rise to 27.7 micro-units.<sup>8)</sup>

As neuroplegics the authors used small doses of a modified mixture M<sub>2</sub> [Hydergin (=DH-Ergotoxin), Sandosten-calcium and Panthesin] which appeared to be better than mixture M<sub>1</sub>, as was also proved by experiment (on 205

burned rats) in which the survival time, the course of healing, the damage to the liver and the kidneys, and the ascorbic acid and lipid content of the suprarenals were observed after standardized burns.<sup>9</sup>) For details of the dosage of the neuroplegic mixture see previous reports.<sup>9 17 19</sup>)

Last year the authors started to use Dianabol CIBA and Durabolin ORGANON as anabolic hormones. Apart from that they also used Agovirin SPOFA (=Testo-



Fig. 4. Patient B. O. — see Fig. 3.

sterone propionate) and Methylandrostendiol SPOFA. In the figures 17 KS, 17 KGS, 17 OH, Na, K are given in mg. per day, urine in ml. per day, ALDO in gamma per day, ADH in micro-units per 1 ml. serum.

## RESULTS

The function of the suprarenals was followed up for longer periods in 55 patients suffering from burns, in 22 of whom the values of aldosterone and anti-diuretic hormone in the urine and the serum were also observed. In almost all patients a more or less significant hypercorticalism was registered (see also<sup>9 10 11 12 13 14</sup> etc). If neuroplegics were administered in addition to the usual treatment, hypercorticalism was not so marked in the first days or even weeks. Small doses of mixture  $M_2$  were capable of preventing the depletion of ascorbic acid in the suprarenal cortex of burned rats as compared with controls or burned rats which had received large doses of Largactil.<sup>9</sup>)

In the following a few instructive cases are reported:

In Fig. 1 there are included the results of observation of 17 KS and 17 OH in patient Š. O., aged 20. 60% of his body surface were scalded (20% 2nd, 40% 3rd degree).<sup>9 14</sup>) See also Fig. 2. The patient was not treated with neuroplegics.



Most marked are the enormous quantities of 17 OH excreted in the urine during the first weeks after injury. The patient also showed metastatic calcifications<sup>15</sup>; and melaena.

In Fig. 3 the results of laboratory examinations are given of patient B. O., aged 18, who sustained burns to 60% of the body surface, mainly of the 3rd degree (Fig. 4). In the first few days after injury he received neuroplegics. Healing

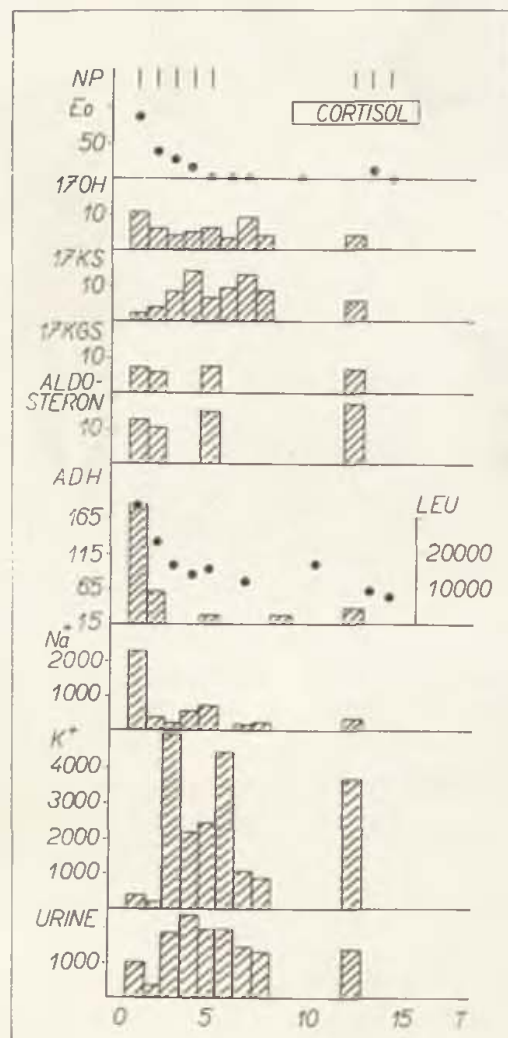


Fig. 5. Patient K. J., aged 33, burned on 67% of body surface nearly all the 3rd degree. He received neuroplegics during the first five days, later again for three days. Comparatively low values of 17 KS, 17 KGS and 17 OH excretion; only the values of ALDO are raised.

High values of ADH in the serum. NP = neuroplegia, EO = eosinophiles per cmm, LEU = leucocytes.

proceeded very unsatisfactorily for many months, and it was improved very considerably only after a few week's administration of Durabolin Organon (25 to 50 mg. per week).

In Fig. 5 the results of laboratory examinations are given of patient K. J., aged 33, who sustained burns to 67% of his body surface almost all of 3rd degree.

He died not quite three weeks after injury. Very marked are the high values of ADH in the serum the first day after injury and the comparatively low values of urine excretion of 17 KS, 17 KGS and 17 OH despite the intravenous administration of cortisol. The amount of aldosterone and potassium in the urine was higher,

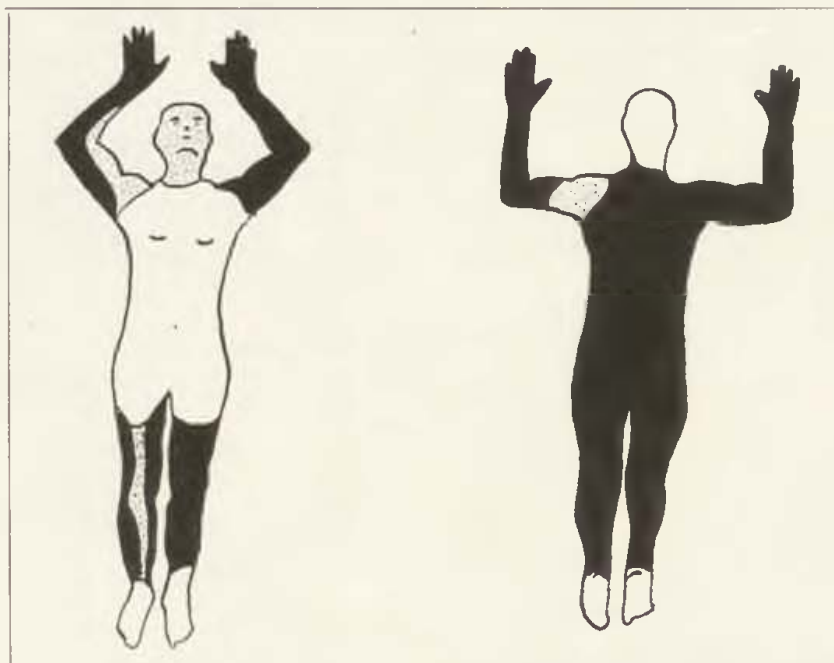


Fig. 6. Patient K. J. — See Fig. 5.

that of sodium lower than normal. The last week before death the patient started having high temperatures (continuously  $39.5^{\circ}\text{C}$  to  $41.0^{\circ}\text{C}$ ) which did not respond to high dosage of antibiotics (Penicillin, Streptomycin, Oleandomycin), antipyretics, neuroplegics, compresses and intravenous cortisol. At the same time a paradoxical decrease in the leucocyte count to normal values (8,000), occurred and the pulse rate did not correspond to the temperature (around 100 to 112 per minute). A similar condition can be observed in certain hypothalamic syndromes.<sup>16)</sup> See Fig. 6.

Patient R. L., a woman, aged 27, who sustained burns to 45% of her body surface, mainly of 3rd degree (Fig. 7), is mentioned as an instance of markedly improved healing after the administration of Dianabol CIBA. For a number of months no healing of the burned surface on the lower extremities could be attained. Very soon after the commencement of the treatment with Dianabol CIBA at a dosage of 15 mg. per day plus Thyreoglobulin mite SPOFA, the healing was markedly speeded up, the patient gained weight, the blood picture improved and the values of serum proteins normalized.

Up to date, the authors have used Dianabol CIBA and Durabolin ORGANON in 15 patients with severe burns, and in all cases recorded good results, particularly when administering the drugs during the phase of the so-called toxic cachexia.<sup>24)</sup>

The influence of the neuroplegic mixture  $M_2$  and Guajacuran SPOFA (guayacol-glycerol-aether), (which the authors also used in infusions sometimes

in the first days after injury and particularly in case of vomiting), on the values of ADH after an osmotic load is shown in Tab. 1. After premedication with the mixture M<sub>2</sub> as well as with Guajacuran, significantly lower values of ADH are obtained in the same patients after a standardized osmotic load than without pre-

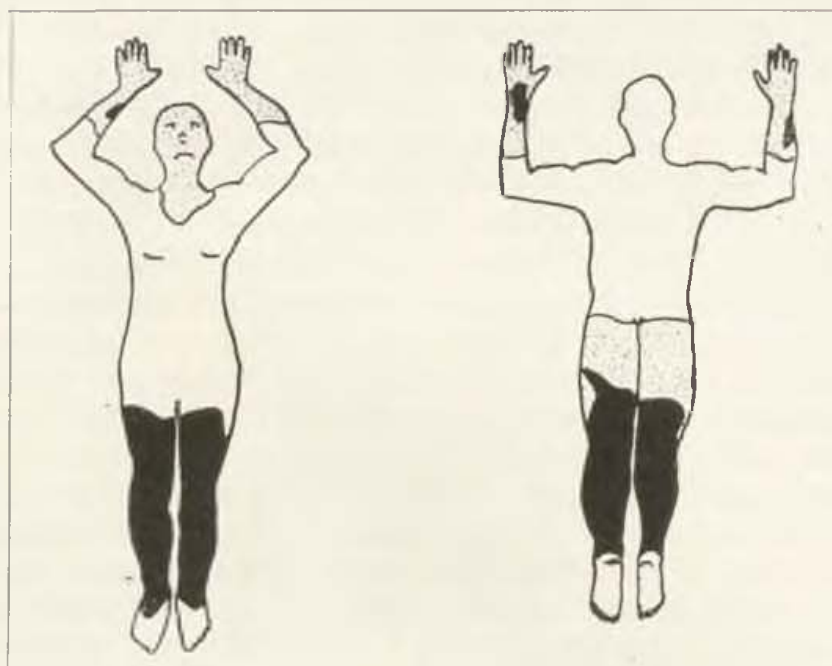


Fig. 7. Patient R. L., a woman of 27. — See text.

Tab. 1. Influence of the neuroplegic mixture M<sub>2</sub> and Guajacuran SPOFA on the values of ADH in the serum after a standard osmotic load.

	Number of cases	Premedication	ADH in microunits after 10% Na Cl I. V.
I.	25	Controls	27,7
II.	16	Hydergin (= Dergotoxin)* Panthesin* Sandosten calcium	22,2
III.	10	Guajacol- Glycerol- Ether (= Guajacuran Spofa)	18,3

I and II  $p < 0.05$

I and III  $p < 0.01$

medication ( $P < 0.01$ ;  $P < 0.01$ ). Guajacuran given in suitable doses can also decrease the reaction of the suprarenal cortex to stress.<sup>22)</sup>

In the figures the dotted areas mark burns of 2nd, and black areas burns of the 3rd degree. T means days.

## DISCUSSION

Let us return once more to the four basic aims of our work:

1. Exaggerated hypercorticalism (as to intensity as well as duration), particularly with regard to its extensive production of glycocorticoids, may cause great damage (osteoporosis, inadequate healing of wounds, spreading of infection, worsening of the condition in diabetes, psychosis, maybe also haemorrhage into the intestinal tract, etc.). Therefore, the authors consider the inconsiderably increased values of ADH may aggravate postoperative antidiuresis or antidiuresis after burns by reabsorption of electrolyte-free water (see also 12 and 18). The patient may sometimes thus be in danger of excessive hydration. In this condition, too, neuroplegics are successful (see Tab. 1).

2. Neuroplegics favourably influence the course of burns disease and its prognosis both experimentally and clinically. For details see the authors' monograph on this subject.<sup>9)</sup> Of 115 severely burned patients, the majority over 30% of the body surface and mainly the 3rd degree, who in addition to current treatment, received neuroplegics and partly also hormone preparations, only 28 died, and these with lesions mostly exceeding 50% of the body surface mainly of the 3rd degree. No death occurred in this series of patients with burns up to 40% of the body surface. The authors also succeeded in decreasing the amount of solutions used for infusions by more than half as compared with that currently used.<sup>9 19)</sup> Therefore, neuroplegics would be suitable for the treatment of mass burns.

Neuroplegics should not inhibit all defensive reactions. The aim is to inhibit only those reactions which are exaggerated. In the authors' experiments as well as in those of others on burned rats large doses of neuroplegics, particularly of mixture M<sub>1</sub>, worsened the course and the prognosis of the burns disease. Similarly,

Tab. 2. Survey of indications for hormone preparations and neurotropic drugs in the various phases of burns disease.

Shock; the first 4—5 days	Toxemia	Toxic cachexia
Neuroplegics (M <sub>2</sub> mixture)	Neuroplegics*) (M <sub>1</sub> or M <sub>2</sub> )	Ataractics
Glucocorticoids**) Anabolic hormones (Agovirin, Dianabol, Durabolin etc.)	Glucocorticoids**) Anabolic hormones	Glucocorticoids**) Anabolic hormones
Mineralocorticoids (?)**)	—	—
Insulin	—	—
		Estrogens Thyroid extracts (e. g. Thyroglobin)

\*) In hyperpyretic states

\*\*) For indications see our previous publications (e. g. R. Doleček et al: Reaction of the Organism after Burns and its Treatment. — Praha 1960 pp. 101)



cooling of dogs who had received neuroplegics, impaired the course and the prognosis of their burn disease.<sup>20)</sup>

3. To avoid repetition, the authors refer to previous reports<sup>9 19)</sup> for details on the rational indications for hormone therapy in patients after burns, particularly in the first few days after the accident. For the sake of completeness,

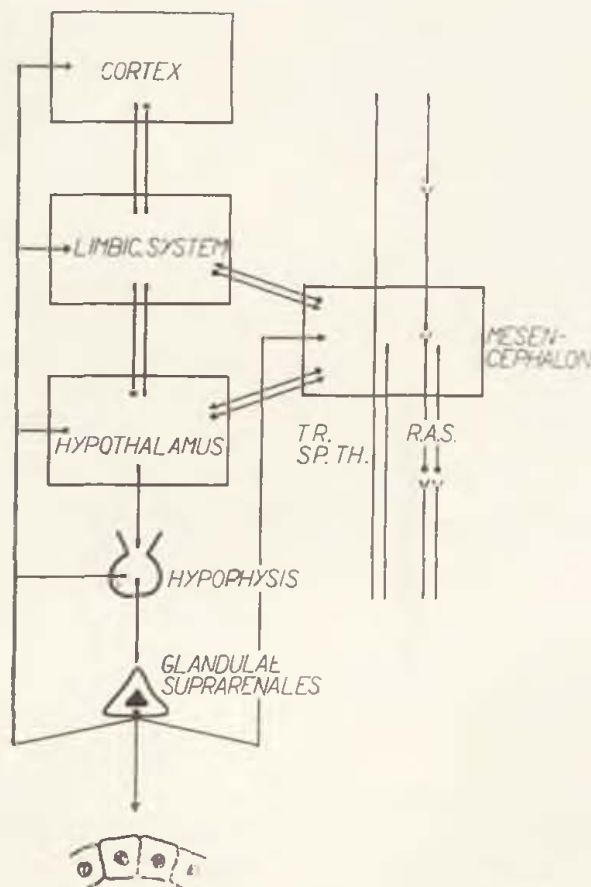


Fig. 8. Diagram of the most important regulatory mechanisms of the reaction of the organism to stress. Their mutual relations. Metabolites from the peripheral tissue are not registered. R.A.S. = reticular activating system. TR.SP.TH. = Tractus spino-thalamicus (transmission of pain). Neuroplegics act predominantly at the level of the mesencephalon-hypothalamic junction.

however, they are partly given in Tab. 2. When properly chosen and well directed, the administration of hormone preparations like that of neuroplegics is capable of improving the course and prognosis of the burns disease. The difference, however, lies in the phase of the illness at which a given preparation is administered. The authors' experience is based on the result of long-period observations not only of the values of excreted steroids, but also on the clinical use of various hormone preparations. A great contribution was made by the introduction of synthetic anabolic hormones such as Dianabol CIBA or Durabolin ORGANON, with which the authors were able to register some quite striking results.

The authors consider the routine use of hormone preparations to be superfluous in patients suffering from burns, particularly with regard to glucocorticoids (cortisol, prednisone, etc.), but in selected cases, as shown in the indications given by the authors,<sup>9 19)</sup> they may substantially improve the general condition, and even save the patient's life. In the first few days after burns it is much better,

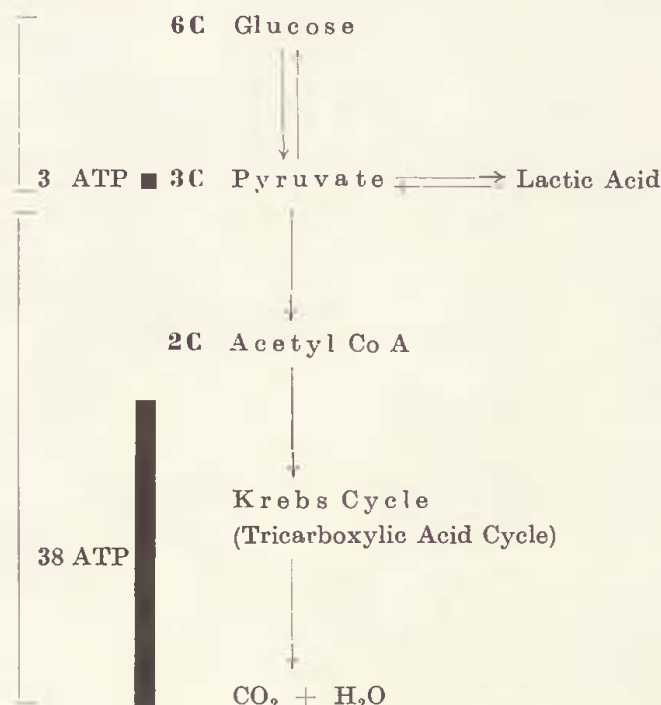


Fig. 9. Diagram of the development of macroergic ATP bonds during metabolism of one molecule of glucose.

if necessary, to administer glucocorticoids than ACTH,<sup>9 19)</sup> until the type of reaction of the peripheral gland (suprarenal cortex) has been established.

Fig. 8 shows a diagram depicting various levels of the regulatory mechanisms after burns which may be influenced by neuroplegics or hormone preparations. A most important site, at which neuroplegics take action is the mesencephalon and its connections with the hypothalamus (see also the conception of the mesencephalic activating system).<sup>23)</sup> The hormones, however, also act directly on the tissues.

4. Finally, the authors would like to mention a further, very important point: Conditions are frequently met with in the treatment of burns which cannot be explained by current pathological or patho-physiological knowledge. Sometimes it is impossible to tell the cause of death in a severely burned patient or exactly which processes have brought about his serious condition (possibly an affection of the hypothalamus?). The pathologist is often unable to give us a satisfactory explanation. In a recent report in this journal,<sup>22)</sup> and also according to the authors' own results in experiments on rats after injury by burns, an increased amount of pyruvic acid and a marked decrease of alpha-keto-glutaric acid were registered in the blood. Pyruvic acid represents the final phase of anaerobic

glycolysis which is a small source of energy (only 3 macroergic ATP bonds per one molecule of glucose), see Fig. 9. The aerobic phase (Krebs' cycle) being the common metabolic pathway for carbohydrates, fats and proteins gives about 38 macroergic ATP bonds on degradation of one molecule of glucose to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ . A block, even a partial block, at the transition of the anaerobic to the aerobic phase of glycolysis (due to a disorder of an enzymatic system?) may well explain the cause of the severe deficiency of energy indispensable for the vital processes. This would mean utilizing nutritives only e. g. by 15 to 20%. This "metabolic paresis" may have far-reaching and disastrous consequences.

This brings us nearer to the tissues, the cell membranes and the basic vital processes which may then decide upon the life or death of the patient.

#### SUMMARY

In the above report the authors have tried to solve four basic problems which they have partly dealt with already in previous papers.

##### 1. *Reaction of the Suprarenal Cortex and Behaviour of ADH after Burns*

After burns, hypercorticalism develops which lasts for varying periods (maybe even many weeks) and which manifests itself by an increase in 17-keto-steroids, 17-hydroxycorticoids and aldosterone excretion in the urine, and by an increase in antidiuretic hormone values in the serum. Both these conditions, when exaggerated, may be harmful.

##### 2. *Possibility of Influencing the Reactions of the Burned Organism With Neuroplegics*

Neuroplegics are capable of partly blocking the reaction of the organism to stress. The results with the use of the modified mixture  $M_2$  [Hydergin, (i.e. DH-Ergotoxin), Sandosten-calcium and Panthesin) in experiments (on burned rats) as well as in patients are referred to. The authors needed a much smaller amount of solutions for infusion in patients treated with neuroplegics than are currently administered, and no death occurred in a group of 115 severely burned patients with involvement of less than 40% of the body surface by 2nd and 3rd degree burns.

##### 3. *Correct Indications for Hormone Therapy in Burns*

On paragraph 2 and 3 more detailed reports were made elsewhere. Here only concise mention was made of the indications for various hormone preparations in the different phases of burn disease. The significance of new synthetic anabolic hormones (Durabolin, Dianabol) was stressed.

##### 4. *Possibility of Serious Metabolic and Energy Problems in Burns*

It seems as though a partial block develops at the point of transition of the anaerobic to the aerobic phase (Krebs' cycle) of glycolysis. This condition could cause a very severe deficiency of macroergic ATP bonds (the anaerobic glycolysis of one molecule of glucose gives 3 ATP, metabolization of one molecule of glucose by the Krebs' cycle to  $\text{CO}_2$  and  $\text{H}_2\text{O}$ , however, about 38 ATP). The serious condition of some patients suffering from burns could, therefore, also be explained by this "metabolic paresis".

## ВЫВОДЫ

### Значение ожоговой реакции организма и возможности воздействия на нее

R. Doleček, J. Kalina, L. Klabusay, L. Endryáš

В приведенной статье авторы решают четыре основные проблемы, о которых уже до этого они опубликовали частичные сведения:

1. Реакция коркового слоя надпочечных желез и роль антидиуретического гормона после ожога. После ожога возникает гиперкортикализм разной продолжительности (в некоторых случаях в течение многих недель), который проявляется повышением показателей 17-кетостероидов, 17-гидрокси-кортикоидов и альдостерона в моче, а также повышением показателей антидиуретического гормона в сыворотке. Оба эти состояния, поскольку они выражены в чрезмерной мере, могут оказывать также вредное действие.

2. Возможность воздействия на ожоговую реакцию организма при помощи нейроплегических средств. Нейроплегические средства способны частично блокировать реакцию организма на стресс. Приводятся результаты, полученные при применении модифицированной смеси  $M_2$  (гидергин) (= дигидроэрготоксин) сандостен-кальций, пантезин в опытах (обожженные крысы), а также у больных с ожогами. Количество растворов для вливаний значительно понизилось у обожженных, которым были введены нейроплегические средства, по сравнению с обычно применяемым количеством, и в группе 115 больных с тяжелыми ожогами не отмечалось ни одного смертного случая при поражении поверхности тела до 40 % ожогами II—III°.

3. Правильные показания к гормональному лечению обожженных. По 2 и 3 пункту приводятся подробные сообщения уже в других статьях. Вкратце приведены показания к применению разных гормональных препаратов в разных фазах ожоговой болезни. Подчеркивается значение новых синтетических анаболических гормонов (дюраболин, дианабол).

4. Возможность возникновения серьезных метаболических и энергетических проблем при лечении обожженных.

Было получено впечатление, что у тяжело обожженных больных возникает частичная блокада при переходе анаэробной фазы гликолиза в аэробную (цикл Кребса). Это состояние влечет за собой весьма серьезный недостаток макроэргических АТФ связей (анаэробный гликолиз 1 молекулы глюкозы предоставляет 3 АТФ, метаболизация 1 молекулы глюкозы в цикле Кребса до  $CO_2$  и  $H_2O$  предоставляет 38 АТФ). Тяжелое состояние некоторых обожженных можно следовательно объяснить также этим «метаболическим парезом».

## RÉSUMÉ

### La signification de la réaction de l'organisme en suites des brûlures et la possibilité de l'influencer

R. Doleček, J. Kalina, L. Klabusay, L. Endryáš

Dans le travail cité les auteurs tâchent de résoudre les quatre problèmes fondamentaux dont ils ont déjà donné des nouvelles partielles.

1. *La réaction de cortex des surrénales et la conduite de ADH en suites des brûlures.* Un hypercorticalisme de différante durée (même quelques semaines) est presque toujours présent. Il est exprimé par l'augmentation de 17-ketosteroides, 17-hydroxycorticoides et d'aldosterone en urine, de même que par l'augmentation d'hormone antidiurétique au sérum. Tous les deux états, quand exagérés, sont nuisables.



2. *La possibilité d'influencer un organisme brûlé par la neuroplegie.* Les moyens de la neuroplegie peuvent partiellement bloquer la réaction de l'organisme en face de stress. On cite les résultats obtenus à l'aide du „cocktail“ M<sub>2</sub> [Hydergin (= DH Ergotoxine) — Sandostène calcium, Panthésine] dans le travail expérimental (les rats brûlés); de même qu'en clinique des brûlés. Les auteurs avaient besoin d'une bien plus petite quantité des solutions intraveineuses chez les sujets traités par des mélanges neuroplégiques et ils n'ont noté aucune mort dans une groupe des 115 grièvement brûlés de II—IIIème grade envisageant la surface de 40 pour cent du corps.

3. *Les indications rationnelles du traitement hormonal des brûlés.* Les deux premières questions furent traitées déjà ailleurs. Les indications de différents remèdes hormonaux en différents stades de la maladie des brûlés ont été données. La signification des nouvelles hormones synthétiques anabolisants (Durabolin, Dianabol) a été soulignée.

4. *La possibilité de graves problèmes métaboliques et énergétiques chez les brûlés.* Il semble que, chez les grièvement brûlés, il y a un bloc partial au moment de transition de la phase anaérobie en aérobie de la glycolyse (cycle de Krebs). Cet état pourrait être la cause du manque important des liaisons macroergiques d'ATP (de la glycolyse anaérobie d'une molécule de la glucose résultent trois ATP, de la métabolisation d'une molécule de la glucose en cycle de Krebs en CO<sub>2</sub> et H<sub>2</sub>O résultent 38 ATP!). L'état grave, dans lequel se trouvent certes brûlés, peut être expliqué alors même par cette „parésie métabolique“.

## ZUSAMMENFASSUNG

### Die Bedeutung der Reaktion des Organismus nach Verbrennungen und die Möglichkeit ihrer Beeinflussung

R. Doleček, J. Kalina, L. Klabusay, L. Endryáš

Die Verfasser befassen sich in der vorliegenden Arbeit mit vier grundlegenden Problemen, über die sie zum Teil schon früher berichtet haben.

1. *Die Reaktion der Nebennierenrinde und das Verhalten des antidiuretischen Hormons nach Verbrennungen:*

Nach der Verbrennung tritt ein verschieden lange dauernder Hyperkortikalismus auf, der unter Umständen sogar mehrere Wochen bestehen kann und der sich durch Anstieg der Werte für 17-Ketosteroide, 17-Hydroxykortikoide und Aldosteron im Harn sowie durch Vermehrung des antidiuretischen Hormons im Serum anzeigt. Diese beiden Reaktionen können, soweit sie übertrieben sind, schädlich wirken.

2. *Die Möglichkeit, die Reaktion des Organismus bei Verbrennungen durch Neuroplegika zu beeinflussen:*

Neuroplegika sind imstande, die Reaktion des Organismus auf Stress teilweise zu blockieren. Es werden die Ergebnisse mit einer modifizierten Kombination M<sub>2</sub> [Hydergin (d. i. Dihydro-Ergotoxin), Sandosten-Calcium, Panthesin] im Experiment (Ratten mit Verbrennungen) und bei Verbrennungen beim Menschen angeführt. Die Verfasser kamen bei neuroplegisch behandelten Patienten mit Verbrennungen mit viel geringeren Mengen von Infusionslösungen aus, als gewöhnlich verabreicht werden, und verzeichneten nicht einen einzigen Todesfall in einer Gruppe von 115 Patienten mit schweren Verbrennungen II. und III. Grades, die bis zu 40% der Körperoberfläche betrafen.

3. *Eine richtige Indikation der hormonalen Behandlung bei Patienten mit Verbrennungen:*

Über Punkt 2. und 3. wurde bereits an anderer Stelle ausführlich berichtet. Die Indikationen der einzelnen Hormonpräparate in den verschiedenen Phasen der Verbren-

nungskrankheit werden in Kürze angeführt. Die Bedeutung neuer synthetischer anaboler Hormone (Durabolin, Dianabol) wird unterstrichen.

4. *Die Möglichkeit des Bestehens schwerwiegender metabolischer und energetischer Störungen bei Patienten mit Verbrennungen:*

Bei schweren Verbrennungen besteht anscheinend eine teilweise Blockade am Übergang von der anaeroben Phase der Glykolyse zur aeroben Phase (Krebs'scher Zyklus). Dies hat einen bedeutenden Mangel an makroergischen ATP-Bindungen zur Folge (die anaerobe Glykolyse eines Moleküls Glukose ergibt 3 ATP, während die Metabolisierung eines Moleküls Glukose im Krebs'schen Zyklus zu CO<sub>2</sub> und H<sub>2</sub>O 38 ATP ergibt!). Der schwere Zustand mancher Patienten mit Verbrennungen kann daher aus durch diese „metabolische Parese“ erklärt werden.

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## LOCAL BURN TREATMENT WITH SILICONES\*)

### New Method of Ensuring Dry Milieu

T. ADAMCZAK, S. MACIEJCZYK

Contemporary research work on the treatment of burns is concerned with elaborating the methods of general and local treatment so as to avoid many difficulties. The aim of local treatment is to create the most favourable conditions for epithelization of burned areas or, at least, for a clean granulating surface suitable for plasty.<sup>5 10 13 16 17</sup>) Speed and a well prepared bed are of decisive significance for the result of a transplantation.<sup>13</sup>)

The main aim of local treatment is to ensure a dry milieu of the burned surface.

It is this milieu which decides the general condition of the patient as well as the progress of the healing processes at the site of the damage and, at the same time, inhibits or prevents the development of infection. The ultimate depth of the lesion depends to a considerable extent on whether the milieu of the wound is dry or moist.<sup>15 16</sup>) The realization of this generally accepted demand meets particular difficulties when the wound has been infected from the start or when infection, even of small extent, has been introduced during the course of treatment.

In order to exert an active influence on the discharge from the burned surface the authors started to use a highly hydrophobic, artificially produced solution of silicones for the treatment of burns.

The authors experiments on animals proved that the silicone oil used (D. C. 703) is not toxic if administered hypodermically in a dose of up to 3% of body weight.<sup>1 2</sup>) It is stable and does not undergo absorption or only very little. The tissue reaction to silicone oil is minimal and similar to that of implanted polyethylene; but the reaction to silicone subsides more rapidly.<sup>2 4 8 9 18</sup>) The stability of silicone oil towards temperatures up to 200° C makes sterilization possible.

#### THE ACTUAL RESEARCH

The clinical material consists of 75 cases; 55 were treated as out-patients and 20 in hospital. Second and third degree burns treated as out-patients were located on the extremities or the face and did not exceed 10% of body surface. In the hospital patients the burned skin surface ranged from 10 % to 70 %.

\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

## THE METHOD OF LOCAL TREATMENT

The surroundings of the burned area were cleansed with benzine or ether and the wound surface rinsed with physiological saline. After this the surroundings were cleansed anew. All blisters and necrotic tissue were removed. Then an Allen-Koch dressing with silicone tulle was applied.

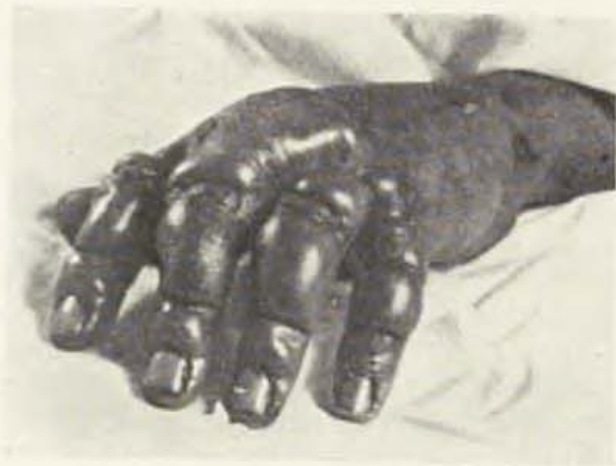


Fig. 1a.



Fig. 1b.

Fig. 1a. Patient K. W. burned by burning petrol (Sept. 29, 1959) — condition prior to removal of blister. — Fig. 1b. Same case fourth day after healing of burned surface and 14th day after commencement of treatment (Oct. 13, 1959) — movements of hand are free.

In all cases, where infection was expected, the silicone tulle was covered with a swab soaked in a solution of 1/1000 Rivanol, 3% chloramine or 3% sulphathiazole. During the treatment the antiseptics were changed according to the biological condition of the wound. The dressings were changed every two to four days.

If the surrounding tissue was oedematous or the skin macerated a 5 % acid silicone paste was applied around the wound.

In the treatment of burns of the face in out-patients only silicone paste was used by the open method, in hospital patients silicone tulle or paste.

In out-patients no antibiotics were administered, in hospital patients antibiotics were given only after stabilization of the bacterial flora.

## THE RESULTS

A total of 55 cases were treated as out-patients. Burns erythema (1st degree) was observed only in the surroundings of deep lesions. When using silicone paste or tulle the erythema subsided within 24 hours.

After four to six days the wound of non-infected superficial burns (2nd degree) appeared like a clean, dry surface bared of epithelium. One or two days later, on dressing, rapidly progressing epithelisation could be found; epithelium covered  $\frac{2}{3}$  to  $\frac{4}{5}$  and sometimes even the whole of the wound area. Complete



healing was achieved in this group of cases within 5 to 11 days, average 7 days [15 cases].

In infected superficial burns (2nd degree) discharge was controlled by the use of antiseptic solutions applied on top of the silicone tulle dressing. The surroundings of the wound were covered with silicone paste. Complete healing was achieved within 5 to 17 days, average 12 days [15 cases].



Fig. 2a. Patient C. M. Corrosion of face, chest and shoulders by hydrochloric acid (Aug. 26, 1959). Extent of burn shown by area bared of epithelium. Definite evaluation of size of burn only possible after two to three days.

Tab. 1. Duration of Treatment — Out-patients.

Type of burn		Number of cases	Duration of treatment						
			5—6	7—8	9—11	12—16	17—25	26—32	33—48
1	Superficial 2nd degree non-infected	15	5	7	3	—	—	—	—
2	Infected	15	1	3	3	7	1	—	—
3	Deep 3rd degree non-infected	9	1	3	4	1	—	—	—
4	Infected	16	—	1	2	4	2	3	4
Total		55	7	14	12	12	3	3	4



Fig. 2b. Same patient six days later — entire surface is covered with fresh epithelium. Skin after burn shows decreased elasticity. The patient performs movements in the shoulder joints unwillingly.



Fig. 2c. Control 15 days after accident. The skin has normal elasticity, its appearance is normal and movements are free.

Non-infected areas of deep burns (3rd degree) healed within 16 days (9 cases). Epithelization started mainly from the wound edges with only traces of epithelial regeneration originating from the remnants of skin elements in the depth of the lesion.



Fig. 3a. Patient B. W. Condition fourth day after sustaining burns by electric sparking. On day of accident silicone tulle was applied without removing blisters. The contents of blisters have somewhat decreased.

Tab. 2. Duration of Treatment — Hospital Patients.

Type of burn		Number of cases	Duration of treatment						
			8	9—11	12—16	17—25	26—40	41—50	fatal
1	2nd degree 14 to 25%	9	3	4	2	—	—	—	—
2	2nd degree 17%	8	1	—	1	1	3	2	—
3	3rd degree 19%	3	—	—	—	1	—	—	2
	2nd degree 60%								
	2nd degree 62%								
Total		20	4	4	3	2	3	2	2

In the group of infected deep burns healing proceeded more slowly. Three patients healed within 10 days, the others (16 cases) within 11 to 48 days.

The hospital material consisted of 20 cases and was divided into groups according to the depth of the burn. In superficial burns (2nd degree the burned



area averaged 14.25% (9 cases), eight of which healed within 11 days, one in 15 days (16% of body surface).

In the group of mixed burns with a predominance of superficial lesions, two of the eight patients with an average of 17% of body-surface burned, healed within 16 days, four within 40 days and the remainder, i. e. two patients, within



Fig. 3b. Same patient five days later, i. e. ninth day after accident. Entire surface is covered with fresh epithelium; still somewhat rigid. Healing of surface was delayed by time during which the blister was left in place at the beginning of treatment.



Fig. 3c. Same case seventh day after healing (16th day after accident). Remnants of scabs, surface markings of skin restored. Movements almost normal.



58 to 80 days (23% and 27% of body surface burned). In the group of deep burns one patient with burns of 19% of the surface body healed within 20 days, the remaining two with burns involving more than 60% of body surface died.

*Wound pain* receded within a few hours. The very application of the dressing or the paste brought immediate relief. Pain persisting for some time could only be observed in cases of primary infection and lasted until the intense inflammatory excretion was brought under control.

*Oedema* of the tissue surrounding the burn receded within 24 hours. This was observed in patients treated by the open method (paste). Protection of the surroundings by silicone paste which was most valuable in burns of the hand, prevented or liquidated late oedema.

*Infection:* No cases were observed without infection of the discharge from the wound. On infection maceration of the skin was successfully prevented by means of the paste. Silicone was not observed to have an influence on the quality of the discharge or the type of bacterial flora. Wound infection was controlled by the application of compresses with antiseptic solutions. It was ascertained that dry gauze was less hydrophilic due to being impregnated with silicone from the tulle.

*Necrotic tissue* in deep burns, particularly chemical burns, was eliminated very early. Demarcation started on about the 6th to 8th day.

*Granulation:* Three phases were observed. 1. beginning of granulation (up to the 10th—14th day), 2. the phase of levelling and smoothing of pink granulations with slight discharge, 3. the phase of stagnating proliferation with the granulations getting paler and discharge more copious.

*Scars and rehabilitation:* Rapid epithelization made it possible to shorten the time of immobilization. Full function was already regained a few days after the ending of immobilization, and in the majority of cases even without rehabilitation. A few weeks later the sites of burns, even infected burns, were almost invisible. Because of spontaneous epithelization, the scars, which developed after deep burns, were often fine, mobile and sometimes quite indiscernible (in the face), which may be explained by the quite thin layer of granulations together with the presence of subcutaneous tissue in the scar bed. Contracting rigid scars were observed only in cases of protracted treatment due to infection which was difficult to control. During the second and third week an increased vulnerability to minute trauma with the appearance of small blisters filled with serohaemorrhagic fluid was observed. Rehabilitation was carried out with the aid of paraffin baths (45° C) and the rubbing-in of hyaluronidase.

#### DISCUSSION

The detrimental influence of a moist milieu to a wound during the course of the treatment of burns is universally stressed. Highly hydrophobic silicones were used in order to have an active effect on the discharge.<sup>1 3 4 9)</sup> The mode of action of silicones is not yet quite clear. There are probably two factors: 1. decreased permeability of the cell surface due to impregnation with a hydrophobic substance, 2. protection of the newly formed epithelial cell from

maceration and destruction by the lytic ferments of the discharge. Their protective properties against digestive ferments have been described separately.<sup>3)</sup>

The rapid recession of the oedema in the surroundings, the considerable decrease in the amount of discharge and the protection of the surroundings from maceration may be considered the main factors effecting the decrease of infection. In case of infection the use of silicone tulle permits the application of antiseptics and antibiotics.<sup>3 6 11)</sup> Although apparently paradoxical, it is also possible to use compresses prophylactically. The inhibitory influence of silicones on the proliferation of granulation tissue is regarded as an advantage, since it results in a thinner base for the future scar. The main field of application for silicones is therefore, superficial burns, although in deep burns they can be of great help in controlling complications arising from a moist milieu.

Further research must not neglect the influence of silicone on blood coagulation. Lengthening of the clotting time was found *in vitro*.<sup>4 9)</sup> The possibility of silicone having carcinogenic properties, which are ascribed to almost all artificial substances, has likewise not yet been ruled out.

#### S U M M A R Y

The authors aimed at decreasing the discharge from the affected skin surface, since apart from worsening the general condition it has an adverse effect on regeneration, facilitates infection, and leads to increased skin loss. They made use of the highly hydrophobic properties of liquid silicones which they applied as a 1% ointment on tulle or as a 5% paste protecting the surroundings of the burn. Experiments on white rats showed that silicones are not toxic, evoke only a minimum tissue reaction, and are not absorbed. Fiftyfive patients with minor burns of the face and hands were treated by this method in out-patients and 20 in hospital. When treating by the closed Allen-Koch method the authors used tulle, soaked as in the open method with silicone paste, which protected the surroundings of the burn. Non-infected burns of 2nd degree healed within seven days. Infected burns were treated with compresses and their mean time of healing was 12 days. Silicones protected the surface and the surroundings of the burn.

In the author's opinion the healing of deep burns was also improved. The above method is recommended for the treatment of superficial burns, it may, however, also be used in deep burns.

#### В Ы В О Д Ы

**Местное лечение ожогов при помощи силиконов. Новый способ обеспечения сухой среды**

T. Adamczak, S. Maciejczyk

Авторы намеревались уменьшить выделение из поврежденной поверхности кожи. Это выделение не только ухудшает общее состояние больного, но еще имеет плохое влияние на регенерацию, облегчает происхождение инфекции и ведет к большой потере кожи.

Авторы использовали при лечении ожогов сильно гидрофобную собственность жидких силиконов, которые они применяли как 1% мазь (только насыщенный мазью) или 5% пасту для обведения отпаренной поверхности.

Экспериментальные исследования на белых крысах показали, что силиконы являются не токсическими. Они дают только незначительную реакцию тканей и не впитываются.

55 больных с небольшими ожогами (лицо, рука) были лечены в поликлинике (амбулатории), а 20 больных с более пространными ожогами в хирургическом отделении.

В лечении методом закрытия по Аллену-Коху использован был тюль насыщенный силиконами, в лечении открытым методом (лицо) — силиконовая паста, которая покрыла также окрестность повреждения, чтобы повреждение сохранилось перед мацерацией. Не инфицированные ожоги II степени зажили обычно через 7 дней. При поверхностных инфицированных ожогах использовался силиконовый тюль с антисептиками. Таким образом рана защищалась перед невыгодным влиянием на заживание. После преодоления инфекции скоро наступало нарастание эпидермы. Обыкновенно такие раны заживают 12 дней.

При глубоких ожогах было подтверждено авторами прежнее отделение некротических тканей, ограничение перероста грануляции и уменьшение выделения с поверхности. Обведение окрестности пастой сделало возможным местное использование разных средств, предупреждая раздражение тканей. Состояние грануляции ускоряло приживание трансплантатов кожи.

В связи с кратким временем заживания ран конечностей было подтверждено авторами тоже сокращение времени реабилитации. Рубцы после поверхностных ожогов были мягкие, без тенденции к перерастанию, исключая случаи с упорной инфекцией.

Авторы предлагают описанный метод лечения при поверхностных ожогах. Этот метод может быть использован и при ожогах глубоких.

## R É S U M É

### **Le traitement local des brûlures à l'aide des silicones. Une nouvelle méthode de l'accomplissement du milieu sec**

T. Adamczak, S. Maciejczyk

Les auteurs avaient pour le but l'abolissement de la sécrétion de la surface brûlée, qui, à part de l'aggravation de l'état général, cause des troubles point négligeables de la régénération, facilite l'infection elle-même et, par là, aggrandit les pertes de la peau. Ils viennent d'utiliser les qualités hydrophobes des silicones liquides, qu'ils avaient appliqué sous forme d'une pommade d'un pour cent dans de tulle gras, ou de la pâte de quinze pour cent, servant à la protection des alentours de la surface brûlée. En expérimentant sur des rats blancs, ils ont donné l'épreuve de la non-toxicité des silicones, en découvrant, en même temps, rien qu'une petite réaction des tissus et le fait de l'absorption absolument nulle.

On a soigné, à l'aide de cette méthode, 55 des malades aux brûlures pas étendues de la face et des mains au lieu de pansement, 20 des malades ont été soignés dans les hôpitaux. En utilisant la méthode au pansement d'Allen-Koch, on employait le tulle à la pommade aux silicones; ceux, qui ont été soignés au ciel ouvert, avaient les alentours de la surface brûlée protégés par la pâte aux silicones.

Les surfaces à non-infection ont guéri en sept jours. Celles, qui ont subi l'infection, étaient traitées par des compresses, le temps moyen de la guérison comptant douze jours. Les silicones protégeaient la surface même ainsi que ses alentours.

Les auteurs sont d'avis que la guérison des brûlures plus profondes vient d'être, à son tour, influencée au sens d'ammélioration. Ils recommandent la méthode décrite pour le traitement des brûlures superficielles, mais on peut s'en servir de même chez les profondes.



## ZUSAMMENFASSUNG

### Die Lokalbehandlung von Verbrennungen mit Sillikonen. Eine neue Methode zur Sicherstellung eines trockenen Milieus

T. Adamczak, S. Maciejczyk

Den Autoren handelte es sich um eine Sekretionsverminderung aus den geschädigten Hautflächen, die neben einer Verschlechterung des Allgemeinzustandes die Regeneration ungünstig beeinflusst, die Entstehung einer Infektion ermöglicht und zu einem grösseren Hautverlust führt. Sie verwerteten die stark hydrophoben Eigenschaften von flüssigen Sillikonen, die zwecks Schutzes der Umgebung von Verbrennungen in Form einer 1% Salbe oder in Form einer 15% Pasta verbraucht wurden. Die experimentellen Versuche an weissen Ratten erwiesen, dass Sillikone nicht toxisch sind, geringfügige Gewebsreaktionen verursachen und nicht resorbieren. Es wurden 55 Kranke mit weniger ausgedehnten Gesichts- und Handverbrennungen ambulant behandelt und 20 Kranke hospitalisiert. Bei der Behandlung mittels geschlossener Methode nach Allen und Koch, wurde wie bei der offenen Methode ein mit Sillikonpasta imprägnierter Tüllstreifen verwendet, der ebenfalls die Umgebung der Verbrennung schützte. Nicht infizierte Verbrennungen zweiten Grades heilten bis zu 7 Tagen. Infizierte Verbrennungen wurden mit Umschlägen behandelt, die Heilungsdauer betrug 12 Tage. Sillikone schützten die Oberfläche und Umgebung der Verbrennungen.

Die Autoren nehmen an, dass auch die Heilung von tiefen Verbrennungen besser ist. Sie empfehlen die beschriebene Methode bei Oberflächenverbrennungen; eine Verwendungsmöglichkeit besteht ebenfalls bei tiefen Verbrennungen.

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## SOME ASPECTS OF TRANSPLANT OF STORED BONE\*)

J. P. REIDY

In Plastic Surgery, there is a need for bone as inlay and onlay grafts in adults, particularly for jaw deformities, facial and nasal deformities. The patients' own bone (autogenous) is as a rule, in sufficient supply to meet their own requirements.

A. In children, there is a similar need for bone to correct deformities of congenital, traumatic and surgical origin.

In certain congenital jaw deformities, osteotomy of one or both rami is indicated, with the insertion of bone both as inlay and onlay grafts, into the gap. At Stoke Mandeville, we have been prepared to do this between 8 and 12 years of age.

B. Again in children, severe nasal obstruction is common. This follows septal distortion by trauma, and also the maldevelopment of the septal cartilage and vomerine spur in unilateral clefts of lip and palate.

It is not always possible to clear the nasal airway by partial submucous resection. Oto-rhinolaryngologists are, in fact, reluctant to perform a partial resection at an early age. More often than not, the child is left to the age of 17 or 18 years of age in a state of continuous partial nasal obstruction and mouth breathing.

For many years I have been prepared to clear the nasal airways as early as 7—8 years of age, even to the extent of performing a total submucous resection of septal cartilage. I believe that good nasal breathing is preferable to nasal obstruction, and I believe that the depression of the lower nasal bridge line which follows total submucous resection, and many partial resection, is better than the certainty of mental and physical deterioration following years of mouth breathing. The removal of the septal support not only produces the depression, but also reduces the stimulus to growth of the soft tissues of the nose, which may therefore lag behind that of the rest of the face.

### SURGICAL PROBLEM

The net result of surgery to jaw, face and nose in children was to create a demand for a rigid material for construction, and for contour, and to stimulate nasal growth. Autogenous bone was the natural choice for replacing gaps in bone

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\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

and for restoration of contour, although for contour other materials have been used, such as fat, cartilage, dermis, and inert plastic substances.

The use of autogenous bone in children is, however, attended by certain grave drawbacks.

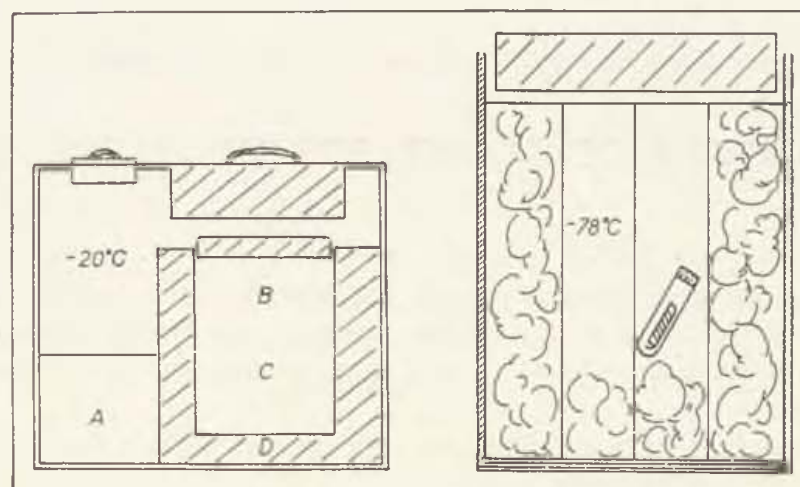


Fig. 1a.

Fig. 1b.

Fig. 1a. Diagram of deep-freeze apparatus. — Fig. 1b. Diagram of Perspex box, showing compartments, with Drikold.

Firstly, the approach to the iliac crest demands reflection of the epiphyseal cartilage, and its replacement after resection of bone from the ilium. This is a major procedure in a child, and one to be avoided if possible, and certainly not repeated.

Secondly, autogenous bone inlay (i.e. in continuity) in a child survives, but as a bridge piece on the nose and or other forms of contour restoration, the same bone is frequently absorbed. In any case, nasal grafts do not grow and there is a need to put in a larger graft every 2—3 years to stimulate soft tissue growth, until at about 18 years when facial growth ceases and the final graft may be inserted.

In order to avoid a major procedure in a child, and certainly any repetition, thoughts turned to using homogenous bone in the hope that it would provide an easily obtained substitute. With the provision of homogenous bone there arose the need for storage of stocks.

#### HISTORY OF STORAGE AND HISTOLOGY

In 1867, Ollier showed that a temperature below  $16^{\circ}\text{C}$  delayed the rate of putrefaction and by freezing bone he transplanted it from one animal to another. Macewen (1881), Carrel (1908), and Calvé (1935), were all interested in the use and storage of homogenous bone.

Inclan (1942) reported on his use of homogenous and autogenous bone grafts refrigerated in citrated blood. He used preserved autogenous bone where a 2-stage procedure was indicated, and used autogenous and homogenous grafts for spinal fusion in children.

Wilson (1951) reviews the literature quoting the work of Ollier, Albee, Carrel and others in this field. He refers to experiences in World War II and the formation of a bone bank in New York in 1946. He carried out clinical studies with autogenous and homogenous bone, using inlay grafts only, in adults.

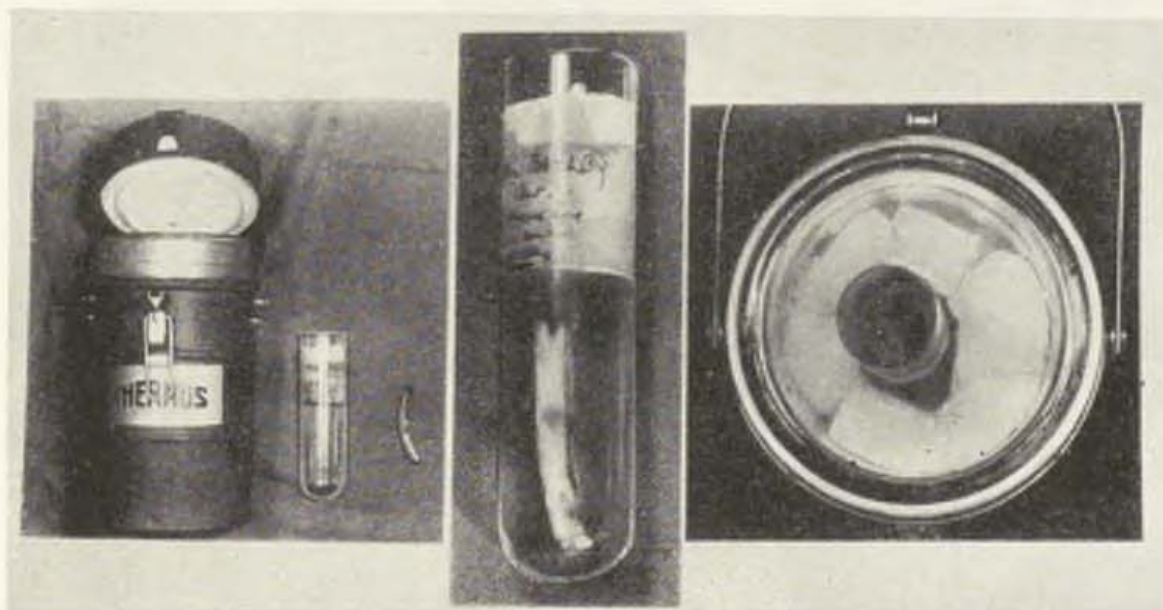


Fig. 2a.

Fig. 2b.

Fig. 2c.

Fig. 2a. Thermos flask, glass tube, piece of rib. — Fig. 2b. Glass tube containing rib bone. — Fig. 2c. "Aerial" view of glass tube, within the flask plus solid  $\text{CO}_2$ . Glass tube is normally sealed with rubber cap.

He also discusses the theories of bone formation in grafts, and cites Phe-mister (1935) "creeping replacement".

Wilson thinks that homogenous bone gives results compatible with those of fresh autogenous bone.

Ray, Degge and others (1952) experimented with the behaviour of autogenous and homogenous grafts in ectopic sites.

Woodruffe (1952) thinks that homogenous bone transplants are replaced by "creeping replacement", but that massive homografts appear to be inferior to autografts.

Hutchison (1952), after various experiments, reaches the same conclusion as Woodruffe.

Campbell (1953) experimented with fresh and frozen grafts of autogenous and homogenous bone, boiled homogenous bone and os purum and studied the extent of osteogenesis where the grafts were applied to muscle and to rib.

De Bruyn and Kabisch (1955) say that implants of frozen autogenous and frozen homogenous bone give less stimulation of osteogenesis than do fresh auto-genous grafts.

Curtiss and Herndon (1956) looked for an immunological factor where homo-genous bone transplants are concerned. They found that there was no retention





Fig. 4. 12. 2. 1955. (Treacher Collins Syndrome) Compare X-rays 4. 10. 1954 (Agenesis lower jaw). — Fig. 5. 6. 3. 1956. Osteotomy premolar region - stored homogenous bone. — 19. 9. 1956. Improved contour.





Fig. 6. (6. 10. 1958) Maintenance of contour. (17. 4. 1960) [compare Fig. 7].

of living cells and that osteogenesis was slow. There was no influence from the blood type of the donor dog.

Chalmers (1959) was also interested in transplantation immunity in bone homografting and thought that there is evidence for an antibody responsible for bone homograft rejection. He states that bone and skin homografts have antigens in common, altered by freeze drying. He concludes that (1) bone homografts (alive or dead) make no significant contribution of living bone tissue.

(2) There is no advantage of living homograft over preserved material and that in fact the latter is preferable in view of its altered antigenicity.

(3) Lack of living cells in homograft (and slower absorption) could account for differences in clinical behaviour between autografts and homografts.

Bush (1947) showed in animals that with an autogenous bone graft, the deeper cells of cortical bone die, while sub-periosteal and endosteal cells live and form new bone. New bone, therefore, is formed by surviving bone cells of the graft, by cells of the host and by metaplasia of connective tissue cells.

Experimentally, Marrangoni (1951) used autogenous cortical bone (deep frozen at  $15^{\circ}$ — $25^{\circ}$  C), and showed that there was very little osteogenic potential in a transplant, which is invaded by osteoblasts from the host side. In frozen



Fig. 8a.

Fig. 8b.

Fig. 8c.

Fig. 8a. Nasal depression. December 1953. — Fig. 8b. Homogenous bone graft. April 1954. — Fig. 8c. Absorption of bone graft. July 1955.

homogenous transplants, there is connective tissue change before invasion by osteoblasts from the host. The cells in the homogenous graft are not viable, and if homogenous bone chips are used, cancellous bone is better than cortical.

#### PRESERVATION OF BONE

The deep freeze method commends itself to me rather than those using chemicals or freeze drying.

The deep freeze apparatus used at Westminster Hospital is that described by Oakland (1954). It consists of an electric ice-cream conservator giving a temperature of  $-20^{\circ}\text{C}$ . Within this lies a perspex box insulated with glass wool from the conservator, and covered with an insulated lid. The centre of the perspex box contains the glass tubes holding the bone specimens, and this is surrounded with solid carbon-dioxide ( $\text{CO}_2$ ) (Drikold) giving a temperature of  $-78^{\circ}\text{C}$ . Solid carbon-dioxide is added daily.

The bone (taken under aseptic conditions) is stripped of all soft tissue, and sealed within a dry sterile tube. The tube is then immersed in alcohol/solid  $\text{CO}_2$  mixture for ten minutes at  $-78^{\circ}\text{C}$ . Rapid freezing is obtained and the tube (with its graft) is placed in the centre of the perspex box until required.

When a graft is required, a tube containing a suitable amount of bone is withdrawn from the bank and placed in a Thermos flask containing crushed solid  $\text{CO}_2$ . This flask is the means of transport to the operating theatre, and allows a margin of time of about 12 hours without adding further solid  $\text{CO}_2$ .

SOME ASPECTS OF TRANSPLANT OF STORED BONE



Fig. 3a.

Fig. 3a. Cyst of humerus (6th September 1954). Bone chips applied. — Fig. 3b. Stored homogenous bone chips (Feb. 1955) — consolidating.

Fig. 3b.





4. 10. 54.



5. 11. 56.

Fig. 5. 4. 10. 1954: Deformity of lower jaw. 5. 11. 1956: To show osteotomy in premolar region (6. 3. 1956) and osteotomy at angles (November 1956). Homogenous bone grafts to each site.





5. 5. 59.



11. 4. 60.

Fig. 7. 5. 5. 1959. Shows consolidation of bone grafts.



Fig. 10. Treacher Collins Syndrome (compare Fig. 9) patient B.S. — 13. 6. 1956: Absent malar bones. — 12. 11. 1956: Homogenous bone chips to malar regions. — 2. 5. 1960: Complete absorption of bone grafts.

V. Rapant, R. Kodousek

REPLACEMENT OF OESOPHAGEAL MUCOSA BY A VASCULAR  
GRAFT



Fig. 2.



Fig. 3.



Fig. 4.



Fig. 5.



Fig. 8.



Fig. 8.



Fig. 9.



Fig. 10.



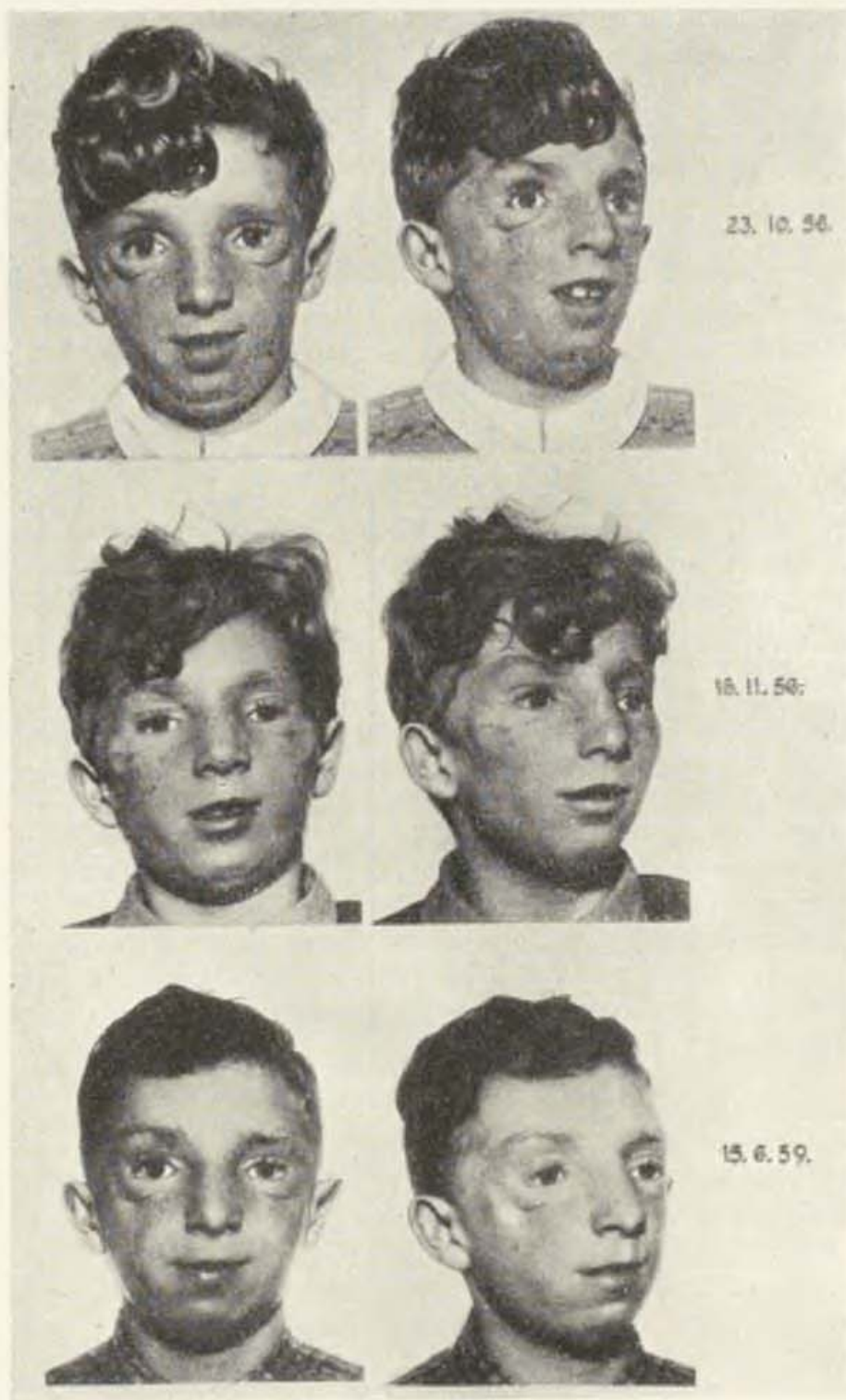


Fig. 9. Treacher Collins Syndrome (compare Fig. 10) patient B. S. — 23. 10. 1956: Underdevelopment of malar bones. — 16. 11. 1958: Homogenous bone grafts to malar regions. — 15. 6. 1959: Absorption of homogenous bone grafts.

In the theatre, the glass tube is opened and the graft tipped into a bowl of normal saline at room temperature. It is then ready for use.

#### SOURCES

Bone for storage can be obtained at operation for thoracotomies, and amputations. Bone can also be obtained from cadavers and must be removed, within six hours of death, under strict asepsis.

All soft tissue is stripped from bone, and pieces of bone are placed within a sterile glass tube which is sealed with an adhesive cover.

Tubes must be labelled the name of the donor and the date, and a record book kept.

#### PRECAUTIONS

Blood grouping is not necessary.

Smear for bacteriology must be taken from all specimens.

Those donors and cadavers must be avoided who have had a history of malaria, hepatitis, poliomyelitis, tuberculosis, syphilis, pyogenic infections and malignancy.

#### INDICATIONS (for bone homografts)

For the most part, previous writers have used stored bone for orthopaedic conditions, e. g. fractures, cyst cavities, and stabilisation of the lumbar spine. These are essentially inlay operations, with a high rate of success. Where children have been treated, only stabilisation of lumbar spine has been instanced.

From the plastic surgical point of view, children and adults have been treated with both inlay grafts, with two objectives — first, to avoid major (and possibly repetitive) surgical procedures in children in particular, and in adults also, secondly, to provide an adequate supply of bone for inlay (repair) and onlay (contour) purposes.

#### RESULTS (Plastic Surgical Series)

Inlay grafts to mandible have been satisfactory.

In the cases under observation, the position of the lower jaw and the bite have been maintained, clinically. Radiologically, the homogenous bone has been replaced by normal bone and no line of demarcation is visible.

I reported (1956) that onlay grafts to the nose were unsatisfactory, and no more have been done, but at that time I had formed a favourable impression of those onlay grafts as applied to the malar and jaw. I now report that these onlay grafts (malar and jaw) are also unreliable.

#### SUMMARY

1. Autogenous bone is an ideal material for restoration of facial contour, but in children its use brings its own problems — and in some opinions these problems are undesirable.

In both children and adults, the use of autogenous bone for contour is not completely reliable since it may be absorbed in children, and more slowly in adults.

2. For many years, homogenous bone has been used successfully in adults and in children for inlay support and reconstruction.

3. This paper draws attention to the failure of homogenous bone when used for contour only.

The fact that homograft onlay bone is unreliable may be due to the fact that scaffolding only is present and creeping substitution is slow and incomplete — by which time some of the mineral content has been absorbed.

The concept of a "pattern of contour", peculiar to facial bones, is attractive. While this may explain the absorption of homogenous onlay bone, it does not explain the retention of autogenous onlay bone for long periods.

4. On the other hand, it is not enough to rely on inert plastic material, and on dermo-fat grafts for contour, and further studies on the behaviour of homogenous onlay bone are in process.

## ВЫВОДЫ

### Несколько замечаний к пересадке консервированной кости

J. P. Reidy

1. Аутогенная кость представляет собой идеальный материал для восстановления рельефа лица, но у детей возникают при этом особые проблемы, благодаря чему некоторые авторы в таких случаях отвергают применение ее.

У детей и у взрослых применение аутогенной кости для восстановления рельефа не является вполне эффективным, так как трансплантат может рассосаться; главным образом, это происходит у детей, но медленно также и у взрослых.

2. В течение многих лет гомогенные трансплантаты применяются у детей и у взрослых в качестве вкладываемых трансплантатов с хорошими результатами при скрепляющих или восстановительных операциях.

3. В предлагаемой работе обращено внимание на безуспешность применения гомогенных костных трансплантатов, если они применены только лишь для реконструкции рельефа.

Тот факт, что гомотрансплантат, примененный для прикладывания, не является надежным, мог бы основываться на том, что такой трансплантат представляет собой только «леса», а «ползучее замещение» происходит лишь медленно и не вполне; но именно в это время рассасывается часть минерального состава трансплантата.

Концепция «выполнения рельефа» („pattern of contour“), характеристичного для костей лица, является привлекательной и объясняет рассасывание гомогенного прикладываемого трансплантата. Не объясняет она, однако, почему аутогенный прикладываемый трансплантат сохраняется в течение долгого времени.

4. С другой стороны, однако, нельзя при восстановлении рельефа возлагать надежды на инертные пластмассы и на трансплантаты кожи с жиром.

В настоящее время мы продолжаем дальнейшее изучение поведения гомогенных прикладываемых трансплантатов.

## R É S U M É

### Quelques aspects du problème de la transplantation de l'os conservé

J. P. Reidy

1. L'os autogène constitue un matériel de choix pour la reconstruction du relief facial, mais s'il s'agit d'enfants, il s'y posent des problèmes spéciaux à cause desquels certains auteurs refusent de l'employer dans ces cas.

Chez les enfants aussi bien que chez les adultes, l'emploi de l'os autogène pour la restauration du relief ne donne pas toujours entièrement satisfaction, étant donné que le greffon peut se résorber, ce qui arrive surtout chez les enfants et, plus lentement, chez les adultes aussi.

2. Depuis de longues années, on se sert des greffons homogènes chez des enfants et des adultes, sous forme de greffon intercalé (inlay), ce qui donne de bons résultats lors des interventions de soutien ou de la reconstruction du relief.

3. Le rapport présenté s'occupe des insuccès des greffes osseuses homoeoplastiques, si celles-ci sont employées uniquement pour la reconstruction du relief.

L'observation que le greffon homoeoplastique sous forme de greffon apposé (onlay) n'est pas satisfaisant, s'expliquerait par le fait qu'un tel greffon ne constituerait qu'un «échafaud», et la «substitution rampante» («creeping substitution») ne se fait que lentement et de façon incomplète. Et c'est à cette période qu'une partie de la substance minérale du greffon est résorbée.

La conception du «maintien du relief» («pattern of contour») caractéristique pour les os faciaux est séduisante et explique la résorption du greffon homoeoplastique apposé (onlay). Mais elle n'explique pas la raison pour laquelle le greffon autoplastique apposé (onlay) se conserve pendant très longtemps.

4. D'un autre côté, on ne peut pas se fier aux substances plastiques inertes et aux greffons cutanés et lipidiques pour arriver à la reconstruction du relief.

Nous allons continuer à étudier le comportement des greffons homoeoplastiques apposés (onlay).

## Z U S A M M E N F A S S U N G

### Einige Aspekte der Transplantation von konservierten Knochen

J. P. Reidy

1. Autogener Knochen ist ein ideales Material für die Rekonstruktion der Gesichtskontur; bei Kindern ergeben sich hierbei jedoch besondere Probleme und deshalb lehnen manche Autoren diese Methode in solchen Fällen ab.

Bei Kindern und bei Erwachsenen ist die Verwendung von autogenem Knochen für die Rekonstruktion der Gesichtskontur nicht vollkommen zuverlässig, da der Knochenspan resorbiert werden kann, besonders bei Kinder, etwas langsamer auch bei Erwachsenen.

2. Seit vielen Jahren benützt man homogene Knochenspäne bei Kindern und Erwachsenen als Inlay-Transplantate mit ausgezeichneten Ergebnissen bei Stütz- und Rekonstruktionsoperationen.

3. Die vorliegende Arbeit weist auf Misserfolge mit homogenen Knochenspänen hin, wenn diese lediglich für die Rekonstruktion der Gesichtskontur benützt werden.

Die Tatsache, dass das als Onlay-Transplantat verwendete Homotransplantat unzuverlässig ist, könnte darauf beruhen, dass so ein Knochenspan bloss ein „Gerüst“ darstellt und der „schleichende Ersatz“ nur allmählich und unvollkommen vor sich geht. Während dieser Zeit wird ein gewisser Teil des Mineralgehalts des Transplantats resorbiert.



Die Konzeption eines bestimmten Konturmusters, das für die Gesichtsknochen charakteristisch sein soll, ist anziehend und erklärt die Resorption eines homogenen Onlay-Knochenspanns, liefert jedoch keine Erklärung dafür, warum ein autogenes Onlay-Transplantat lange Zeit erhalten bleibt.

4. Andererseits kann man sich jedoch nicht auf inertes plastisches Material und auf Haut-Fettgewebe-Transplantate bei der Rekonstruktion der Gesichtskontur verlassen.

Der Verfasser setzt seine Studien über das Verhalten homogener Onlay-Knochenspäne fort.

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## REPLACEMENT OF OESOPHAGEAL MUCOSA BY A VASCULAR GRAFT\*)

V. RAPANT, R. KOĐOUSEK

In the surgery of benign disorders of the oesophagus we not infrequently meet with an anatomical lesion confined to the mucosa and submucosa, whereas the muscularis has remained intact. For instance, there are some types of tubular stenosis after *corrosion* by alkali or acids and the other following *reflux oesophagitis* where the location of the subsequent fibrotic changes does not permit extramucous extirpation of the callous masses according to Allison (Fig. 1) or where the extent of these changes prevents resection of the affected parts with subsequent re-suture. This also applies to direct operations on the oesophagus in the case of *oesophageal varices* due to pre- or intra-hepatic hypertension, where resection of the mucosa for 2 to 3 cm., as recommended and repeatedly performed by the author, interrupts the porto-systemic connections above the oesophago-cardiac junction<sup>1 2 3)</sup> and, at the same time, removes the part of the oesophageal mucosa which is the most dangerous with regard to haemorrhage and the most inaccessible by any known surgical method, *but does not* prevent renewed link-up of the portal vascular system with the submucous veins of the oesophagus.

Thus in the patient S. J., a girl of eight with prehepatic hypertension (Fig. 2, 3) in whom a splenorenal anastomosis was performed without success, the author achieved a perfect result which has been maintained for 33 months by this type of resection (Fig. 4). On the other hand in the patient A. O., a boy of six, who also suffered from prehepatic hypertension with approximately the same extent of oesophageal varices (Fig. 5), no haemorrhage occurred after resection performed 29 months previously, but the X-ray (taken on March 17th, 1960) showed renewed signs of varices (Fig. 6) even though of small extent.

The authors, therefore, tried to eliminate these shortcomings by means of a vascular graft and expected that after it anatomical and — to a certain extent — also functional transformation the transplant would replace the pathologically changed oesophageal mucosa removed by resection. In cases of long oesophageal stenosis, following a lesion confined to the mucosa and submucosa, which makes segmental resection of the entire wall and re-suture impracticable, it would be

\*) Delivered at the International Symposium of Plastic Surgery in Mariánské Lázně (Czechoslovakia), June 28, 1960.

possible to avoid such measures which are frequently mutilating, always serious and complicated, and from the point of view of renewal of the passage not yet free from grave consequences. To the latter belong the reflux of gastric juice into of the oesophagus after transposition of the stomach intrathoracally, and stagnation of the intestinal contents in the interposed loop of large intestine



Fig. 1. A fibrous strip causing stenosis of oesophagus has been resected through a longitudinal myotomy [according to Allison: J. thorac. Surg. 32 :150, 1956].

which many surgeons now prefer to a jejunal loop for replacing resected parts of the oesophagus.

The authors regard the indications for replacement of the oesophageal mucosa by means of a vascular graft as becoming more frequent in the treatment of bleeding oesophageal varices following portal hypertension, particularly of the prehepatic type, where the direct anastomosis between the vena portae and v. cava is rarely practicable and the spleno-renal anastomosis, perhaps with the exception of suitable anatomic conditions for central anastomosis (Clatworthy<sup>4</sup>), frequently ends up with an early obliteration by thrombosis. The vascular graft replacing the part of the oesophageal mucosa resected for varicose changes prevents the portal system from linking up with that of the superior vena cava, to which the blood from the oesophageal mucosa situated above the graft is drained. Thus recanalization of the thrombotic veins of the oesophageal submucosa after transoesophageal,<sup>5</sup>) extramucous<sup>6</sup>) or extramucous<sup>7</sup>) suture is also prevented. The vascular graft, however, cannot prevent the formation of varices in the mucosa laying above it, in the case of the valves of the perforating veins, which under physiological conditions drain the blood from the submucous

venous plexus of the oesophagus into the perioesophageal veins, becoming insufficient<sup>8</sup>).

#### EXPERIMENTAL PART

In experiments on dogs the authors resected 4—5 cm. of mucosa by dissection through a longitudinal myotomy 6—8 cm. in length and replaced it by a vascular



Fig. 7. Dog No 9, resected mucosa replaced by aortal graft; condition three months after operation. Anatomically perfect take of graft with slight longitudinal retraction. Oesophagus above the graft is slightly dilated, at the site of graft (marked by arrows) quite patent.

graft. Either fresh transplants or transplants stored in blood plasma for two to eight days were used.

In dogs in contradistinction to man, the freeing of the mucosa from the muscularis is much more difficult and can only be effected by dissection with a sharp instrument. It is necessary to take great care in controlling any haemorrhage from the musculature (by coagulation), so that haematoma formation does not prevent the early accolement of the mucosa to the musculature. In the beginning, therefore, the authors fixed the graft to the muscularis with a few mattress sutures penetrating both the graft and the muscle and knotted outside the musculature. Soon, however, this was abandoned as superfluous. The dogs did not receive antibiotics. Already the first day after operation they were given fluids per os, after 6 to 7 days they received semi-fluid food, and after further 6 to 7 days normal food.



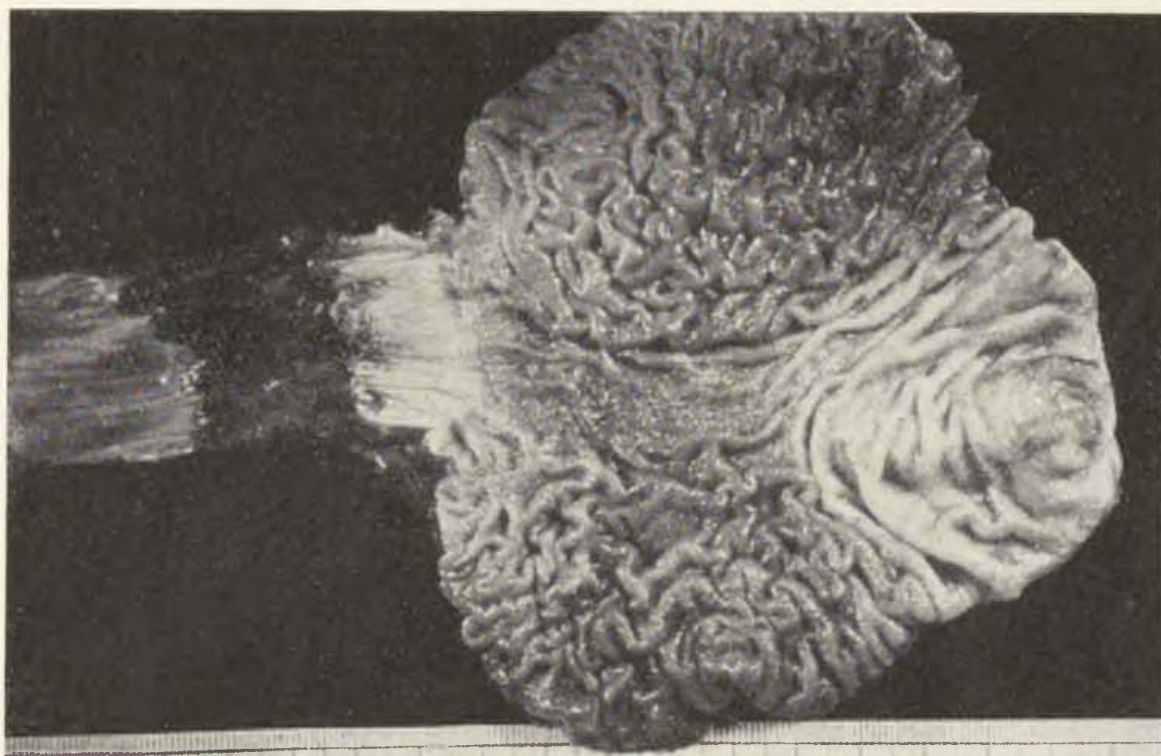


Fig. 11. Dog No 34, macroscopic picture seven days after transplantation of venous graft: continuous granulating area at the site of graft.

As post-operative complications — apart from those causing death of the animal (see Tab. 1) — only vomiting was registered which in venous transplants passed off comparatively soon and was always caused by incongruence of the oesophageal mucosa.

In the first series of experiments (six dogs) the resected mucosa was replaced by an *aortal graft* of 4.5 cm. mean length. The lower anastomosis was made 0.5 cm. above the anatomical cardia in four dogs, all of whom died. In two other dogs the anastomosis was placed at the level of 1.5 cm. and of 3 cm. respectively above the cardia, and both dogs survived the operation. In two dogs incongruence of calibre of the aortal graft and the oesophagus caused fatal me-

Tab. 1.

Graft	No.	Survival	Deaths	Cause of death
Aortic	6	2	66.6%	Leak at anast. 2 Leak at suture 1 Perforation 1
Single venous	16	14	12.5%	Hemothorax 1 Contamination 1
Double venous	4	2	50.0%	Leak at suture 2

diastinitis due to leakage once at the upper and the other time at the upper and lower anastomosis. Once mediastinitis occurred through leakage in the longitudinal suture of a two-piece graft, another time following perforation of the oesophagus by a straw. In the remaining two dogs the graft took perfectly. Although anatomically the passage through the graft remained good (Fig. 7) in the sur-



Fig. 12. Dog No 34, microscopic picture seven days after transplantation of venous graft: proliferating granulation tissue and remnants of elastic lamellae.

viving two dogs persistent rigidity of the graft caused *functional stenosis* (X-ray Fig. 8) followed by progressive cachexia, and for which, the animals had to be killed, one after two and a half, and the other after three months.

In the second series of 20 dogs the resected part of oesophageal mucosa was replaced by a *venous graft* taken from the superior, rarely from the inferior vena cava. To avoid incongruence of calibre two grafts joined longitudinally were used in four dogs. The length of the venous grafts varied between 3—5 cm. In eight dogs the lower anastomosis was made at a distance of 0.3 to 0.5 cm. above the anatomical cardia; neither of the dogs died. In five dogs it was made 1—2 cm above the cardia (two died). In seven dogs 2—5 cm. above the cardia and of this group two dogs, both with a two-piece graft, died.

From the total of 16 dogs, in whom one continuous graft was used, two died, one from haemothorax, the cause of which could not be ascertained, the other from contamination during operation. *No dog died from leakage at the site of anastomosis of the graft with the oesophageal mucosa.* Two out of four dogs with a two-piece graft died, both because of a 5 and 7 mm. leak respectively at the site of the longitudinal suture joining both parts of the graft. This may have been due to faulty technique of the longitudinal suture, since only continuous suturing was used.

If the calibre of the venous graft corresponded to that of the oesophagus the post-operative course proceeded without the slightest complication and on X-ray

there were no morphological or functional changes in the passage of the oesophagus. If the calibre of the graft was substantially smaller than that of the oesophagus the dogs sometimes started to vomit as soon as they were given semi-solid or solid food. On X-ray signs of stenosis could be ascertained. Gradually, however, the condition improved and the X-ray signs of stenosis also disappeared (X-ray — Fig. 9, 10).



Fig. 13.

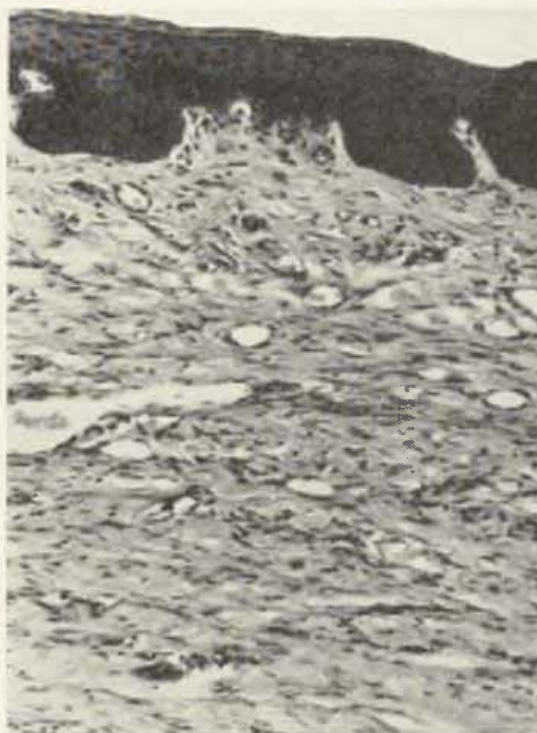


Fig. 14.

Fig. 13. Dog No 26, macroscopic picture 28 days after transplantation of venous graft: graft has taken and except for a few minute islets there is perfect epithelization. — Fig. 14. Dog No 26, microscopic picture 28 days after transplantation of venous graft: perfect fibrous transformation of graft with rudiments of elastic fibres. Except for a few minute islets, epithelization is completed.

Of the remaining 16 dogs 13 were killed at intervals ranging between three days and more than one year. The last three dogs are still alive after one year.

*After one week* (Fig. 11) the implanted graft appears macroscopically as a continuous granulating surface. Microscopically (Fig. 12) the area of resected mucosa replaced by the venous graft shows a continuous layer of proliferating granulation tissue with remnants of elastic lamellae. Epithelization is lacking.

*After four weeks* (Fig. 13) the graft has macroscopically taken and the smoothed-out relief is covered by epithelium with the exception of minute foci of ulceration. Microscopically, complete collagenous transformation (Fig. 14) with rudiments of elastic lamellae can be seen. With the exception of some small islets of granulations epithelization has been completed.



After six months and more the graft has, macroscopically (Fig. 15), taken perfectly. Microscopically (Fig. 16) perfect fibrous transformation of the graft and perfect epithelization has taken place.

#### DISCUSSION

This experimental research was aimed at replacing one of the anatomical structures of the oesophagus, i. e. the mucosa, whilst the other important structure,



Fig. 15.

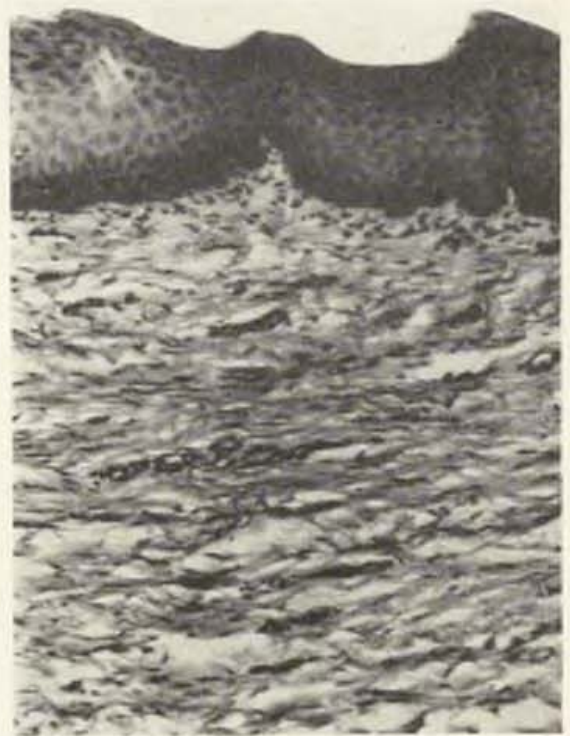


Fig. 16.

Fig. 15. Dog No 23, macroscopic picture six months after transplantation of venous graft: the graft has taken perfectly. — Fig. 16. Dog No 23, microscopic picture six months after transplantation of venous graft: perfect fibrous transformation with perfect epithelization.

the muscularis remained intact. That is the difference between this and other well-known experimental and clinical works dealing with the problem of replacing an resected oesophageal segment. With a few exceptions these works were concerned with the surgery of malignant conditions of the oesophagus where the seriousness of the usual operation as well as the grave prognosis these procedures by were justified. The results achieved are, however, unsatisfactory both immediate and late, and that regardless as to whether the resected parts of the oesophagus were replaced by *artificial prostheses*, rigid or elastic [Berman,<sup>9 10</sup> Maynard et al.<sup>11</sup>] without or in combination with fascia [Moore,<sup>12</sup> Dumm et al.<sup>13</sup>] or a metal net [Braunwald et al.,<sup>14</sup>] by *skin* [Rubenstein,<sup>15</sup> Szábó et al.<sup>16</sup>] or by an oesophageal homotransplant [Rubenstein et al.,<sup>15</sup> Pataky et al.<sup>17</sup>] etc. The final results of replacement by means of organic transplants were made



worse by the graft retracting both in a longitudinal and transverse direction leading to stenosis.

The same fate was experienced by aortal grafts, both hetero- and homologous, as used experimentally by Roux et al.<sup>18)</sup> and in the treatment of malignant tumours by Smith and Raison,<sup>19)</sup> and Rogers,<sup>20)</sup> although the patient's fate was determined rather by the recurrence of carcinoma.

In the authors' experiments the replacement of the mucosa by an aortal homograft did not prove satisfactory. This will have to be supplemented, since it seems that the bad functional result due to the rigidity of the graft was caused particularly by the incongruence of the calibre of the aorta and the oesophagus. When using a venous homotransplant it was ascertained that transformation of the graft as well as epithelization from the edges of the preserved oesophageal mucosa proceeded rapidly which prevented any substantial shrinking in the longitudinal axis, whilst shrinkage in the transverse axis was almost indiscernible. On the contrary, one gained the impression that the graft adapted itself in the transverse axis to the calibre of the oesophagus with normal mucosa.

In the majority of cases the authors placed the lower anastomosis in the close vicinity of the anatomical cardia. Not infrequently the suture penetrated to the borderline between the oesophageal and gastric mucosa. The authors tried to observe whether resection of the most distal part of the mucosa would disrupt the complicated mechanism of closing of the cardia, one component of which, though not the most important, are the folds of mucosa at the site of the cardiooesophageal junction. *In dogs no reflux and thus no endangering of the lower anastomosis occurred.* The significance of reflux to the fate of the venous graft was proved by implanting a venous graft into the gastric wall in its antral part after the excision of its mucosa. The graft was destroyed by autodigestion, and at its site only a stellate scar could be found.

Although the results of experiments on dogs cannot be applied directly to man, and the authors have in mind particularly the problem of the mechanism of closing of the cardia, they, nevertheless, consider that the perfect transformation of the venous graft and its functional adaptation give surgeons a chance of using a venous graft in benign disorders of the oesophagus, where the anatomical lesion remains confined to the mucosa and submucosa leaving the oesophageal muscularis intact. This applies particularly to varices of the oesophagus where such a procedure may prevent recanalization (after suture) or regeneration of new porto-systemic connections (after resection). The same procedure is feasible in a benign stenosis (following reflux oesophagitis or corrosion) where the muscularis is left intact and the length of the stenosis makes resection of the entire part of the oesophagus with end-to-end suture obviously unsuitable and is, therefore, rejected by the authors. At the same time the authors think that the location of the lower anastomosis is not of decisive importance for the fate of the graft and its free passage since the mechanism of closure of the cardia is not disrupted by resection of the most distal parts of the mucosa.

## SUMMARY

Replacement of the oesophageal mucosa, resected around the entire circumference of the oesophagus by longitudinal myotomy, was effected experimentally in dogs by means of a vascular graft. The experiment was aimed at demonstrating the possibility of replacing the mucosa where it was affected in isolation, the muscularis remaining intact. This kind of lesion can be found in some types of stenosis following corrosion or reflux oesophagitis. In bleeding oesophageal varices the described replacement of the mucosa by a vascular graft is also possible and suitable in cases, where, for anatomical reasons, a splenorenal or portocaval anastomosis is impracticable. This is particularly the case in pre-hepatic hypertension with oesophageal varices.

The mucosa was replaced by a homologous aortal graft in six dogs. In those surviving, rigidity of the graft caused cachexia, despite good anatomical patency.

The mucosa was replaced by a vena cava graft in twenty dogs. The transformation of the graft was followed up both macro- and microscopically at intervals of three days to more than one year. This technique shown to be of value by the rapid transformation of the graft with a minimum of retraction in the longitudinal axis and perfect adaptation in the transverse axis. In addition, the mechanism of closure of the cardia remained intact so that healing of the anastomosis was not affected by regurgitation of the gastric contents.

By the experiments described above the authors wished to demonstrate the suitability of a venous graft for the treatment of a lesion confined to the oesophageal mucosa.

## ВЫВОДЫ

### Замещение слизистой пищевода сосудистым трансплантатом

V. Rapant, R. Kodousek

В опытах на собаках решался вопрос замены слизистой пищевода, резецированной по всей его окружности путем продольной миотомии. Замещение осуществлялось при помощи сосудистого трансплантата. Цель экспериментальной работы состояла в исследовании возможности замещения изолированно пораженной слизистой при ненарушенной мускулатуре пищевода, что встречается при некоторых стенозах пищевода, возникающих вследствие коррозии или эзофагита на почве обратного забрасывания содержимого желудка в пищевод. При кровоточащих варикозно расширенных венах пищевода также напрашивается возможность применения этого метода и его целесообразность во всех тех случаях, когда по каким бы то ни было анатомическим причинам нельзя осуществить портокавальный анастомоз; это касается, главным образом, предпеченочной гипертензии с наличием варикозно расширенных вен пищевода.

У 6 собак слизистая пищевода была заменена аортальным гомотрансплантатом. У выживших собак ригидность трансплантата, при хорошей анатомической проходимости, обусловила кахексию собак.

У 20 собак слизистая была заменена трансплантатом поллой вены. Перестройка трансплантата исследовалась путем макроанатомических и микроскопических наблюдений в интервалах от 3 дней до одного года и более с момента пересадки. Быстрая перестройка трансплантата с минимальным сокращением по продольной оси, его способность к полной адаптации по поперечной оси, свидетельствуют о пригодности этого метода. Кроме того

сохраняется механизм закрытия кардии, так что заживление анастомоза не нарушается обратным забрасыванием содержимого желудка.

Экспериментальные результаты указывают на пригодность венозного трансплантата для замещения изолированно поврежденной слизистой.

## R É S U M É

### **Le remplacement de la muqueuse oesophagienne à l'aide d'un greffon vasculaire**

V. R a p a n t, R. K o d o u s e k

Les auteurs tâchent de résoudre la question du remplacement de la muqueuse oesophagienne, dont la résection complète, faite d'une myotomie longitudinale, comprenait toute la largeur de la circonférence d'oesophage. Le remplacement est réalisé à l'aide d'un greffon artériel. Comme animal d'expérimentation, ils ont employé des chiens. Le but du travail était de trouver la possibilité de remplacer la muqueuse endommagée de l'oesophage dont la musculature reste intacte, comme on en voit chez quelques-unes des sténoses, causées par la corrosion ou par le reflux de l'oesophagite. De même, on peut s'en servir au cas des varices oesophagiennes saignantes, partout où l'anastomose porto-cave n'est point praticable faute de difficulté anatomique, comme en est le cas de l'hypertension praehépatique suivit des varices oesophagiennes. Chez les 6 chiens, la muqueuse fut remplacée par un greffon homologue aortique. La rigidité du greffon — en présence même d'un bon passage anatomique — fut cause de la cachexie des chiens en survie.

Chez les vingt chiens la muqueuse fut remplacée par un greffon de la veine cave. La transformation du greffon en période de trois jours à plus d'une année fut étudiée à l'aide de l'examination macro- et microscopique. La transformation rapide du greffon suivie d'une rétraction minimale quand à l'axe longitudinale de même que la faculté d'une adaptation complète quand à l'axe transversale ne fait qu'approuver la convenance d'une pareille méthode. En surplus, le mécanisme de la fermeture du cardia reste intact, si bien que la guérison de l'anastomose n'est point dérangée par le contenu de l'estomac en régurgitation.

Ainsi, on approuve en expérimentation, la convenance du greffon veineux pour le remplacement de la muqueuse endommagée isolément.

## Z U S A M M E N F A S S U N G

### **Der Ersatz der Speiseröhrenschleimhaut durch ein Gefäßstransplantat**

V. R a p a n t, R. K o d o u s e k

In der vorliegenden Arbeit lösen die Verfasser experimentell an Hunden das Problem des Ersatzes der Oesophagusschleimhaut, die im gesamten Speiseröhrenumfang von einer längsgeführten Myotomie aus reseziert worden war. Der Ersatz wurde mit Hilfe eines Gefäßstransplantats verwirklicht. Zweck der vorliegenden Arbeit war der Nachweis, eine isoliert geschädigte Oesophagusschleimhaut bei intakter Muskelschicht, wie wir dies bei manchen Speiseröhrenstenosen als Folge einer Verätzung oder einer Refluxoesophagitis antreffen, ersetzen zu können. Auch bei blutenden Oesophagusvarizen ist dieser Eingriff möglich und zweckmässig überall dort, wo aus den verschiedensten anatomischen Gründen eine portokavale Anastomose nicht durchführbar ist. Dies gilt vor allem für die praehepatische Hypertension mit Oesophagusvarizen.



Bei 6 Hunden wurde die Schleimhaut durch ein homologes Transplant aus Aortenwandmaterial ersetzt. Bei den überlebenden Hunden verursachte die Rigidität des Transplantats die Entwicklung einer Kachexie der Hunde trotz einwandfreier anatomischer Durchgängigkeit.

Bei 20 Hunden wurde die Schleimhaut durch ein Transplantat von der Vena cava ersetzt. Makroskopisch und mikroskopisch wurde der Umbau des Transplantats im Abstand von 3 Tagen bis zu mehr als einem Jahr nach der Operation verfolgt. Der schnelle Umbau des Transplantats mit einer minimalen Retraktion in der Längsachse und die Fähigkeit einer vollkommenen Adaption in der Querrichtung beweisen die Richtigkeit eines solchen Vorgehens. Ueberdies bleibt der Mechanismus des Kardiaverschlusses erhalten, so dass die Heilung der Anastomose nicht durch regurgitierenden Mageninhalt gestört wird.

Experimentell ist somit der Nachweis erbracht worden, daß das Transplantat aus Venenwandmaterial als Ersatz der isoliert geschädigten Oesophagusschleimhaut geeignet ist.

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Text to the illustration on the chalk paper supplement

Fig. 2. S. J., aged eight, splenoportogram proving extrahepatic hypertension due to malformation of portal vein; filling of oesophageal varices from the vena coronaria ventriculi. — Fig. 3. S. J., aged eight, extensive varicosity of oesophagus. — Fig. 4. S. J., X-ray findings 33 months after resection of mucosa. — Fig. 5. A. O., aged six, extrahepatic hypertension due to malformation of portal vein; filling of oesophageal varices through the vena coronaria ventriculi. — Fig. 6. A. O., 29 months after resection of mucosa; slight varicosity of oesophagus. — Fig. 8. Dog No 9, oesophagogram three months after operation shows slight narrowing at the site of aortal graft due to rigidity of graft (see Fig. 7). — Fig. 9. Dog No 19, resected mucosa replaced by venous graft, 23rd day after operation; slight narrowing corresponding to the length of graft. — Fig. 10. Dog No 19, X-ray examination one year after operation shows free passage of oesophagus without any signs of stenosis at the site of the transplanted graft (see Fig. 9).

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PROF. FRANTIŠEK BURIAN, M. D.

## CHIRURGIE ROZŠTĚPU RTU A PATRA

### *Surgery of Cleft Palate and Harelip*

The author of the book presents to the medical circles a picture of the present situation concerning prosoposchisis. At the same time he gives information on the experiences that have been gained in the treatment of these malformations in the course of more than thirty years. In recent decades enormous success has been achieved in therapy of cleft palate and harelip, but, nevertheless, there remains the main problem to be solved- an effort to prevent this defect. A surgeon who wishes to operate fissures, must nowadays be familiar with new operative methods and must form correct idea of the anatomical, physiological and embryological aspect of the defect. The publication contains a description of comprehensive therapy according to a new concept worked out by a group of specialists. Methods of lip and palate operations are described and fully illustrated.

LECT. JAN KUČERA, M. D.

## CHIRURGIE HYDRONEFROSY

### *Surgery of Hydronephrosis*

The author discusses in this book pathology, diagnostics and surgical treatment of hydronephrosis and uretohydronephrosis. After having mentioned the principal anatomical advantages, he pays more attention to the function of the lower urinary tract and to its pathophysiology during obstruction. Longer passages are devoted to the pathology and pathophysiology of the pelviureteral part, to the clinical picture of hydronephrosis and above all to the diagnostic principles. Same care is given to the discussion of uretohydronephrosis. The last chapter deals with laqueus of the small and large intestine in urology. Following brief pathological comments there are elucidated general principles of ileoplasty and coloplasty as well as different operative plastic methods and their indication in surgical treatment of hydronephrosis and uretohydronephrosis. All chapters are illustrated with the author's own experiences.

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