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EPIDEMIOLOGIC RELATIONSHIP OF AGE OF PARENTS TO TYPE AND EXTENT OF FACIAL CLEFTS

L. H. MESKIN, S. PRUZANSKY

INTRODUCTION

Little consistency exists in the results of previous investigations regarding the epidemiologic relationship of parental age to facial clefting. While a number of investigators have demonstrated a strong correlation between advanced parental age and clefting (1, 2) others utilizing the same variable (3, 4) have found no relationship.

Table 1. Mean age of mothers of subjects distributed according to the "Three major group" classification

Group	N	Mean age in years	Statistic
Cleft Lip	54	25.44	
Cleft Lip with Cleft Palate	238	25.91	F = 2.25 df = 2; 502 p = 0.11
Cleft Palate	211	26.93	
Control	503	26.41	F = 1.58 df = 3; 1005 p = 0.20

This inconsistency could be due to one or more of the following.

1. Biased samples or populations.
2. Sampling variability — no true difference exists.
3. Investigator differences in the categorization and collection of data.
4. Inconsistency between investigators in the mode of analysis of data.

Table 2. Mean age of mothers of subjects distributed according to the "Twenty group" classification

Subgroup	N	Mean age in years	Statistic
Complete Bilateral Cleft Lip	3	26.33	Subgroup 1–20 F = 1.16 df = 19; 502 p = 0.28
Incomplete Bilateral Cleft Lip	5	24.40	
Complete Right Side Cleft Lip	3	31.00	
Incomplete Right Side Cleft Lip	15	25.67	
Complete Left Side Cleft Lip	4	31.75	
Incomplete Left Side Cleft Lip	24	23.67	
Complete Bilateral Cleft Lip and Cleft Palate	47	25.89	
Incomplete Bilateral Cleft Lip	49	25.88	
Complete Right Side Cleft Lip and Cleft Palate	31	26.23	
Incomplete Right Side Cleft Lip and Cleft Palate	19	23.84	
Complete Left Side Cleft Lip and Cleft Palate	67	26.76	Subgroup 1–20 and Control F = 1.14 df = 20; 1005 p = 0.31
Incomplete Left Side Cleft Lip and Cleft Palate	25	24.88	
Complete Cleft of Hard Palate	41	26.10	
Incomplete Cleft of Hard Palate	77	26.65	
Complete Cleft of Soft Palate	28	26.50	
Incomplete Cleft of Soft Palate	21	27.33	
Palatal Shortness	15	28.07	
Submucous and Regular Clefts of Complete Soft and Hard Palate	5	28.20	
Submucous and Regular Clefts of Complete Soft, Partial Hard Palate	16	28.25	
Submucous and Regular Clefts of Soft Palate Only	8	28.88	
Control	503	26.41	

While all or none of these factors may be the answer to the inconsistencies noted in previous parental age analysis, the first mentioned item, we believe, warrants thorough investigation.

One of the greatest contributor to biased populations or samples is a pathological state characterized by variable expression. Facial clefts are a prime example, since their expression can range from a minimal, almost unrecognizable, cleft of the uvula to a complete bilateral cleft of the lip, alveolar process and palate. If differences in epidemiologic variables exist within the spectrum of such an entity, and the sample or population utilized for study contains a disproportionate amount of certain segments of that entity, results obtained

from such investigations may not reflect the true state of that particular condition in the universe.

In a previous study it was shown that the more easily recognizable the cleft, the more often is it reported on the birth certificate (5). In addition, facial cleft populations derived from surgical records contain a disproportionate number of the more severe cases since they miss cases not severe enough to present for surgical correction and also those which died before surgical correction was possible.

Table 3. Mean age of fathers of subjects distributed according to the "Three major group" classification

Group	N	Mean age in years	Statistic
Cleft Lip	53	29.28	
Cleft Lip with Cleft Palate	232	29.53	F = 0.38 df = 2; 492 p = 0.69
Cleft Palate	208	29.99	
Control	493	29.62	F = 0.26 df = 3; 985 p = 0.85

Therefore, since birth certificates and surgical records supply the sample or population for the majority of epidemiologic studies on facial clefts, it is essential to know if intergroup differences regarding parental age exist within the spectrum of this condition. For, if such intergroup differences do exist, a serious sample or population bias may have existed in past studies and will exist in future epidemiologic studies on facial clefts.

METHODS AND MATERIALS

The study material consisted of preoperative dental casts of 503 Caucasian facial cleft patients who were treated at the University of Illinois Cleft Palate Clinic from 1950 through 1964. In addition, birth certificates for all of these patients and a matched control group were obtained from the Illinois State Department of Health. The control certificate was obtained by choosing the next consecutive birth certificate that followed the birth certificate of the index case. Further requirements for the control certificate were that it be of the same sex and race as the index case and have the same county of birth registration.

The casts were examined and graded according to extent of cleft, using criteria advocated by the American Cleft Palate Association (6). Although this was an excellent method for initial categorization, the extremely large number of combinations this system produced made it necessary to group the facial

Table 4. Mean age of fathers of subjects distributed according to the „Twenty group" classification

Subgroup	N	Mean age in years	Statistic
Complete Bilateral Cleft Lip	3	28.67	Subgroup 1—20 F = 1.56 df = 19; 492 p = 0.06
Incomplete Bilateral Cleft Lip	5	26.80	
Complete Right Side Cleft Lip	3	36.00	
Incomplete Right Side Cleft Lip	15	30.80	
Complete Left Side Cleft Lip	4	37.25	
Incomplete Left Side Cleft Lip	23	26.65	
Complete Bilateral Cleft Lip and Cleft Palate	45	30.91	
Incomplete Bilateral Cleft Lip and Cleft Palate	46	28.87	
Complete Right Side Cleft Lip and Cleft Palate	30	29.17	
Incomplete Right Side Cleft Lip and Cleft Palate	19	27.21	
Complete Left Side Cleft Lip and Cleft Palate	67	30.48	Subgroup 1—20 and Control F = 1.45 df = 20; 985 p = 0.09
Incomplete Left Side Cleft Lip and Cleft Palate	25	27.88	
Complete Cleft of Hard Palate	40	29.05	
Incomplete Cleft of Hard Palate	77	29.73	
Complete Cleft of Soft Palate	28	28.89	
Incomplete Cleft of Soft Palate	21	30.29	
Palatal Shortness	13	32.92	
Submucous and Regular Clefts of Complete Soft and Hard Palate	5	32.60	
Submucous and Regular Clefts of Complete Soft, Partial Hard Palate	16	31.94	
Submucous and Regular Clefts of Soft Palate Only	8	29.88	
Control	493	29.62	

clefts into the following categories: „Three Major Cleft Group" classification which included cases categorized according to:

Isolated cleft lip (CL)
Cleft lip in combination with cleft palate (CL/CP)
Isolated cleft palate (CP), and
A control group.

„Twenty Cleft Group" classification, which included cases categorized according to:

1. Complete bilateral cleft of lip
2. Incomplete bilateral cleft of lip
3. Complete right side cleft of lip

4. Incomplete right side cleft of lip
5. Complete left side cleft of the lip
6. Incomplete left side cleft of the lip
7. Complete bilateral cleft of the lip and palate
8. Incomplete bilateral cleft of the lip and palate
9. Complete cleft of right lip and palate
10. Incomplete cleft of right lip and palate
11. Complete cleft of left lip and palate
12. Incomplete cleft of left lip and palate
13. Complete cleft of the hard and soft palate
14. Incomplete cleft of the hard palate and complete cleft of the soft palate
15. Complete cleft of the soft palate
16. Incomplete cleft of the soft palate
17. Palatal shortness
18. Combination of submucous and regular clefts of the hard and soft palate where the hard and soft palate were completely involved.
19. Combination of submucous and regular clefts of the hard and soft palate where the soft palate was completely involved and the hard palate was partially involved
20. Combination of submucous and regular clefts of the soft palate only, and
21. A control group

Using these classifications two types of analyses were carried out:

1. The „Three Major Cleft Group" classification alone and with control and the „Twenty Cleft Group" classification alone and with control were tested for inter-group differences utilizing analysis of variance.
2. a) All component two group contrasts of the „Three Major Cleft Group" classification and control were tested using the t-test and the Scheffee Multiplier (*a-posteriori* hypothesis testing).

   b) In analyses utilizing the „Twenty Cleft Group" classification certain specific contrasts were tested using the t-test and the Scheffee Multiplier (*a-posteriori* hypothesis testing). The contrasts tested were as follows: Groups 1 vs. 2; 3 vs. 4; 5 vs. 6; 7 vs. 8; 9 vs. 10; 11 vs. 12; 13 vs. 16; 14 vs. 15; (13 + 14) vs. (15 + 16); (1 + 3 + 5) vs. (2 + 4 + 6); (7 + 9 + 11) vs. (8 + 10 + 12); (1 + 3 + 5 + 7 + 9 + 11) vs. (2 + 4 + 6 + 8 + 10 + 12).

RESULTS

A. Maternal Age

Significant differences in mean age of mother at birth of index case were noted when mothers of patient with CL, CL/CP and CP were tested by analysis of variance. This difference was also noted when the mean ages of mothers of the matched control group were added to the analysis. Mothers of CP patients had the greatest mean age, and were followed in descending order by the mothers of controls, mothers of patients with CL/CP and mothers of CL patients (Table 1).

The *a posteriori* hypothesis analysis of each individual contrast indicated that only the comparison between the CP group and combinations of CL and CL/CP group were statistically significant. Analysis of variance testing of the "Twenty Cleft Group" classification was not statistically significant, nor was any significance encoutered when the control group was added to the analysis (Table 2). However, study of individual contrasts and a nonparametric sign test indicated that a heretofore unreported phenomenon existed.

Table 5. Mean combined ages of mother and father of subjects distributed according to the "Three major group" classification

Group	N	Mean age in years	Statistic
Cleft Lip	53	54.81	
Cleft Lip with Cleft Palate	232	55.61	F = 1.15 df = 2; 492 p = 0.33
Cleft Palate	208	57.02	
Control	493	55.92	F = 0.79 df = 3; 985 p = 0.50

For the twelve subgroups of CL and CL/CP, the mothers of patients with complete clefts had higher mean ages than mothers of children with incomplete clefts of corresponding types (Table 2). Although this finding was not statistically significant in an *a posteriori* hypothesis analysis, the nonparametric sign test ($p=0.017$) indicated that a relationship may well exist between completeness of clefting and mother's age. Further subdivision of these twelve groups into two further categories consisting of the six subdivisions of CL and six subdivisions of CL/CP indicated that this maternal age effect was most marked in the complete CL groupings.

B. Paternal Age

Analyses of the "Three Major Cleft Group" classifications utilizing the mean age of the fathers of facial cleft patients and control subjects indicated that although the differences noted were not statistically significant, fathers of CP patients had the greatest mean age, and were followed on descending order by the fathers of controls, fathers of patients with CL/CP cleft lip and palate combinations, and fathers of CL patients (Table 3). Similar testing of the "Twenty Cleft Group" classification alone and with the controls revealed statistically significant differences in mean paternal ages at the chosen level of significance (Table 4). As was the case in the maternal age analysis, those subgroups representing complete forms of clefts had higher mean paternal ages than the

Table 6. Mean combined ages of mother and father of subjects distributed according to the "Twenty group" classification

Subgroup	N	Mean age in years	Statistic
Complete Bilateral Cleft Lip	3	55.00	Subgroup 1–20 F = 1.48 df = 19; 492
Incomplete Bilateral Cleft Lip	5	51.20	
Complete Right Side Cleft Lip	3	67.00	
Incomplete Right Side Cleft Lip	15	56.47	
Complete Left Side Cleft Lip	4	69.00	
Incomplete Left Side Cleft Lip	23	50.43	
Complete Bilateral Cleft Lip and Cleft Palate	45	57.20	
Incomplete Bilateral Cleft Lip and Cleft Palate	46	54.96	
Complete Right Side Cleft Lip and Cleft Palate	30	55.87	
Incomplete Right Side Cleft Lip and Cleft Palate	19	51.05	
Complete Left Side Cleft Lip and Cleft Palate	67	57.24	Subgroup 1–20 and Control F = 1.40 df = 20; 985 p = 0.10
Incomplete Left Side Cleft Lip and Cleft Palate	25	52.76	
Complete Cleft of Hard Palate	40	55.35	
Incomplete Cleft of Hard Palate	77	56.38	
Complete Cleft of Soft Palate	28	55.39	
Incomplete Cleft of Soft Palate	21	57.62	
Palatal Shortness	13	62.08	
Submucous and Regular Clefts of Complete Soft and Hard Palate	5	60.80	
Submucous and Regular Clefts of Complete Soft, Partial Hard Palate	16	60.19	
Submucous and Regular Clefts of Soft Palate Only	8	58.75	
Control	493	55.92	

mean paternal age noted in the corresponding incomplete forms. The difference was most marked in the complete CL groupings.

C. Combined Age of Mother and Father

When the combined age of mother and father was analyzed according to the extent of facial clefting, significant differences were noted only for the "Twenty Cleft Group" classification alone and with the matched control group and an *a posteriori* contrast between combinations of CL and CL/CP and CP (Tables 5 and 6). As would be expected from the previous analyses of mother's and father's ages, the CP group had the greatest mean combined parental age

followed in descending order by the control group, CL/CP and CL. The phenomenon noted between subgroups representing complete and incomplete forms of CL and CL/CP clefts in the two previous analyses was magnified by the summation of the two groups, as were the differences between the CL grouping. Although none of the contrasts utilizing the "Twenty Cleft Group" classifications were significant after *a posteriori* hypothesis analysis, it is quite evident from the nonparametric sign tests that the chance of getting twelve contrasts (24 groups) to show an identical pattern is equal to a probability of less than 0.0005 (Table 6).

DISCUSSION

Although statistical significance was noted in only a few analyses relating parental age to extent of cleft, a consistant pattern was noted. Maternal age, paternal age, or combination of both were greatest in families with a CP child and were followed in descending order by control families, CL/CP families and CL families. These results are only partially in accord with those noted by Greene et al (7), Fraser and Calner (8), and others (9, 10). Indeed, they only add additional material to the already confused relationship between parental age and facial clefting.

However, these inconsistencies could conceivably be explained by the findings noted in this study which indicated that parents of subjects with complete CL and CL/CP are older on the average than the parents of patients with incomplete clefts of the same type.

For example, if a sample or population selected for epidemiologic study contained a disproportionate amount of complete CL and CL/CP patients (surgical records), it is conceivable that a higher mean age might be noted for the parents of such patients when compared with the mean parental age of parents of CL and CL/CP births chosen from a birth certificate series of facial clefts.

However, even samples drawn from birth certificates may not be free of this error since we have noted previously that birth certificates are not representative of the universe of facial clefts (5). For example, in this study 87% of complete CL and CL/CP cases ware reported on the birth certificate whereas only 78% of incomplete CL and CL/CP cases were similarly noted. Therefore, had only birth certificates been utilized in analyzing data from this study the results would have indicated a higher mean parental age than what truly existed for the entire group of facial clefts.

Such examples should warn investigators that assumption of homogeneity in the selection of a sample for epidemiologic study of facial clefts may lead to erroneous or incomplete conclusions.

Biologic interpretation of this new association between parental age and complete and incomplete clefts also merits discussion. MacMahon (11) has pointed out that there are three areas which might affect parental age differences. They are: (A) nongenetic cytoplasmic inheritance, (B) maternal structural and functional changes associated with changes in age and parity, and (C) social determinants of fertility patterns.

Evidence for the first mechanism has been limited to studies of animals and has not been shown for man (12). The third mechanism provides little direct evidence for explanation of the parental age effects noted in this study. Regarding the second mechanism, it must first be established that it is mother's age that is contributing to the differences between age and completeness of the clefts noted in this study. It could easily be hypothesized that it is the father's elevated age that is related to the extent of clefting and that the only reason a mother's elevated age was noted was due to the fact that on the average the older the father is the older the mother will be.

The studies of Green et al. (13) may reflect some positive knowledge on the subject. This group noted a high correlation between maternal and paternal age in our society and examined the effect of paternal age on the occurence of facial clefts by holding the age of the mother constant. They found that if this age disparity was greater than ten years, the risk of pruducing a cleft child was increased and that this was most marked for fathers over thirty.

The large number of subjects needed to complete a similar analysis, utilizing extent of cleft rather than occurrence of cleft, was lacking in this study. With a larger number of subjects, it is quite conceivable that an answer as to whether one or both parents are responsible for this newly described phenomenon could be found. However, the difficulty of obtaining even the limited number of subjects in this study, makes it doubtful that such a study is feasible in the near future.

SUMMARY

An epidemiologic study relating parental age to type and extent of facial clefting indicated that maternal age, paternal age or combinations of both were greatest in families with a CP child and were followed in descending order by control families, CL/CP families and CL families. Such findings add to the inconsistencies noted in previous investigations concerning this variable and facial clefting.

A heretofore unreported finding demonstrated that the mean parental age, individually or combined, of parents with children with complete CL or CL/CP was greater in every instance that the mean parental age of parents of children with the corresponding incomplete forms of the same entities.

Such findings may be used to explain the inconsistencies noted in previous age analyses and in addition, should warn the epidemiologist against assumption of homogeneity in the selection of a sample for epidemiologic study of facial clefts.

RÉSUMÉ

La relation épidémiologique entre l'âge des parents et le type et l'étendue de la fente de la face

L. H. Meskin, S. Pruzansky

Une étude épidémiologique concernant la relation entre l'âge des parents et le type et l'étendue de le fente de la face a prouvé que l'âge de la mère ou celui du père de même que la combinaison des deux données étaient les plus augmentés dans les

familles dont les enfants souffraient de la fente du palais: cette relation a été soumise aux examens à l'arrière-ordre dans des familles de contrôle, celles à la fente du palais accompagnée de bec-de-lièvre de même que celles au simple bec-de-lièvre. Les recherches pareilles augmentent encore plus les nómbres des défectuosités que montraient les examens cités ci-dessus touchant cette variabilité et la fente du palais.

Une donnée jusqu'alors nulle part décrite nous a montré que l'âge moyen (individuel et en combinaison) des parents des enfants à la fente combinée du palais et du bec-de-lièvre est toujours plus haut de celui des parents des enfants à la forme incomplète respective de ces unités nosologiques.

On peut employer ces données pour expliquer les incompabilités dans les analyses précédentes touchant la relation de l'âge des parents vis-à-vis de l'existence de la fente et, en surplus, ces données pourraient avertir les épidémiologues contre la supposition de l'homogénité au cas du besoin des spéciments respectifs pour les recherches epidémiologiques de la fente de la face.

ZUSAMMENFASSUNG

Epidemiologische Beziehung zwischen dem Alter der Eltern und dem Typ und Umfang der Gesichtsspalten

L. H. Meskin, S. Pruzansky

Epidemiologische Untersuchung über die Beziehung zwischen dem Alter der Eltern und dem Typ und Umfang der Gesichtsspalte hat gezeigt, dass die höchsten Werte für das Alter der Mutter, oder des Vaters, oder für die Kombination dieser beiden Werte in Familien mit Kindern mit Geschichtsspalte vorzufinden sind. Diese Befunde wurden verfolgt in rückgängiger Ordnung an Kontrollfamilien, Familien mit Lippen- und Gaumenspalte und Familien mit Lippenspalte. Diese Befunde verschärfen noch weiter die Differenzen, die bei den früheren Untersuchungen dieser Variablen und der Gesichtsspalte ermittelt worden sind.

Dieser bisher unbeschriebener Befund hat nachgewiesen, dass das durchschnittliche Alter der Eltern (individuell oder kombiniert) von Kindern mit kompletter Lippenspalte oder mit kompletter Lippen- und Gaumenspalte stets höher ist, als das durchschnittliche Alter bei Eltern von Kindern mit entsprechender unvollständiger Form dieser nosologischen Einheiten.

Diese Ermittlung kann zur Klärung von Differenzen dienen, die bei den früheren Altersanalysen beobachtet wurden, ausserdem sollten sie auch die Epidemiologen vor der Annahme einer Homogenität bei der Auswahl der Population für epidemiologische Untersuchungen der Gesichtsspalte warnen.

RESUMEN

Relaciones epidemiológicas entre la edad de los padres y el tipo y la extensión de las fisuras faciales

L. H. Meskin, S. Pruzansky

Un estudio epidemiológico referente a la edad parental y al tipo y a la extensión de las fisuras faciales demostró que la edad maternal, la edad paternal o las ambas en combinaciones aparecieron en máximas cantidades en las familias con un hijo con la fisura palatina y pues siguieron en orden descendente las familias bajo control, familias con fisuras labiales y palatinas y las familias con fisuras labilales. Tales

hallazgos llevan relación con las inconsistencias mencionadas en las investigaciones antecedentes que pertenecían a las fisuras variables y faciales.

Este hallazgo hasta ahora no relatado demonstró que la edad parental media, individual o combinada, de los padres con hijos con fisuras labiales completas o fisuras labiales o palatinas fue mayor en todos los casos que la edad parental media de los padres con hijos con formas incompletas de la misma entidad.

Tales hallazgos pueden explicar las inconsistencias observadas en el análisis previo de la edad y aparte de esto, ellos deben avisar a los epidemiológistas de que no se trata de una homogeneidad en la selección de una muestra para el estudio epidemiológico de las fisuras faciales.

REFERENCES

1. **Mazaheri, M.**: Statistical analysis of patients with congenital cleft lip and/or palate at the Lancaster Cleft Palate Clinic. Plast. reconstr. Surg. 1958, 21 : 193—203.
2. **Fogh-Andersen, P.**: Inheritance of Harelip and Cleft Palate, Kobenhavn: Ejnar Munksgaard, 1943.
3. **DeVoss, H.**: A study of the factors relative to the incidence of cleft palate births from 1945 to 1949 in San Bernadino County. Speech Monog. 1952, 19 : 31—38.
4. **Oldfield, M. C.**: Some observations on the cause and treatment of harelip and cleft palate based on treatment of 1,041 patients. Brit. J. Surg., 1959, 46 : 311—321.
5. **Meskin, L. H., Pruzansky, S.**: Validity of the birth certificate in the epidemiologic assessment of facial clefts. Journal of Dental Research, 1967 (in press).
6. **Harkins, C. S., Berlin, A., Harding, R. L., Longacre, J. J., Snodgrasse, R. M.**: A classification of cleft lip and cleft palate. Plast. reconstr. Surg. 1962, 29 : 31—39.
7. **Greene, J. C., Vermillion, J. R., Hay, S., Gibbens, S. F., Kerschbaum, S.**: Epidemiologic study of cleft lip and cleft palate in four states. J. A. D. A. 1964, 68 : 387—404.
8. **Fraser, G. R., Calnan, J. S.**: Cleft lip and palate: Seasonal incidence, birth weight, birth rank, sex, site, associated malformations, and parental age: a statistical survey. Arch. Dis. Child. 1961, 36 : 420—423.
9. **MacMahon, B., McKeown, T.**: The incidence of harelip and cleft palate related to birth weight and maternal age. Amer. J. Human Genet. 1953, 5 : 176—183.
10. **Donahue, R. F.**: Birth variables and the incidence of cleft palate: Part I. Cleft Palate J. 1965, 2 : 282—290.
11. **MacMahon, B., Pugh, T. F., Ipsen, J.**: Epidemiologic Methods, Boston and Toronto: Little, Brown and Co., 1960, p. 302.
12. **Lansing, A.**: A transmissible, cumulative, and reversible factor in aging. J. Gerontol. 1947, 2 : 228—239.
13. **Greene, J. C., Vermillion, J. R., Hay, S.**: Utilization of birth certificates in epidemiologic studies of cleft lip and palate. Cleft Palate J. 1965, 2 : 141—156.

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ATTEMPT AT EVALUATION OF FUNCTIONAL CONDITIONS IN THE REGION OF CLEFT LIP

(employing EMG and EEG examinations)

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Congenital malformations, such as cleft lip and palate, form an important and independent pathological unit. Because of their trend toward increasing incidence, Burian stated in 1959 (1), that „they constitute a danger to the biological foundations of human society".

Attempts at preventing these malformations did not lead to evident success, because neither their aetiology not their essence are yet known exactly. Up to the present, surgery has merely taken heed of the shape and size of the defect in cleft lip and palate. Many authors, however, have already suggested a more exact classification of these malformations, i.e. one according to the type and extent of the cleft and the phenomena connected with it. Other authors have attempted to evaluate them according to their morphogenetic foundations (3). Ontogenetically, cleft of lip and palate makes its appearance very early, much earlier than the development of bone structure, which means that, as a rule, the deficit in soft tissue is present first. This fact leads to the assumption that the disorder in development is not only limited to the site of predilection, i.e. the face and oral cavity, where it manifests itself as a cleft, but that it also affects the surroundings of the actual malformation over a large area.

Various methods have been tried for determining the extent to which the close vicinity of the cleft has been affected. In the literature, there are more studies dealing with the pathophysiology of muscles of the palate and pharynx in the presence of a cleft palate (Mitrinowiczowa, 1961) (9), than articles on the functional conditions of facial muscles in the vicinity of a cleft lip.

Functional examinations in cleft palate (2) are mainly aimed at testing the motility of the soft palate and whether the nasopharyngeal occlusion is adequate. Hitherto, this has been evaluated on hand of the findings of radiography, cinefluorography and cineroentgenography.

Functional examinations of the soft tissues of the face in cleft lip are aimed at testing the motility of the orbicularis oris, the mentalis and the group of muscles innervated by the lower branch of the facial nerve.

In order to make the values in testing the functional condition (4) of facial muscles in cleft lip as exact as possible, some authors chose electromyographic examinations. Their method was verified in a series of children with cleft lip and palate treated at the University Department of Plastic Surgery in Prague, Czechoslovakia (10).

MATERIAL AND METHOD

In all children with cleft lip, action potentials (5) were taken of motor units of the orbicularis oris (and in some cases also of the mentalis) with the concentric unipolar needle electrode DISA. These action potentials were photographed after amplification with a symmetric pre-amplifier of the two-trace osciloscope DISA onto a 35 mm. film. After enlargement of the recorded curves, the different parameters of the record, such as the shape, duration and amplitude of the action potentials of motor units, the frequency and the pattern of the entire record (i.e. single action potentials, the transient condition and the interference activity (6)], were evaluated. The electrical activity was recorded at rest, during slight contradiction and during provoked, if possible maximum contraction of the muscle.

The trunk of the facial nerve in front of the tragus was also stimulated by the bipolar surface stimulation electrode DISA with an interelectrodal distance of 25 mm. Stimulation was always carried out by right-angle electrical stimuli of a duration of 1.0 msec. and of supramaximal intensity (multistim disa). Simultaneously, the evoked action potentials of muscular response to the stimuli were recorded on a 35 mm. film band. The latency of muscular response, i.e. the time between the start of the artificial stimulus and the deviation of the evoked action potential from the base-line, was taken as the measure for evaluation. The amplitude and morphology of the action potential, too, were used for evaluation.

In addition, EEG examinations were carried out in a group of 15 children with cleft lip and palate, aged between 3 and 14 months. Tab. 1 shows the types of cleft in this group.

Table 1.

Type of cleft	Number of patients
Slightly indicated cleft of lip	4
Incomplete cleft of lip	4
Unilateral total cleft (one case with bridge)	2
Unilateral cleft of lip and jaw	1
Bilateral total cleft	4
Total	15

Electrophysiological examinations were carried out prior to primary suture. In unilateral cleft, EMG tests were taken on the side of the cleft and in bilateral cleft on both sides. The prolabium was not tested.

The fine needle electrode was introduced through the unanaesthetized skin which, after a transient unrest following the puncture, was well tolerated by all subjects. Measuring, of course, started after the baby had calmed down.

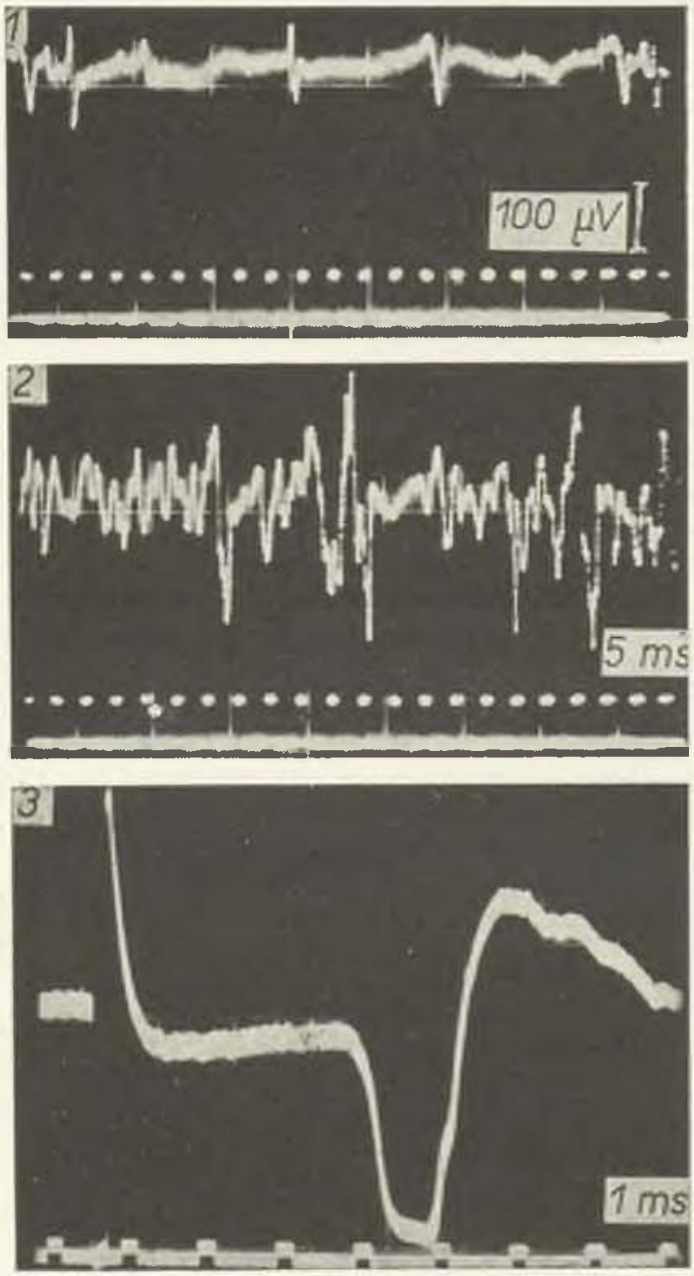

Fig. 1. Patient D. P., aged 5 months, with incomplete cleft lip of very slight degree on left side, case paper No 3360. 1 and 2 are electromyograms of orbicularis oris during slight and maximum voluntary innervation. 3 is the action potential of muscle response of orbicularis oris to stimulation of facial nerve trunk on left side

RESULTS

Slightly indicated cleft of lip (four cases): In none of the subjects did we find any fibrillation or denervation activity at rest. After insertion of the needle, activity was within the range of normal. In three subjects, a transient condition of action potentials or an interference pattern

of activity appeared on maximum innervation. In one case, only occasional action potentials of motor units were recorded. The action potentials were biphasic or triphasic and frequently doublets, i.e. repeated burst in the same motor unit, appeared in the records. The duration of action potentials was 3 to 4 msec. in two cases, 2 msec. in one case and 4 to 5 msec. in one case. On stimulation of the motor nerve, a polyphasic action potential of muscle response

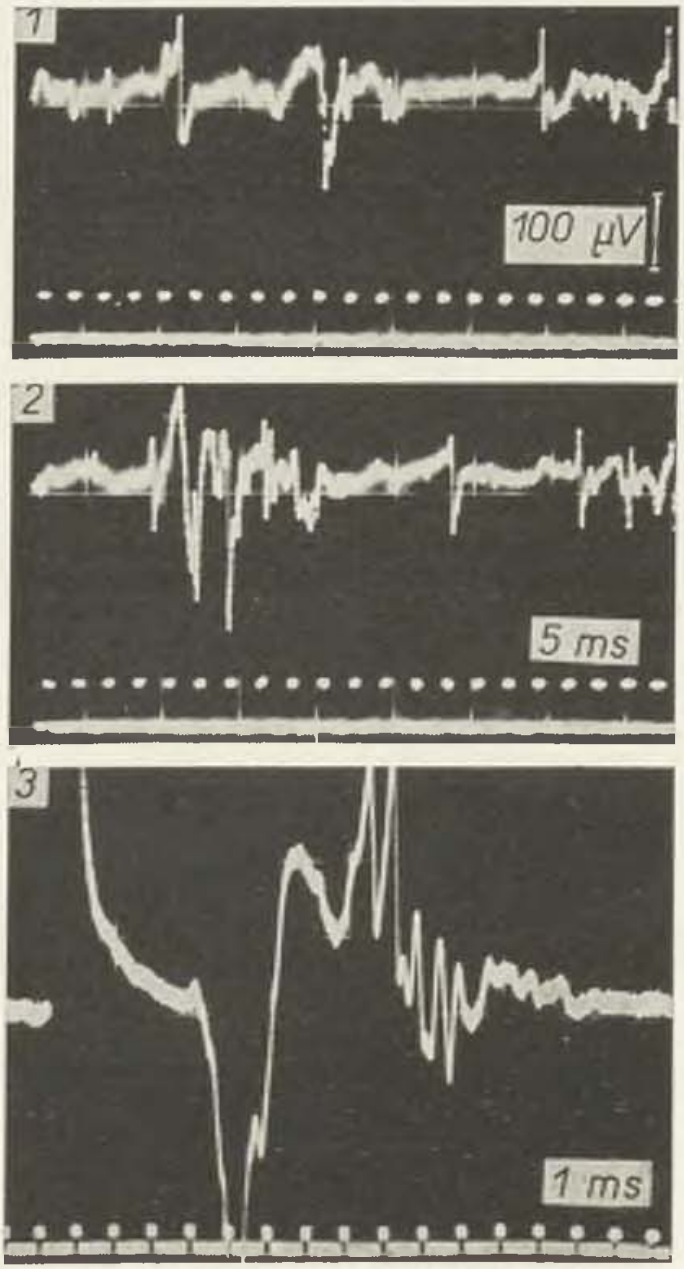

Fig. 2. Patient B. R., aged 12 months, with bilateral total cleft of lip and palate of extremely severe degree, case paper No 3481. 1 and 2 are EMG records during slight and maximum voluntary innervation. 3 shows a markedly polyphasic action potential of muscle response to stimulation of facial nerve trunk on left side

with an amplitude of 200—1000 μV, appeared in all subjects. In two cases, the latency of muscle response was 3.0 and 3.6 and in another two 4.1 and 6.7 msec.

Incomplete cleft of lip (four cases): No fibrillation or denervation activity was recorded in these cases. After insertion, of the needle, activity was also within the range of normal. On maximum innervation, interference activity was recorded in two and occasional action potentials of some

motor units in another two subjects. There were some action potentials of biphasic or triphasic patterns with a mean amplitude between 200 and 400 μV and a duration of 2 to 4 msec. Latency of muscle response to stimuli of the facial nerve trunk amounted to 2.8 and 3.2 msec. in two patients and to 3.7 msec. in a third. The amplitude of action potentials of muscle response oscillated between 1 and 2 mV and only in one patient was it extremely low, i.e. around 100 μV (fig. 1).

Unilateral cleft lip and jaw or unilateral total cleft (three cases): Neither in these types did we record fibrillation or denervation action potentials. On voluntary innervation, an imperfect interference activity appeared in one case and individual action potentials of motor units to even transient conditions of action potentials with significant grouping in another two cases. The amplitude of the potentials was bi- or triphasic and oscillated between 100 and 500 μV. The duration of the potentials measured between 3 and 5 msec. (most of them actually lasted for 4 msec.). The latency of muscle response to stimuli of the facial nerve trunk was 4.2 msec. in two patients and 3.5 msec. in a third. The amplitude of action potentials of muscle response oscillated between 400 and 1500 μV.

Bilateral total cleft (4 cases): Two patients were examined prior to operation. Occasional action potentials of motor units appeared in the record of one patient, while in that of the other, only rudimentary action potentials of motor units with an amplitude of 100 μV and a duration of around 4 msec., could be discerned here and there. In this patient, however, a perfect interference activity was recorded from the mentalis. The period of latency of muscle response to stimuli of the facial nerve trunk was 3.2 and 3.4 msec. resp. The potentials had an amplitude of around 500 μV. In two patients, five and seven months after operation, occasional action potentials of motor units and only very rarely a transient condition of action potentials, were recorded on voluntary contraction. The potentials were narrow, i.e. of a duration of around 2 to 3 msec., bi- and triphasic, and the number of polyphasic potentials did not exceed normal limits. The amplitude oscillated between 200 and 1000 μV. Latency of muscle response to stimuli of the facial nerve trunk amounted to 3.9 and 4.3 msec. The potentials of muscle response were highly desynchronized and polyphasic. The amplitude was 1300 and 2400 μV (fig. 2).

Out of the total of 15 children in whom EEG examination was carried out, eleven showed a normal record corresponding to their age. In two others, a biparietal anomaly of slow waves, was quite evident. In one case the record showed a focal retardation in the left frontotemporal region, in another it showed frequency asymmetry of sides. Twice, conspicuous synchronism was observed. In one case, the record was normal, while in another, there was a biparietal anomaly.

DISCUSSION AND CONCLUSIONS

The above results have proved that in cleft lip, maxilla and palate of different degrees, the peripheral motor neuron may be affected to any degree, from slight to severe. Not in a single instance was it possible to record normal bio-

electrical muscle activity. Latency of muscle response, too, i.e. the velocity of motor nerve fibre conduction, was normal in no case. On the other hand, denervation of the muscles innervated by the facial nerve was not found in any case. Since conduction velocity is directly proportional to the diameter of individual nerve fibres (Glasser et Erlanger, 1927 and Hursch, 1939), it may be assumed that the histiogram of nerve fibre diameters is very broad in these cases and that, in the facial nerve, there must be a large proportion of fibres of small calibres and with imperfect myelinization. A kind of congenital anomaly of motor nerve cells in the facial nerv nucleus, cannot be excluded.

The results also showed that complete denervation of the orbicularis oris was present in no instance. That is why it may be assumd that suture of the lip leading to fixation of muscles could normalize the proprioceptive reflex activity of muscles and thus also the stereotype of motor innervation in the face.

SUMMARY

In 15 children, aged between 3 and 14 months, with cleft lip and palate, EMG and EEG examinations were carried out prior to the primary suture of the lip. Complete denervation of the orbicularis oris could not be ascertained by EMG examination. EEG examination disclosed — apart from a few exceptions-normal findings corresponding to the age of the subject.

This preliminary report is intended to induce further research in the functional conditions of facial muscles and their innervation in the region of a cleft lip.

RÉSUMÉ

L'essai du jugement de l'état fonctionel de la région du bec-de-lièvre (en se servant des données du EEG et EMG)

L. Spinadel, B. Drechsler, M. Laštovka, I. Lesný

Les auteurs ont entrepris des épreuves du EMG et du EEG chez 15 des enfants à l'âge de 3—14 mois, souffrant du bec-de-lièvre et de la fente du palais avant que la sutture primaire de la lèvre soit réalisée. Les données du EMG n'ont pas montré une dénervation complète du muscle orbiculaire. Les données du EEG ont été — à l'exception de quelques-unes — tout à fait normales quand à l'age de l'enfant en question. Cette communication précoce est destinée à servir une rechercomplète touchant la fonction du tissu musculair et de l'appareil innervatoir des tissus mous de la face dans la région du bec-de-lièvre.

ZUSAMMENFASSUNG

Versuch einer Beurteilung des Funktionszustandes des Lippenspaltenbereichs (unter Verwendung der elektromyographischen und der elektroenzephalographischen Untersuchung)

L. Spinadel, B. Drechsler, M. Laštovka, I. Lesný

Es wurde die EMG- und die EEG-Untersuchung bei 15 Kindern im Alter von 3 bis 14 Monaten mit Lippen- und Gaumenspalte vor der primären Lippensutur durchgeführt. Die EMG-Untersuchung ergab keine komplette Denervation des M. orbicularis. Bei der

EEG-Untersuchung wurde bis auf geringe Ausnahmen ein im Hinblick auf das Alter normaler Befund festgestellt. Diese vorläufige Mitteilung soll der weiteren funktionellen Erforschung der Muskelstrukturen und des Innervations apparates der Gesichtsweichteile im Bereich der Lippenspalte dienen.

RESUMEN

Los ensayos de juzgar el estado funcional de la región de la fisura labial (empleando las examinaciones EMG y EEG)

L. Spinadel, B. Drechsler, M. Laštovka, I. Lesný

Los autores llevaron a cabo las examinaciones EMG y EEG en 15 niños en la edad entre 3 hasta 14 meses con la fisura labial y palatina antes de la sutura primaria del labio. La examinación EMG no ha comprobado la denervación de m. orbicularis. Por lo que se refiere a la examinación EMG ésta avariguó, con excepciones de poca importancia, un registro normal en relación con la edad. Estos resultados preliminares, según los autores, deben servir a un próximo estudio funcional de la estructura muscular y del aparato de inervación dee las blandas partes de la cara en la región de la fisura labial.

REFERENCES

1. **Burian, F.**: Plastic Surgery. Prague, Czechoslov. Academy of Sciences and Artis., 1962.
2. **Burian F.**: Chirurgie rozštěpu rtu a patra (Surgery of Cleft Lip and Palate), Praha, SZdN 1954.
3. **Burian, F.**: The prevention of Congenital Malformations, espec. Cleft Lip and Palate. Transactions of the Internat. Soc. of Plastic Surgeons, pp. 23—25, Livingstone Ltd., Edinburg, London 1960.
4. **Burston W. R., Kernahan D. A. et all.**: A Morphological Basis for the Analysis and Treatment of the Cleft Lip and Cleft Palate Condition Dtto 1960, pp. 9—15.
5. **Chou-Luh et al.**: Electromyographic Study of Cleft Palate. Plast. reconstr. Surg. 1958, 21 : 427—432.
6. **Drechsler B.**: Elektromyographie. Veb Verl. u. Gesud., Berlin 1964.
7. **Gasser H. S., Erlanger J.**: The role played by the sizes of the constituent fibres of a nerve trunk in determining the form of its action potential wave. Amer. J. Physiol. 1927, 80 : 522.
8. **Hursh J. B.**: Conduction velocity and diameter of nerve fibres. Amer. J. Physiol. 1939, 127 : 131.
9. **Mitrinowicz, A.**: Chronaxie u rozštěpu patra (Chronaxie in Cleft Palate), lecture, Praha, 1961.
10. **Schule H. (W. Germany)**: Clinical, histological and electromyographic evaluation in the bilateral cleft lip surgery. Fourth International Congress of Plastic Surgery, Lecture Rome, October 8—13, 1967.

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GROWTH OF THE FINGERS AND PERIODS SUITED FOR OPERATION ON THEIR CONGENITAL DEFECTS

K. HAJNIŠ

In the period of childhood and adolescence, the fingers, like the rest of the hand as well as other parts of the body, go through a considerable growth and thus also change in the shape. In the period of Infans I and at the beginning of Infans II they are pronouncedly short and chubby. In this period their shape is in correlation with the short and altogether broad (brachycheirous or hyperbrachycheirous) hand of this period (see K. Hajniš, in the press). In the course of further development, under the influence of the relatively prevalent growth of the fingers in their length over the growth in their circumference, a marked slimming occurs, analogous to the prolongation of the whole hand, as described in the quoted work of the present author. The whole postnatal ontogenic development of the shape of the fingers thus consists in a gradual change from short and plump fingers to long and slim fingers which are characteristic of a prevailing majority of our adolescent youth.

In spite of great effort, we have not found, in the anthropological and anatomical literature, a single work dealing with the special problem of growth of the absolute sizes of the fingers. There certainly exists a number of works, especially from the earlier period, concerned with the proportion of the lengths of the individual fingers and determining various formulas for it (e. g. 342 or 324), but the results of these works are in fact hardly of any practical use. Their conception is rather theoretical and with a phylogenetic aspect (see e.g. M. Ecker 1875, J. Kollmann 1886 and 1903, J. Ranke 1887, A. Rauber 1892, R. Virchow 1895, R. Weissenberg 1895, V. Volockij 1924, E. Koenner 1938 and others).

In this country, J. Jelínek (1950), L. Crhák (1957), M. F. Pospíšil (1959) and I. Drobný (1959) also linked up with these works in their studies.

MATERIAL AND METHOD

For the study of the growth rhythm of the total length of all the five fingers a population of 1707 children and adolescents of both sexes (854 boys and 853 girls) from Prague was used.

Both the boys and girls were followed-up in 28 age groups from birth up to the age of 18 years. The compass of these groups can be seen in the tables and graphs. The size of the age groups in the various periods was chosen according to the expected rate of growth. This means that their extent is smallest in the period up to the age of three years and in the period of pre-puberty and puberty. The propositus was classified into an age group on the basis of the difference between the date of birth and the date of examination. The so called anthropological age was used, according to which e. g. the

Fig. 1. Length of the fingers between the points phalangion — dactylion

age group of the seven-year-olds includes all persons under examination within the range of 6 years, 6 months and 1 day up to 7 years and 6 months, etc. Each of the age groups contains at least 30 proposituses. A cross-section study was made.

In the present paper only the results of the study of the growth of the total length of the fingers are presented but we also have data on the rate of growth of the individual phallanges in all the five fingers. Of course, the lengths were examined separately in both hands. They were measured by means of a slide calliper after R. Martin (R. Martin - K. Saller, 1957) between the points phalangion I — dactylion I, phalangion II — dactylion II etc. (see Fig. 1). Correct measurement of the length of each digit was controlled by the sum of the lengths of its individual phalanges which must agree with the mentioned total length.

The tables contain, besides the number of the proposituses (n) in each age group also the mean values of the length of the digits along with the triple mean error of this mean ($X \pm 3 \cdot s_{\bar{x}}$), the standard deviation (s), the coefficient of variation (v) and the lowest and highest individual value (min-max) occurred.

On the basis of the tables graphs with curves of the growth dynamics were plotted. Deliberately we avoided their compensation in order not to smooth possible irregularities which are important for the registration of periods of decreased growth or of periods of relative rest which are of greatest importance for practical purposes in surgery.

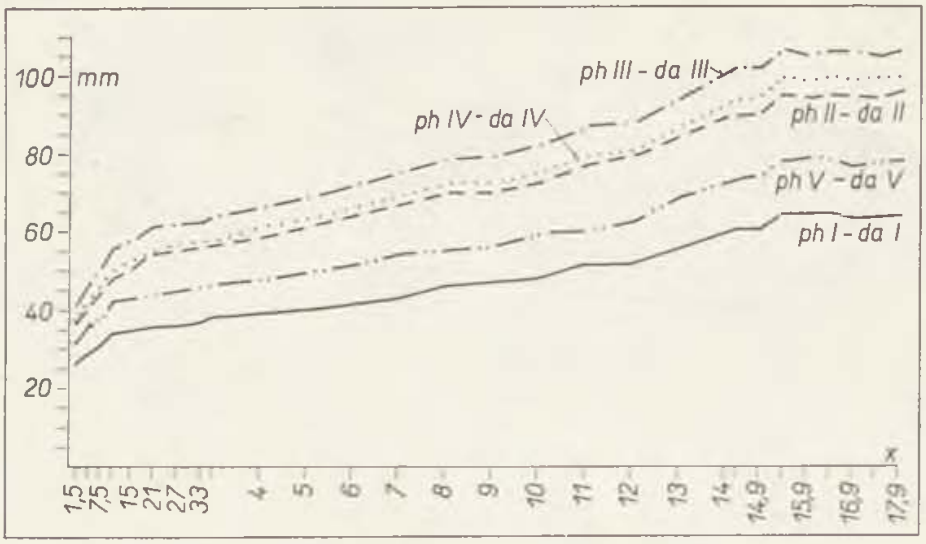

Fig. 2. Growth of the fingers in length. Left hand. Boys. Months. Years. Age

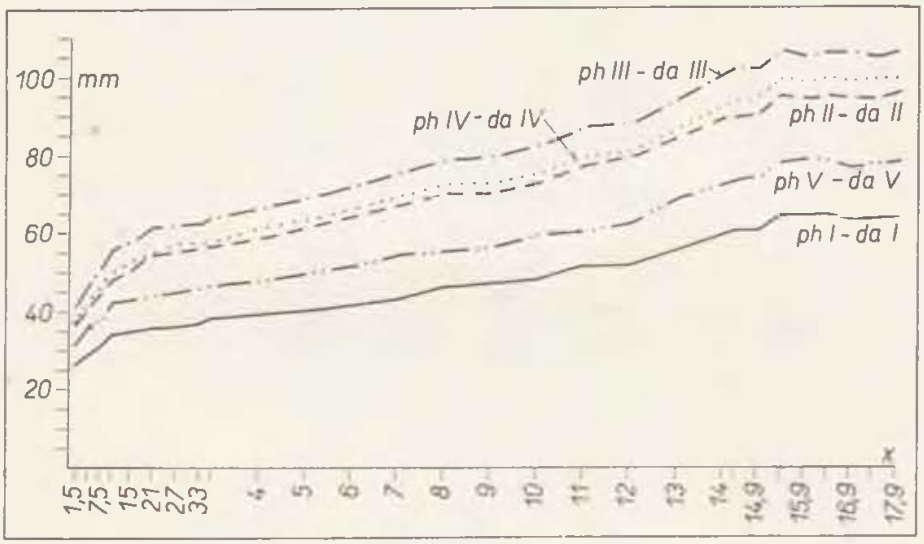

Fig. 3. Growth of the fingers in length. Right hand. Boys. Months. Years. Age

GROWTH OF THE FINGERS

If we study the growth dynamics of the length of the digits in the left and the right hand of the boys and the girls in our tables, we can see that it consists of several phases. The most intensive growth which lasts from the birth up to about the end of the first year of life is common to all digits, while in the further development the thumbs and the little fingers of both hands differ from the second, third and fourth fingers.

After the termination of the mentioned initial phase of vehement growth, the first and the fifth fingers in both sexes enter the second phase, characterized by smaller increments. In the boys, this phase lasts until about the age of 15 to 15-and-a-half years, in the girls it ends somewhat earlier, namely about 14 years. The second half of this period, i. e. the puberty, shows rather

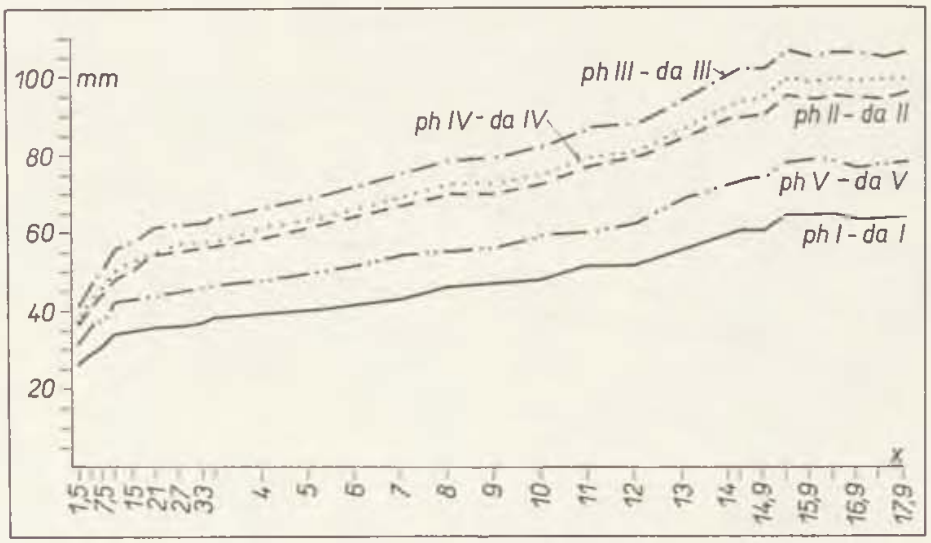

Fig. 4. Growth of the fingers in length. Left hand. Girls. Months. Years. Age

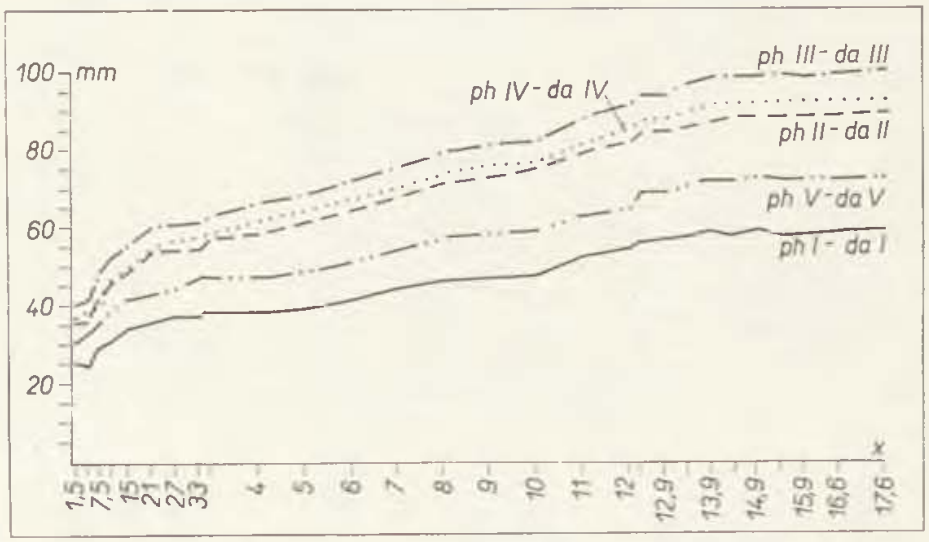

Fig. 5. Growth of the fingers in length. Right hand. Girls. Months. Years. Age

higher increases than the first part of this phase, especially in the boys; this can be well seen, especially in the graphs. The steeper curve of growth in the period of puberty is more conspicuous in the boys than in the girls. From the mentionad age of about 14 years in the girls and 15 to 15-and-a-half years in the boys neither the thumb nor the little finger show any vehement growth, and consequently the curves in the graphs take an almost horizontal course in this third phase.

Similarly to the little finger and the thumb, also the second to fourth digits show a moderate rate of growth after the termination of the first phase of growth. Of course, the increases in this second phase of their growth are far larger than those in the second phase of the thumb and the little finger, as mentioned earlier. Only closely febore the second year, these three inner digits develop approximately the same rate of growth as the first and fifth digit. Of course, a careful study of the graphs and the tables shows that all the same, the growth dynamics of these fingers is slightly larger than that of the two outer digits. We consider this period as the third phase of growth. The fourth growth phase of the second, third and fourth finger is identical in time with the third growth phase of the little finger and the thumb, i. e. it sets in at the age of about 15-and-a-half years in the boys and at the age of 14 years in the girls.

The mentioned observation of the partially different dynamics of growth of the two outer fingers, namely the thumb and the little finger on the one hand, and the three central fingers on the other hand, draws attention to the functional distribution of the digits of the hand into the mentioned two groups.

Table 1. Length of the thumb. Ph I - da I. Boys

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	26,90±3.0,03	2,10	8,14	21—31	30	26,96±3.0,04	2,30	8,53	20—30
4,5	30	28,43±3.0,07	3,90	13,89	21—38	30	29,36±3.0,07	3,90	13,52	22—39
7,5	30	30,63±3.0,03	2,00	6,66	27—35	30	31,26±3.0,03	1,90	6,20	28—35
10,5	30	34,20±3.0,05	3,10	9,23	29—41	30	34,56±3.0,05	2,80	8,18	29—40
15	30	35,36±3.0,04	2,60	7,55	30—39	30	35,33±3.0,04	2,40	7,01	30—40
21	30	36,30±3.0,03	1,60	4,49	33—39	30	36,40±3.0,03	1,50	4,04	33—39
27	30	36,46±3.0,03	1,60	4,52	34—40	30	36,70±3.0,02	1,60	4,46	34—40
33	30	37,80±3.0,04	2,20	6,00	34—45	30	37,51±3.0,04	2,40	6,47	34—45
36	30	38,80±3.0,05	2,70	7,06	34—45	30	38,80±3.0,05	2,70	6,90	34—44
4	30	39,33±3.0,05	3,10	7,95	33—45	30	39,66±3.0,05	2,80	7,16	33—45
5	30	40,70±3.0,04	2,30	5,72	36—46	30	40,70±3.0,04	2,20	5,42	36—46
6	30	42,30±3.0,06	3,20	7,46	36—48	30	42,30±3.0,06	3,20	7,71	36—48
7	30	43,80±3.0,06	3,10	7,04	35—52	30	43,90±3.0,05	2,70	6,10	38—52
8	30	46,80±3.0,07	3,70	7,93	41—53	30	46,90±3.0,07	3,70	7,91	41—54
9	30	47,60±3.0,06	3,40	7,23	41—55	30	47,60±3.0,06	3,40	7,16	41—55
10	30	48,50±3.0,07	3,70	7,71	42—58	30	48,70±3.0,06	3,50	7,21	42—56
11	30	51,70±3.0,05	2,60	4,95	45—56	30	52,10±3.0,04	2,40	4,67	44—61
12	30	52,20±3.0,06	3,20	6,13	47—61	30	52,40±3.0,06	3,20	6,16	47—61
13	30	56,40±3.0,07	3,90	6,87	50—66	30	56,70±3.0,07	4,00	7,08	50—66
14	30	60,80±3.0,10	5,20	8,64	48—70	30	60,60±3.0,11	5,80	9,65	48—72
14,3	30	61,80±3.0,08	4,50	7,25	53—75	30	61,60±3.0,08	4,70	7,57	52—75
14,9	30	61,60±3.0,09	4,90	8,06	54—70	30	61,50±3.0,08	4,20	6,78	52—70
15,3	30	65,30±3.0,07	4,00	6,17	58—75	30	65,20±3.0,07	3,90	5,96	58—74
15,9	31	65,40±3.0,07	4,00	6,10	57—74	31	65,20±3.0,07	3,70	5,77	53—71
16,3	34	65,50±3.0,08	4,80	7,38	57—81	34	65,50±3.0,07	4,10	6,44	57—72
16,9	39	64,90±3.0,09	5,60	8,70	54—78	39	64,20±3.0,09	5,40	8,48	52—75
17,3	30	65,00±3.0,07	3,90	6,04	58—73	30	64,70±3.0,07	3,70	5,77	60—74
17,9	30	65,60±3.0,07	3,60	5,54	56—72	30	65,10±3.0,07	3,90	6,09	56—72

Table 2. Length of the second finger. Ph II - da II. Boys

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	36,83±3.0,04	2,40	6,57	31— 42	30	36,76±3.0,05	2,90	7,96	31— 43
4,5	30	41,00±3.0,07	4,30	10,56	33— 49	30	41,73±3.0,07	4,20	10,28	34— 49
7,5	30	44,33±3.0,03	2,00	4,71	41— 49	30	44,80±3.0,03	2,00	4,66	41— 49
10,5	30	47,83±3.0,04	2,50	5,41	42— 56	30	48,26±3.0,04	2,50	5,32	43— 55
15	30	50,60±3.0,06	3,70	7,41	45— 58	30	50,56±3.0,07	4,00	7,91	43— 58
21	30	55,00±3.0,07	3,80	6,94	54— 64	30	55,20±3.0,07	3,60	6,59	49— 63
27	30	55,73±3.0,05	2,70	4,97	50— 62	30	55,86±3.0,05	2,90	5,20	50— 63
33	30	56,48±3.0,06	3,70	6,55	49— 60	30	56,54±3.0,06	3,50	6,26	49— 63
36	30	57,13±3.0,04	2,60	4,67	52— 64	30	57,13±3.0,04	2,50	4,44	53— 64
4	30	59,50±3.0,06	3,40	5,66	54— 66	30	59,30±3.0,06	3,40	5,71	52— 66
5	30	62,60±3.0,06	3,10	4 91	55— 70	30	62,60±3.0,05	2,80	4,46	56— 70
6	30	65,00±3.0,07	3,70	5,73	56— 72	30	65,10±3.0,07	3,70	5,63	56— 72
7	30	68,10±3.0,07	3,60	5,35	61— 77	30	68,10±3.0,07	3,80	5,64	60— 77
8	30	71,00±3.0,09	4,90	6,89	60— 82	30	71,40±3.0.09	5,00	6,95	60— 83
9	30	71,80±3.0,10	5,40	7,60	63— 82	30	71,90±3.0,10	5,30	7,42	63— 81
10	30	74,30±3.0,08	4,70	6,27	67— 82	30	74,60±3.0,08	4,50	6,10	67— 82
11	30	78,30±3.0,07	3,70	4,69	69— 85	30	78,80±3.0,07	3,70	4,76	69— 91
12	30	80,80±3.0,11	6,10	7,50	71— 92	30	81,10±3.0,11	5,90	7,28	71— 92
13	30	85,90±3.0,10	5,30	6,18	76— 97	30	86,40±3.0,10	5,40	6,25	76— 97
14	30	91,30±3.0,10	5,40	5,95	79—105	30	91,90±3.0,10	5,60	6,13	79—106
14,3	30	91,70±3.0,13	7,40	8,12	78—107	30	91,70±3.0,13	7,10	7,80	80—105
14,9	30	93,40±3.0,10	5,60	5,99	84—106	30	92,90±3.0,10	5,80	6,31	79—103
15,3	30	96,60±3.0,10	5,50	5,72	87—105	30	97,30±3.0,10	5,60	5,79	88—107
15,9	31	96,60±3.0,09	5,00	5,18	82—106	31	96,90±3.0,10	5,60	5,78	81—107
16,3	34	97,20±3.0,08	5,00	5,10	90—107	34	97,20±3.0,09	5,00	5,17	88—110
16,9	39	97,50±3.0,10	6,40	6,55	84—118	39	97,10±3.0,09	5,60	5,77	87—109
17,3	30	97,30±3.0,09	5,20	5,34	88—110	30	97,00±3.0,08	4,30	5,80	83—108
17,9	30	98,30±3.0,10	5,60	5,73	85—108	30	98,30±3.0,10	5,60	5,80	83—108

The more accomplished muscular equipment of the thumb and the little finger as compared with the other fingers is probably in connection with their peripheral position in the hand, and perhaps one of the causes of its perfect grasping ability. The rather different functional load of the little finger and the thumb as compared with that of the three inner fingers, as it appears in man, might be the cause of the observed difference in the growth in the two groups and may also become a base of their further phylogenetic classification.

Along with the growth of the fingers, an icrease in the difference in their length can be observed. This is clearly visible in the graphs, especially as concerns the growth of the thumb and the little finger on the one hand and that of the three remaining fingers on the other hand. At the same time, the originally small mean difference between the length of the second and the fourth finger in the earliest childhood increases gradually to reach even several millimetres, although this growth is not quite regular. The greatest differences between the individual fingers, both in absolute numbers and in percentages, occur in the period of puberty. The difference between the two mentioned groups of fingers (1+5 and 2+3+4) naturally does not increase

during the period of the last growth phases, because their length remains then almost unchanged.

A study of the mutual, thus relative length of the individual fingers in our children and adolescents up to the age of 18 years reveals that it does not change throughout the whole period of development. The third finger is the longest, which actually is the rule in man as well as in a majority of apes. The third finger is constantly followed, as to the average length, by the fourth and then the second finger, in all age groups. Among the triphalangeal fingers, the little finger is the shortest, the thumb being the shortest of all, which is in agreement with its biphalangia.

A number of authors quoted earlier were concerned with the problem of relative length of the fingers especially in the second half of the last century. For ignorance of the normal mutual relation of the length of the index and the ring-finger in man, the length of the fingers following the sequence 342 was wrongly considered as primitive by M. Ecker (1875) and J. Kollmann (1886) on the alleged ground that it is the rule in some apes. But a reverse relation of the length of the second and fourth finger, i. e. the relation 324, cannot be

Table 3. Length of the third finger. Ph III - da III. Boys

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	41,09±3.0,04	2,50	6,23	35— 45	30	41,09±3.0,05	2,80	6,96	35— 45
4,5	30	46,10±3.0,08	4,60	10,02	35— 56	30	46,80±3.0,08	4,50	9,61	36— 55
7,5	30	49,26±3.0,03	1,90	3,93	45— 53	30	50,13±3.0,03	1,70	3,55	46— 53
10,5	30	54,83±3.0,05	3,10	5,72	47— 60	30	55,60±3.0,05	2,90	5,25	48— 61
15	30	57,63±3.0,06	3,30	5,76	52— 67	30	57,83±3.0,06	3,30	5,77	52— 66
21	30	61,23±3.0,04	2,40	4,01	57— 65	30	61,36±3.0,04	2,30	3,82	56— 66
27	30	61,80±3.0,07	3,90	6,27	54— 70	30	62,20±3.0,07	3,80	6,15	54— 70
33	30	62,87±3.0,05	3,10	5,01	57— 69	30	62,67±3.0,05	3,10	4,94	57— 69
36	30	64,36±3.0,04	2,40	3,79	57— 68	30	64,20±3.0,04	2,40	3,86	58— 68
4	30	66,40±3.0,06	3,50	5,26	59— 74	30	66,60±3.0,06	3,30	5,02	60— 74
5	30	69,10±3.0,07	3,60	5,28	62— 79	30	69,40±3.0,06	3,10	4,50	63— 75
6	30	71,80±3.0,07	3,70	5,19	64— 79	30	72,20±3.0,06	3,60	5,00	65— 79
7	30	75,50±3.0,07	3,90	5,26	67— 84	30	76,10±3.0,07	4,10	5,44	67— 85
8	30	79,10±3.0,07	3,60	4,60	70— 86	30	79,50±3.0,07	3,80	4,74	70— 87
9	30	80,00±3.0,11	6,20	7,70	69— 93	30	80,40±3.0,11	6,10	7,61	71— 93
10	30	82,40±3.0,10	5,50	6,68	72— 94	30	83,30±3.0,10	5,50	6,57	73— 95
11	30	87,40±3.0,09	4,70	5,41	72— 95	30	88,00±3.0,09	4,80	5,48	78— 97
12	30	89,00±3.0,10	5,60	6,35	80—100	30	89,50±3.0,10	5,70	6,42	80—100
13	30	94,50±3.0,10	5,40	5,75	82—105	30	95,30±3.0,10	5,50	5,81	85—107
14	30	101,30±3.0,11	6,30	6,24	85—114	30	102,20±3.0,12	6,60	6,51	86—116
14,3	30	103,50±3.0,12	6,70	6,45	90—119	30	103,70±3.0,12	6,80	6,72	86—118
14,9	30	104,40±3.0.09	5,20	4,97	95—115	30	104,10±3.0,09	5,00	4,87	94—116
15,3	30	107,90±3.0,10	5,80	5,39	97—118	30	108,50±3.0,10	5,70	5,28	96—118
15,9	31	108,00±3.0,09	5,20	4,83	92—119	31	107,70±3.0,10	5,90	5,55	95—118
16,3	34	108,30±3.0,09	5,00	4,60	100—120	34	108,30±3.0,09	5,40	5,05	100—119
16,9	39	108,00±3.0,09	5,70	5,29	100—123	39	108,20±3.0,10	6,00	5,53	100—123
17,3	30	108,40±3.0,09	5,00	4,66	97—123	30	107,70±3.0,08	4,40	4,12	100—116
17,9	30	108,60±3.0,09	5,10	4,65	99—119	30	108,50±3.0,10	5,40	4,98	96—119

Table 4. Length of the fourth finger. Ph IV - da IV. Boys

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	37,64 ± 3.0,04	2,40	6,45	34 — 42	30	37,87 ± 3.0,04	2,50	6,83	32 — 43
4,5	30	41,76 ± 3.0,08	4,80	11,49	31 — 54	30	42,50 ± 3.0,08	4,60	10,82	32 — 53
7,5	30	44,86 ± 3.0,04	2,50	5,75	39 — 49	30	45,53 ± 3.0,04	2,30	5,13	40 — 50
10,5	30	49,63 ± 3.0,06	3,40	6,97	43 — 57	30	50,13 ± 3.0,06	3,40	6,88	44 — 58
15	30	53,30 ± 3.0,06	3,40	6,37	47 — 60	30	53,30 ± 3.0,06	3,30	6,30	46 — 59
21	30	55,16 ± 3.0,05	3,00	5,43	50 — 63	30	55,60 ± 3.0,04	2,50	4,64	51 — 62
27	30	57,80 ± 3.0,07	3,90	6,69	50 — 65	30	58,00 ± 3.0,07	3,80	6,58	50 — 66
33	30	58,20 ± 3.0,03	2,10	3,60	55 — 63	30	58,30 ± 3.0,03	1,80	3,15	54 — 62
36	30	58,90 ± 3.0,04	2,50	4,39	55 — 64	30	58,80 ± 3.0,04	2,70	4,72	54 — 60
4	30	62,30 ± 3.0,06	3,20	5,20	56 — 70	30	62,40 ± 3.0,06	3,30	5,33	56 — 70
5	30	64,70 ± 3.0,06	3,10	4,87	59 — 71	30	64,80 ± 3.0,06	3,20	5,01	60 — 72
6	30	67,50 ± 3.0,06	3,60	5,27	61 — 74	30	67,70 ± 3.0,07	3,60	5,35	61 — 74
7	30	70,80 ± 3.0,07	3,80	5,34	62 — 81	30	71,00 ± 3.0,07	3,90	5,56	62 — 81
8	30	73,90 ± 3.0,07	3,50	4,78	66 — 82	30	74,20 ± 3.0,07	3,60	4,90	66 — 83
9	30	74,60 ± 3.0,11	6,10	8,22	63 — 87	30	74,90 ± 3.0,11	6,00	8,02	66 — 86
10	30	77,10 ± 3.0,10	5,60	7,33	68 — 89	30	77,20 ± 3.0,10	5,60	7,28	68 — 89
11	30	81,00 ± 3.0,08	4,50	5,54	68 — 90	30	81,60 ± 3.0,08	4,70	5,80	72 — 94
12	30	82,80 ± 3.0,10	5,50	6,59	73 — 94	30	83,20 ± 3.0,10	5,30	6,37	73 — 93
13	30	88,60 ± 3.0,10	5,60	6,38	76 — 100	30	89,10 ± 3.0,10	5,60	6,34	78 — 100
14	30	94,70 ± 3.0,11	6,20	6,50	78 — 105	30	95,40 ± 3.0,12	6,50	6,87	79 — 107
14,3	30	96,10 ± 3.0,16	8,90	9,17	80 — 111	30	96,40 ± 3.0,14	7,80	8,03	85 — 110
14,9	30	97,90 ± 3.0,11	5,90	6,05	88 — 110	30	97,70 ± 3.0,09	5,00	5,11	90 — 108
15,3	30	102,50 ± 3.0,10	5,70	5,58	90 — 113	30	102,30 ± 3.0,09	4,80	4,74	90 — 110
15,9	31	101,50 ± 3.0,12	6 50	6,38	82 — 113	31	101,40 ± 3.0,12	6,80	6,72	79 — 114
16,3	34	102,60 ± 3.0,09	5,10	4,89	95 — 119	34	102,60 ± 3.0,08	4,60	4,47	94 — 111
16,9	39	102,30 ± 3.0,09	5,60	5,37	91 — 114	39	102,00 ± 3.0,09	5,80	5,68	92 — 117
17,3	30	102,80 ± 3.0,09	4,70	4,57	95 — 113	30	102,80 ± 3.0,10	5,60	5,46	88 — 112
17,9	30	102,70 ± 3.0,10	5,40	5,25	90 — 115	30	102,80 ± 3.0,10	5,60	5,46	88 — 112

considered inferior either because it quite often occurs in all human populations, and in some of them it even prevails. Nevertheless, in a predominant majority of groups which have been so far examined from this point of view (including our populations) the relation 342 occurs in most cases (J. Jelínek 1950, L. Crhák 1957, M. F. Pospíšil 1959, I. Drobný 1959, R. Weissenberg 1895 and others). R. Weissenberg (1895) mentions that in about 10 to 15% of men and 20 to 25% of women the relation of the lengths of the fingers is different in their two hands. J. Jelínek (1950) mentions this asymmetry in length in 43% of boys and in 9% of girls, M. F. Pospíšil (1959) in 15.82% of boys and in 20.52% of girls.

The determination of the relation of the length of the fingers which occurs most frequently in our populations may provide a valuable aid in surgical reconstruction of the fingers. The absolute length of the individual fingers in the different age groups of our populations is determined by the mean values in the tables 1—10.

One of the most important questions in surgery of the hand is the question whether or not, in the follow-up of its growth dynamics, some periods of

decreased growth activity, or even periods of the so called growth rest can be found. We believe that it will be of advantage to use these periods of smaller increases in size or periods of growth rest for various operations on the hand, especially on its skeleton, in the first place for congenital developmental defects.

We have searched for such periods in the tables and in the mentioned charts of growth curves of all five fingers. A survey of them si given in Table 11.

As the graphs and the table show, the first bilateral decrease in growth activity common to three radial fingers was found in the boys as early as after 21 months of life. In the thumb and the index this period lasts only until about the 27th month while in the middle finger it continues until the age of about 33 months. At the age of 2 years and 3 months a similar decrease in the rate of growth sets in also in the two remaining fingers — the ring finger and the little finger — and lasts until the age of 33 months, similarly as in the third finger. Another period of decreased growth activity in all the five fingers bilaterally and symmetrically sets in about the age of 8 years and lasts only one year, until about 9 years. Only for the thumb this period of

Table 5. Length of the fifth finger. Ph V - da V. Boys

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	31,61 ± 3.0,06	3,60	11,54	27—37	30	31,93 ± 3.0,05	3,20	10,11	26—38
4,5	30	35,16 ± 3.0,07	4,00	11,57	28—43	30	36,00 ± 3.0,07	4,10	11,38	28—42
7,5	30	37,93 ± 3.0,02	1,40	3,82	35—41	30	38,66 ± 3.0,02	1,30	3,54	36—42
10,5	30	40,46 ± 3.0,04	2,50	5,88	38—43	30	42,96 ± 3.0,04	2,30	5,44	39—49
15	30	43,30 ± 3.0,04	2,60	6,18	40—49	30	43,40 ± 3.0,05	2,70	6,38	39—49
21	30	44,20 ± 3.0,06	3,50	8,04	35—54	30	44,30 ± 3.0,06	3,50	7,91	35—54
27	30	45,30 ± 3.0,04	2,50	5,54	39—50	30	45,53 ± 3.0,04	2,50	5,60	40—51
33	30	46,30 ± 3.0,05	3,20	7,04	43—56	30	46,40 ± 3.0,06	3,30	7,11	43—56
36	30	47,22 ± 3.0,05	2,90	6,31	41—54	30	47,38 ± 3.0,05	2,90	6,24	41—54
4	30	48,60 ± 3.0,05	2,90	6,07	43—55	30	48,40 ± 3.0,06	3,20	6,71	41—55
5	30	50,30 ± 3.0,06	3,20	6,36	44—58	30	50,20 ± 3.0,05	2,90	5,88	45—56
6	30	52,40 ± 3.0,05	2,60	5,02	48—58	30	52,40 ± 3.0,05	2,60	4,94	48—58
7	30	55,20 ± 3.0,07	3,90	7,09	47—64	30	55,20 ± 3.0,07	3,80	6,97	46—64
8	30	56,80 ± 3.0,06	3,50	6,09	51—65	30	56,90 ± 3.0,06	3,60	6,27	51—65
9	30	57,70 ± 3.0,08	4,70	8,11	50—67	30	57,70 ± 3.0,08	4,50	7,88	50—66
10	30	60,70 ± 3.0,07	4,10	6,82	53—70	30	60,90 ± 3.0,07	4,00	6,58	54—72
11	30	61,90 ± 3.0,08	4,20	6,85	52—68	30	61,90 ± 3.0,07	4,10	6,62	52—72
12	30	63,90 ± 3.0,09	4,90	7,68	57—74	30	64,20 ± 3.0,08	4,70	7,30	58—74
13	30	70,40 ± 3.0,08	4,20	6,04	62—79	30	70,50 ± 3.0,07	4,10	5,87	62—79
14	30	74,20 ± 3.0,10	5,60	7,49	63—87	30	74,80 ± 3.0,10	5,60	7,49	64—88
14,3	30	74,90 ± 3.0,12	6,80	9,06	60—85	30	75,70 ± 3.0,11	6,30	8,33	61—89
14,9	30	76,40 ± 3.0,12	6,40	8,39	66—90	30	76,90 ± 3.0,11	6,20	8,09	67—92
15,3	30	79,80 ± 3.0,10	5,70	7,09	64—90	30	80,40 ± 3.0,09	5,00	6,29	67—91
15,9	31	81,90 ± 3.0,11	6,10	7,47	70—96	31	81,50 ± 3.0,10	5,60	6,90	70—96
16,3	34	81,20 ± 3.0,08	4,70	5,75	74—90	34	81,10 ± 3.0,07	4,00	5,01	72—89
16,9	39	79,80 ± 3.0,08	5,30	6,63	64—88	39	79,70 ± 3.0,08	5,00	6,24	70—90
17,3	30	80,20 ± 3.0,07	3,70	4,57	70—89	30	80,60 ± 3.0,08	4,20	5,18	73—90
17,9	30	81,10 ± 3.0,10	5,40	6,67	67—93	30	80,80 ± 3.0,10	5,30	6,56	70—95

Table 6. Length of the thumb. Ph I - da I. Girls

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	24,80±3.0,03	1,90	6,77	22—29	30	25,25±3.0,02	1,50	6,17	22—29
4,5	30	23,80±3.0,03	2,10	8,90	18—29	30	24,83±3.0,03	1,70	6,88	22—29
7,5	30	28,50±3.0,04	2,60	9,33	23—35	30	29,26±3.0,04	2,30	7,96	24—35
10,5	30	30,50±3.0,05	2,90	9,60	25—38	30	30,83±3.0,05	2,80	9,11	26—30
15	30	33,78±3.0,04	2,70	8,14	29—39	30	33,87±3.0,04	2,50	7,64	31—35
21	30	35,30±3.0,05	2,80	7,80	30—42	30	35,60±3.0,04	2,50	6,96	32—42
27	30	36,43±3.0,03	1,90	5,18	35—43	30	37,20±3.0,04	2,40	6,50	33—42
33	30	37,76±3.0,03	2,00	5,44	33—40	30	37,70±3.0,03	1,90	5,06	34—42
36	30	38,63±3.0,03	1,90	5,04	35—43	30	38,66±3.0,03	1,80	4,75	36—43
4	30	38,60±3.0,04	2,40	6,35	34—44	30	38,60±3.0,04	2,50	6,50	34—44
5	30	39,80±3.0,05	2,50	6,33	36—45	30	39,80±3.0,04	2,40	6,16	35—44
6	30	41,70±3.0,06	3,10	7,44	37—50	30	41,60±3.0,06	3,10	7,52	37—50
7	30	44,00±3.0,06	3,10	7,04	37—48	30	44,40±3.0,05	2,90	6,64	39—48
8	30	46,50±3.0,07	3,70	8,00	40—53	30	46,50±3.0,07	3,70	7,88	41—52
9	30	47,20±3.0,06	3,40	7,29	40—54	30	47,10±3.0,06	3,20	6,88	40—54
10	30	47,70±3.0,09	4,80	10,12	39—56	30	47,90±3.0,09	4,80	9,97	39—56
11	30	52,00±3.0,08	4,40	8,38	44—61	30	52,10±3.0,08	4,20	8,07	46—56
12	30	54,30±3.0,07	3,90	7,14	48—63	30	54,50±3.0,07	3,60	6,70	48—62
12,3	30	56,70±3.0,07	3,70	6,64	48—64	30	56,20±3.0,07	3,80	6,77	46—65
12,9	30	57,30±3.0,08	4,30	7,62	45—63	30	57,20±3.0,07	3,70	6,51	50—66
13,3	30	58,40±3.0,06	3,10	5,45	53—65	30	57,80±3.0,07	3,70	6,34	50—66
13,9	30	59,20±3.0,07	3,70	6,28	52—70	30	59,20±3.0,05	3,00	5,15	54—67
14,3	31	58,70±3.0,07	3,80	6,48	50—67	31	58,40±3.0,06	3,40	5,86	51—65
14,9	30	59,00±3.0,07	3,50	6,06	50—64	30	59,60±3.0,07	3,60	6,33	52—67
15,3	31	59,30±3.0,07	3,70	6,36	53—67	31	58,40±3.0,06	3,40	5,87	52—64
15,9	36	58,90±3.0,06	3,60	6,10	53—64	36	58,40±3.0,06	3,90	6,62	51—65
16,6	35	59,80±3.0,05	3,00	5,14	54—64	35	59,70±3.0,06	3,50	5,78	53—67
17,6	30	60,30±3.0,07	3,70	6,19	54—70	30	60,20±3.0,06	3,60	5,92	50—69

smaller increases is longer, lasting until the age of 10 years. There is another period of about one year's duration in which the growth curve shows a smaller decline in the boys. It is between the 11th and 12th year in the thumb, the middle finger and the ring finger. In the index this period cannot be taken into consideration at all because the growth curve shows a rather vehement rise in this period while in the little finger it sets in one year earlier, i. e. lasts approximately from the age of 10 to the age of 11 years.

In the boys, the growth of the first four fingers is finished at the age of about 15 years and 6 months; in the thumb it is only about the age of 16 years that no more increases occur.

In the girl's hand, the first period of decreased average increments in length appear in the index — again at the age between 21 to 33 months. Six months later, i. e. at the age of 2 years and 6 months, a period of decreased growth activity sets in also for the third and fourth finger. Like in the second finger, this period lasts until the age of two years and nine months.

In the little finger and the thumb, as far as the length is concerned, the period of a complete rest of growth begins at the age of three years. In the

fifth finger, this period lasts only one year, i. e. until the age of four years, while in the thumb it lasts perhaps until the age of five years. The second period of a considerably decreased growth activity in the length of the fingers in the girls begins in all fingers except for the fourth finger approximately after the age of eight years. In the ring finger, however, it begins only at the age of nine years and can be observed only until the completed tenth year, similarly as in the first, third and fifth finger. In the index this period of reduced average increments also lasts for one year only and after the age of nine years a more rapid growth can be observed again.

Such average values as would not essentially differ from the lengths observed in the last age groups of our two populations are achieved by the individual fingers of girl's hand at various intervals between the age of 14 and 15 years. This does not exclude the possibility of further increments of length in the following year, i.e. after the age of 15. The length of all fingers still grows in this period, and probably it does even after the age of 18, but of course, these increments are but small. The same applies to boy's hand.

Our observation concerning the period of termination of the growth of

Table 7. Length of the second finger. Ph II - da II. Girls

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	35,67±3.0,04	2,60	7,42	30—42	30	35,93±3.0,03	2,10	6,03	31— 40
4,5	30	35,68±3.0,05	2,70	7,85	31—41	30	36,16±3.0,05	3,00	8,40	32— 42
7,5	30	41,33±3.0,04	2,30	5,78	37—46	30	41,80±3.0,05	2,80	6,74	36— 47
10,5	30	45,50±3.0,05	3,10	6,94	38—53	30	45,53±3.0,05	3,20	7,05	39— 52
15	30	48,62±3.0,06	3,90	7,91	43—57	30	48,90±3.0,06	3,70	7,58	43— 57
21	30	53,66±3.0,05	3,20	6,03	47—60	30	53,70±3.0,06	3,20	6,12	46— 59
27	30	54,40±3.0,07	3,70	6,73	48—64	30	54,50±3.0,07	3,70	6,86	48— 65
33	30	54,46±3.0,05	3,10	5,74	49—60	30	54,76±3.0,05	3,00	5,62	50— 60
36	30	57,00±3.0,05	3,20	5,61	51—65	30	57,06±3.0,05	3,10	5,55	52— 65
4	30	58,60±3.0,05	2,60	4,48	54—64	30	58,70±3.0,05	2,70	4,62	54— 64
5	30	61,70±3.0,06	3,40	5,57	52—68	30	61,70±3.0,06	3,60	5,82	52— 69
6	30	64,40±3.0,07	3,60	5,62	58—73	30	64,60±3.0,07	3,70	5,70	58— 74
7	30	67,60±3.0,07	4,00	5,96	59—75	30	68,00±3.0,07	3,80	5,56	60— 75
8	30	71,30±3.0,08	4,50	6,28	62—83	30	71,40±3.0,08	4,40	6,10	63— 83
9	30	72,90±3.0,07	4,00	5,50	62—81	30	73,30±3.0,07	3,80	5,18	63— 80
10	30	74,50±3.0,10	5,50	7,45	64—89	30	74,80±3.0,10	5,30	7,11	65— 88
11	30	79,10±3.0,10	5,30	6,66	69—91	30	79,50±3.0,10	5,20	6,54	69— 85
12	30	82,10±3.0,10	5,70	6,99	67—98	30	82,60±3.0,10	5,60	6,81	67— 98
12,3	30	84,60±3.0,13	7,10	8,50	70—97	30	84,70±3.0,09	4,80	5,65	76— 93
12,9	30	85,10±3.0,08	4,80	5,26	75—94	30	84,80±3.0,09	4,90	5,78	76— 97
13,3	30	86,60±3.0,07	3,90	4,52	77—94	30	86,20±3.0,09	4,70	5,47	78— 96
13,9	30	88,00±3.0,09	4,80	5,53	80—95	30	87,30±3.0,11	6,30	7,22	78— 98
14,3	31	88,70±3.0,08	4,60	5,24	80—98	31	88,90±3.0,11	6,40	7,25	62— 96
14,9	30	88,30±3.0,07	3,70	4,17	81—96	30	88,60±3.0,08	4,50	5,15	80— 99
15,3	31	88,50±3.0,08	4,70	5,37	81—98	31	89,00±3.0,09	4,90	5,55	80— 98
15,9	36	88,50±3.0,07	4,40	4,99	76—97	36	89,00±3.0,07	4,30	4,85	82—100
16,6	35	88,80±3.0,08	4,90	5,51	73—97	35	89,40±3.0,07	4,30	4,84	80— 98
17,6	30	89,10±3.0,08	4,60	5,20	81—99	30	90,10±3.0,10	5,30	5,97	82—102

Table 8. Length of the third finger. Ph III - da III. Girls

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min max
1,5	30	39,61±3.0,03	1,90	4,89	36— 45	30	40,16±3.0,02	1,40	3,48	37— 45
4,5	30	40,53±3.0,06	3,70	9,35	33— 46	30	41,46±3.0,06	3,70	9,06	34— 47
7,5	30	47,30±3.0,05	2,70	5,85	41— 53	30	48,06±3.0,04	2,70	5,61	42— 53
10,5	30	52,66±3.0,07	3,90	7,53	44— 59	30	52,60±3.0,07	4,00	7,73	45— 59
15	30	55,50±3.0,07	4,30	7,78	48— 64	30	55,46±3.0.07	4,00	7,23	48— 63
21	30	58,90±3.0,05	2,70	4,60	55— 65	30	60,16±3.0,04	2,50	4,30	55— 65
27	30	60,90±3.0,07	3,70	6,00	53— 70	30	61,00±3.0,07	3,70	6,02	53— 70
33	30	61,23±3.0,05	3,10	5,20	56— 68	30	61,43±3.0,05	3,10	5,06	57— 68
36	30	63,00±3.0,04	2,40	3,90	58— 68	30	63,00±3.0,04	2,40	3,87	58— 68
4	30	66,00±3.0,05	2,90	4,40	62— 71	30	66,20±3.0,05	2,70	4,03	63— 71
5	30	67,90±3.0,06	3,60	5,26	60— 74	30	68,40±3.0,07	3,70	5,47	61— 74
6	30	71,70±3.0,06	3,40	4,73	65— 79	30	72,10±3.0,06	3,40	4,72	65— 80
7	30	75,30±3.0,08	4,30	5,72	68— 82	30	75,60±3.0,07	4,20	5 50	69— 82
8	30	79 10±3.0,09	5,20	6,62	71— 90	30	79,70±3.0,09	5,00	6,25	71— 90
9	30	80,80±3.0,07	4,10	5,11	69— 88	30	81,40±3.0,07	4,10	5,02	70— 89
10	30	82,20±3.0,11	5,90	7,22	72— 94	30	82,80±3.0,10	5,70	6,83	72— 95
11	30	87,70±3.0,09	5,20	5,96	78— 88	30	88,20±3.0,09	5,10	5,75	72— 96
12	30	90,80±3.0,10	5,50	6,02	79—104	30	92,00±3.0,10	5,60	5,98	80—104
12,3	30	93,80±3.0,13	7,00	7,40	83—108	30	94,20±3.0,11	6,30	6,65	68—108
12,9	30	94,70±3.0,09	5,20	5,46	82—103	30	94,60±3.0,10	5,40	5,80	81—103
13,3	30	97,00±3.0,09	5,30	5,45	89—100	30	97,20±3.0,10	5,20	5,43	88—108
13.9	30	99,00±3.0,10	5,50	5,59	90—108	30	99,00±3.0,09	4,90	5,01	91—107
14,3	31	99,00±3.0,08	4,50	4,56	90—109	31	99,00±3.0,09	4,90	4,90	91—110
14,9	30	98,80±3.0,09	5,00	5,10	90—108	30	99,20±3.0,08	4,40	4,45	91—111
15,3	31	99,20±3.0,09	4,90	5,00	89—108	31	100,00±3.0,10	5,80	5,80	87—112
15,9	36	99,00±3.0,07	4,00	4,03	91—107	36	99,20±3.0,07	4,40	4,49	90—108
16,6	35	100,20±3.0,07	4,20	4,22	89—107	35	100,30±3.0,06	3,90	3,91	92—110
17.6	30	101,00±3.0,10	5,50	5,42	92—116	30	101,10±3.0,09	5,30	5,30	91—114

the hand (K. Hajniš, in the press) and of the fingers, especially in the girls, is in keeping with the earlier termination of the physical growth in general, as compared with the earlier populations, to which our attention has been drawn (J. A. Valšík, personal communication).

DISCUSSION

There are good reasons for the belief that the periods of reduced growth activity in the length of the fingers can be practically made use of for operations on various types of congenital developmental defects of the fingers, which occur more frequently in the boys than in the girls (G. Micali 1965). On the basis of a detailed analysis of growth curves (see the charts) all the mentioned periods can be recommended. Nevertheless, the mentioned third period in the boys, i. e. from the age of 10 to 11 or from 11 to 12 years (Table 11) should be considered as a subsidiary one and should be used only in urgent cases. Corrective operations on the fingers too, especially as far as the phalanges are concerned, should be performed with some delay after the

age which has been determined as an average for the achievement of practically the final length.

We believe that the rest periods of growth and the periods of reduced growth activity are best suited for surgical operations. The growth of the hand, similar to that of other parts of the body, is namely dependent predominantly on the growth of the skeleton. Operative interventions on the skeleton of the phalanges, which might cause a decrease in the growth or even its complete stoppage if performed in a period of its great intensity, probably cannot influence the organism in the period when the growth is small or none to such an extent as in the period of vehement growth dynamics.

In the literature, however, we find very few actual data concerning the time of operations on the fingers.

H. Neumann (1965) recommends the end of the second and the beginning of the third year for operations on the thumb for triphalangia. This period is exactly in keeping with the period of the first reduced growth activity of the thumb, as observed by us in the boys but it precedes one year the period of relative rest of growth in the girls.

Table 9. Length of the fourth finger. Ph IV - da IV. Girls

	Left					Right				
Age	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 . s_{\bar{x}}$	s	v	min-max
1,5	30	36,29±3.0,04	2,20	6,28	30— 43	30	36,74±3.0,03	2,10	5,77	32— 43
4,5	30	37,63±3.0,07	4,10	10,97	30— 44	30	38 40±3.0,07	4,00	10,62	31— 45
7,5	30	43,53±3.0,03	2,10	4,98	40— 49	30	44,10±3.0,04	2,20	5,12	40— 49
10,5	30	46,40±3.0,06	3,60	7,75	40— 53	30	46,70±3.0,06	3,60	7,77	40— 53
15	30	48,96±3.1,00	5,90	12,07	31— 57	30	49,93±3.0,08	4,70	9,43	42— 58
21	30	54,33±3.0,05	2,90	5,42	49— 61	30	54,23±3.0,05	2,90	5,51	49— 60
27	30	56,70±3.0,07	3,80	6,75	50— 64	30	56,70±3.0,07	3,80	6,68	50— 64
33	30	57,23±3.0,04	2,70	4,71	53— 63	30	57,20±3.0,05	2,70	4,86	52— 63
36	30	58,30±3.0,05	2,90	4,99	51— 64	30	58,13±3.0,05	2,90	5,00	51— 64
4	30	61,50±3.0,06	3,20	5,23	55— 67	30	61,80±3.0,05	2,90	4,76	56— 68
5	30	64,10±3.0,06	3,40	5,35	55— 70	30	64,20±3.0,06	3,40	5,23	56— 69
6	30	67,20±3.0,06	3,40	5,12	60— 75	30	67,30±3.0,06	3,30	4,93	60— 75
7	30	69,90±3.0,07	3,90	5,59	62— 77	30	70,10±3.0,07	3,90	5,60	62— 77
8	30	73,60±3.0,10	5,30	7,24	64— 86	30	73,90±3.0,09	5,20	7,00	64— 87
9	30	75,90±3.0,07	4,00	5,26	63— 82	30	76,20±3.0,07	4,10	5,41	64— 83
10	30	76,20±3.0,10	5,70	7,48	67— 90	30	76,80±3.0,10	5,40	7,10	68— 90
11	30	81,30±3.0,10	5,70	7,03	70— 95	30	81,90±3.0,10	5,40	6,60	69— 92
12	30	84,50±3.0,09	5,20	6,21	47— 98	30	85,20±3.0,10	5,70	6,65	75— 99
12,3	30	87,80±3.0,12	6,70	7,55	75— 99	30	88,00±3.0,13	7,10	8,08	75—100
12,9	30	88,60±3.0,09	4,70	5,28	75—100	30	88,80±3.0,09	5,00	5,63	80— 99
13,3	30	90,50±3.0,09	4,60	5,14	83—100	30	90,50±3.0,09	5,00	5,51	82—107
13,9	30	92,40±3.0,11	6,00	6,53	80—104	30	92,20±3.0,09	5,00	5,49	83—103
14,3	31	92,60±3.0,08	4,50	4,86	84—102	31	92,50±3.0,09	4,70	5,13	83—100
14,9	30	92,30±3.0,09	5,10	5,48	81—102	30	92,60±3.0,09	5,30	5,74	81—111
15,3	31	92,50±3.0,12	6,70	7,21	84—102	31	93,10±3.0,06	3,20	3,47	81—103
15,9	36	92,50±3.0,09	5,30	5,76	80—104	36	93,00±3.0,07	4,20	4,25	85—103
16,6	35	93,70±3.0,08	4,60	4,93	80—102	35	93,60±3.0,07	4,10	4,35	84—104
17,6	30	94,00±3.0,09	5,40	5,75	84—107	30	93,50±3.0,09	4,90	5,21	85—104

The observed growth dynamics of the fingers is important, among other things, also in the determination of the period suited for operations for syndactylia and other congenital defects of the fingers and the hand, which require their reconstruction or may, in some way or other, negatively influence their normal growth. B. Rypáčková (1951) mentions that it is recommended to postpone operations for syndactylia until the age of 4 or 6 years, or even until later. J. Geldmacher (1967) believes that syndactylia must be resolved until the age of 10 years at the latest. Otherwise hypoplasia of the fingers develops, as he says. The danger of a late operative intervention which may even induce stoppage of the growth of the fingers in length and thus brachydactylia, is pointed out also by H. Millesi (1965).

The presented mean values of length of the individual fingers of both the left and the right hand must be considered as average data valid for a whole population of children from the birth up to the age of 18 years in the Czech lands. It cannot be expected, however, that each individual in this region will develop, as to the length of the fingers, exactly following the mentioned mean values. There evidently exists a certain individual variability,

Table 10. Length of the fifth finger. Ph V - da V. Girls

	Left					Right				
Age	n	$\bar{x} \pm 3 \cdot s_{\bar{x}}$	s	v	min-max	n	$\bar{x} \pm 3 \cdot s_{\bar{x}}$	s	v	min-max
1,5	30	30,19 ± 3.0,03	1,70	5,76	27—35	30	30,45 ± 3.0,03	1,80	5,91	27—33
4,5	30	31,80 ± 3.0,07	4,20	13,30	25—40	30	32,30 ± 3.0,07	4,00	12,41	26—41
7,5	30	35,70 ± 3.0,03	1,70	4,98	32—40	30	36,06 ± 3.0,03	2,10	5,85	31—41
10,5	30	38,53 ± 3.0,04	2,40	6,33	32—43	30	38,63 ± 3.0,04	2,70	7,06	31—43
15	30	41,28 ± 3.0,06	3,40	8,38	36—48	30	41,37 ± 3.0,06	3,70	8,96	36—48
21	30	43,00 ± 3.0,07	3,80	8,81	35—49	30	43,00 ± 3.0,07	3,80	8,80	35—49
27	30	44,50 ± 3.0,05	2,70	6,26	39—49	30	44,83 ± 3.0,04	2,30	5,14	41—48
33	30	47,16 ± 3.0,04	2,70	5,78	43—54	30	47,00 ± 3.0,04	2,70	5,78	42—54
36	30	47,86 ± 3.0,06	3,40	7,12	40—57	30	47,83 ± 3.0,06	3,40	7,15	40—56
4	30	47,20 ± 3.0,04	2,40	5,05	42—51	30	47,30 ± 3.0,05	2,50	5,33	42—52
5	30	49,20 ± 3.0,06	3,10	6,28	41—54	30	49,20 ± 3.0,05	2,90	5,99	42—54
6	30	51,50 ± 3.0,06	3,20	6,31	45—57	30	51,40 ± 3.0,06	3,30	6,42	43—57
7	30	54,50 ± 3.0,08	4,60	8,38	44—63	30	54,60 ± 3.0,08	4,50	8,31	45—63
8	30	57,50 ± 3.0,08	4,50	7,83	50—68	30	57,60 ± 3.0,08	4,20	7,31	51—68
9	30	58,60 ± 3.0,09	4,70	7,99	47—66	30	58,90 ± 3.0,09	4,90	8,30	47—67
10	30	59,00 ± 3.0,09	5,10	8,64	51—76	30	59,60 ± 3.0,09	5,00	8,47	52—76
11	30	63,10 ± 3.0,09	4,90	7,78	50—72	30	63,20 ± 3.0,09	4,90	7,83	52—68
12	30	65,00 ± 3.0,07	3,70	5,59	59—73	30	65,40 ± 3.0,07	3,70	5,56	60—74
12,3	30	68,90 ± 3.0,09	4,80	6,94	60—77	30	69,30 ± 3.0,09	5,10	7,35	56—78
12,9	30	68,60 ± 3.0 07	3,80	5,62	57—77	30	69,60 ± 3.0,07	4,00	5,75	62—78
13,3	30	71,10 ± 3.0,09	4,90	6,94	63—87	30	71,10 ± 3.0,09	4,70	6,59	60—82
13,9	30	72,50 ± 3.0,08	4,60	6,29	64—84	30	72,50 ± 3.0,09	4,70	6,53	64—84
14,3	31	72,20 ± 3.0,07	4,20	5,78	62—80	31	72,50 ± 3.0,08	4,50	6,16	62—82
14,9	30	72,40 ± 3.0,08	4,20	5,80	66—87	30	73,00 ± 3.0,10	5,20	7,21	67—81
15,3	31	72,30 ± 3.0,07	4,50	6,35	62—81	31	72,70 ± 3.0,08	4,40	6,11	63—83
15,9	36	72,30 ± 3.0,08	4,30	5,98	65—81	36	73,00 ± 3.0,08	4,70	6,47	66—82
16,6	35	72,40 ± 3.0,07	4,30	5,87	63—82	35	72,80 ± 3.0,07	4,00	5,58	64—81
17,6	30	73,60 ± 3.0,07	3,80	5,16	67—81	30	73,60 ± 3.0,08	4,20	5,77	66—82

Table 11. Periods of decreased growth activity or relative rest of growth in the length of the fingers

Finger	Boys	Girls
	years/months	years/months
1	1/9–2/3, 8–10, 11–12, 15/6→	3–5, 8–10, 15 →
2	1/9–2/3, 8–9, 15/6 →	1/9–2/9, 8–9, 14/6 →
3	1/9–2/9, 8–9, 11–12, 15/6 →	2/3–2/9, 8–10, 14 →
4	2/3–2/9, 8–9, 11–12, 15/6 →	2/3–2/9, 9–10, 14 →
5	2/3–2/9, 8–9, 10–11, 16 →	3–4, 8–10, 14/6 →

but on the basis of generally valid statistical laws the present condition can be evaluated and a long-term estimation of the growth dynamics can be made for a large majority of the population according to the calculated values mentioned in our tables.

CONCLUSION

A study of the size and length dynamics of the fingers in Prague children and adolescents of both sexes from birth to the age of 18 years has revealed the following:

1) Norms for the length of all fingers in the individual age groups, separately on the left and on the right, separately for boys and girls have been determined (Tables 1—10).

2) The mean relative length of the fingers in the course of postnatal ontogenetic development always follows the sequence 34251.

3) By analysis of the growth curves periods of reduced growth activity or relative growth rest in the length of fingers have been determined, which can be made use of in operations for congenital developmental defects (Table 11). The facts established by the author as well as other scarce data about the time, as mentioned in the literature, show that operations for syndactylia and other congenital developmental defects of the fingers should be performed preferably between the ages 8—9 or 8—10 years.

4) The dynamics of growth is not the same in all the fingers. For the first and fifth finger, three growth phases were determined, for the second, third and fourth finger four growth phases.

5) The different growth dynamics of the two outer fingers (1+5) as compared with the three inner fingers (2+3+4) can be perhaps explained in part by the different function of these two groups, resulting from their position in the hand. The different growth dynamics in the two groups may form, in further development, also a basis for phylogenetic classification of the digits of the hand into these two groups.

SUMMARY

On the basis of examination of the length of all the five fingers of the hand (ph I — da I, ph II — da II etc.) in 1707 Prague children (854 boys and 853 girls) from birth up to the age of 18 years the dynamics of their growth has been followed-up. From the graphs and tables of mean values some periods of reduced growth activity or even growth rest have become obvious which would be probably suited for various operations for congenital developmental defects of the fingers. A survey is presented in Table 11. The average values along with other statistical characteristics in the Tables 1—10 give information on the length of the fingers in individual age groups.

RÉSUMÉ

La croissance des doigts de la main et le temps opératoire juste pour la réconstruction opératoire de leurs défauts innés

K. Hajniš

A la base des recherches touchant la grandeur des cinq doigts de la main (ph I—da I, ph II—da II et cet.) chez 1707 des enfants de provenance de Prague, dont 854 des garçons et 853 des filles dans la période concernant la naissance et le développement jusqu'à la 18ème année la dynamique d'accroissement des mains a été étudiée. Des graphiques et des tabules des données moyennes quelques-unes des périodes de l'activité de croissance réduite et même des périodes de croissance nulle ont été montrées. Ces périodes pourraient être utilisées pour les réconstructions nécessaires des défauts innés des doigts de la main. Em somne, ils sont présentés dans les tabules Nro 11. Ces données moyennes accompagnées d'autres caractéristiques statistiques dans les tabules Nro 1 à 10 donnent des informations de la longueur des doigts dans des diverses périodes d'âge.

ZUSAMMENFASSUNG

Das Wachstum der Finger und die geeignete Operationszeit bei angeborener Missbildung der Finger

K. Hajniš

Bei 1707 Prager Kindern (854 Knaben und 853 Mädchen) im Alter von 0 bis 18 Jahren wurde die Länge aller 5 Finger gemessen (pH I. — da I., ph II. — da II. usw.) und auf Grund dieser Untersuchung die Dynamik des Fingerwachstums verfolgt. Aus den Diagrammen und Tabellen der Durchschnittswerte geht hervor, dass Zeitabschnitte mit verminderter Wachstumsaktivität oder sogar mit Wachstumsstillstand vorkommen, die wahrscheinlich für die verschiedenen Operationen angeborener Missbildungen der Finger ausgenützt werden könnten. Diese Zeitabschnitte werden zusammenfassend in Tabelle 11 angeführt. Die Durchschnittswerte und weitere statistische Angaben in Tabelle 1 bis 10 informieren über die Fingerlänge in den einzelnen Altereskategorien.

RESUMEN

Crecimiento de los dedos de la mano y períodos convenientes para operaciones de sus defectos congénitos

K. Hajniš

A base de la investigación de los cinco dedos de la mano (ph I. — da I., ph II. — da II. etc.) en 1707 niños de Praga (854 muchachos y 853 muchachas). desde el nacimiento hasta los 18 anos de edad se observaba da dinámica de su crecimiento. Los diagramas y gráficos de valores medios indicaron algunos períodos de reducida actividad del crecimiento o hasta de une interrupción de éste; estos períodos probablemente podrían aprovecharse para varias operaciones de defectos congénitos del desarollo de los dedos. En resumen los muestra el gráfico 11. Los valores medios junto con otras características estadísticas en los cuadros 1—10 informan sobre la longitud de los dedos en diferentes períodos de edad.

LITERATURE

1. **Borovanský, L., Hněvkovský, O.**: Body growth and ossification process in boys from birth to the age of 19, Praha, ČAVU 1930.
2. **Boyes, J. H.**: Bunnell's Surgery of the Hand, Montreal, J. B. Lippincott Comp. Philadelphia 1964.
3. **Bunnell, M. D.**: Surgery of the Hand, J. B. Lippincott, Philadelphia 1944.
4. **Čihák, R., Eiselt, B., Fleischmann, M.**: Reconstruction of thumb opposition by intrinsic hand muscles, Acta Univ. Carol. medica. 1963 : 3—26.
5. **Crhák, L.**: Contribution to the morphology of the palm of boys from Opava, Přír. sbor. ostrav. kraje 1957, 3 : 329—341.
6. **Drobný, I.**: Relative finger length in children from Horní Liptov, Acta F. R. N. Univ. Comen. Anthropologia, 3, 1959, 5—8 : 339—346.
7. **Ecker, M.**: Einige Bemerkungen über einen schwankenden Charakter in der Hand des Menschen, Arch. Anthrop. 1875 8.
8. **Geldmacher, J.**: Kritische Bemerkungen zum Zeitpunkt und zur Technik korrigierender Eingriffe bei angeborenen Fingermissbildungen, Referat. 84. Tagung Deutscher Gesell. f. Chirurgie, München, 1963.
9. **Groff, C. W.**: Comparative Anthropology of Man's Hand, Clin. Ortop. 1959, 13 : 9—23.
10. **Hajniš, K.**: Growth of the Hand and Timing of Operations. Anthropologie (in press).
11. **Harrison, G. A., Weiner, J. S., Tanner, J. M., Barnicot, N. A.**: Human Biology. Oxford. Clarendon Press, 1964.
12. **Jägerová, J.**: Dynamics of hand growth, Prague, Antropolog. ústav KU, 1966.
13. **Jelínek, J.**: Contribution to the morphology of the palm of Greek children, Zprávy antrop. společnosti. 3, 1950, 8 : 25—28.
14. **Koenner, E.**: Ein Beitrag zur Morphologie der Hand, Verb. d. Deutsch. Gess. f. Rassenforschung. 1938, 9.
15. **Kollmann, J.**: Plastische Anatomie, Leipzig, 1886.
16. **Kollmann, J.**: Die Rassenanatomie der Hand u. d. Persistenz der Rassenmerkmale, Arch. Anthrop., 28, 1903.
17. **Křečková, B.**: Growth dynamics of the hand in children from birth to the age of three years, Praha, Antropol. ústav KU, 1966.
18. **Martin, R.**: Lehrbuch der Anthropologie, Jena, G. Fischer, 1928.
19. **Martin, R.**: Lehrbuch der Anthropologie, Stuttgart, G. Fischer, 1957.

20. **Micali, G.**: Congenital Malformation of the Hand, Bratislava, Congressus chirurgicus, 1965.
21. **Millesi, H.**: Behandlungsergebnisse bei kombinierten Missbildungen der Finger, Bratislava, Congressus chirurgicus, 1965.
22. **Neumann, H.**: Die operative Behandlung der Triphalangie des Daumens, Bratislava, Congressus chirurgicus, 1965.
23. **Orlov, J. A.**: Někotoryje dannyje o strojenii pervovo paťca i morfologičeskom značenie bifalangii. Arch. biol. nauk. 37, 1935, 3 : 837—843.
24. **Pospíšil, M. F.**: Morphology of the hand in Serbs from Lausitz, Acta F. R. N. Univ. Comen. 3, 1959, 5—8 : 311—325.
25. **Ranke, J.**: Der Mensch, Leipzig 1887.
26. **Rauber, A.**: Lehrbuch der Anatomie des Menschen, Leipzig 1892.
27. **Rypáčková, B.**: The present state of operations of syndactylia, Čas. lék. čes. 90, 1951, 36—37 : 1081—1084.
28. **Šimůnková, A.**: The dynamics of hand growth, Praha, Antropolog. ústav KU, 1966.
29. **Valšík, J. A.**: Personal communication 1967.
30. **Virchov, R.**: Dinka. Z. Ethnol. 1895.
31. **Volockij, V.**: O dvuch formach ludskej ruky, J. russ. anthropologie 13, 1924.
32. **Weissenberg, R.**: Über die Formen der Hand und des Fusses, Z. Ethnol. 1895.

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Academician F. Burian: **The Plastic Surgery Atlas.** Prague, 1967. 933 p., 1800 photo, 880 draw.

The Atlas was issued in Prague, Czechoslovakia, in 1967, as a co-edition of SZN (Czechoslovak State Medical Publishing House) in Prague, Butterworth in London and Medgiz in Moscow. It comprises three volumes with 933 pages, 1800 photographs and 880 drawings. It was published in English and Russian (and a Japanese edition is been prepared).

The work gives a picture of the development of modern plastic surgery and of the part Czechoslovak plastic surgery has played in it. It sums up ther fifty-year experience of the founder of Czechoslovak plastic surgery, academician Burian, one of the world pioneers in this branch. Unlike other publications of this kind, the Atlas only brings together the experience of the author and his disciples who worked under his guidance up to his sudden death. Apart from good resuts of the treatment, the reader is also informed about the complications which no surgeon can ever be spared of experiencing. The surgical activity of academician Burian, which continued for many decades, has made it possible to elaborate specific surgical procedures for many types of deformities and defects on the surface of the human body both congenital and developing as sequelae of trauma or disease. Many of these conditions require an individual approach, and in this respect, Burian's Atlas gives quite definite directives. The fact that numerous surgical procedures introduced many years ago and practiced with success on large series of patients are published in this work for the first time, can only be explained by the exceptional modesty of the author.

The division of the Atlas into the different chapters presents the reflexion of the method of Burian's school of plastic surgery which paid equal attention to all parts of the body. The character of this work is expressed by the graphic lay-out, i. e. the predominance of documentary photographs with only short captions aug-

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Department for experimental traumatology and orthopaedia (head: A. G. Lapchinsky) of the Central Institute for Traumatology and Orthopaedia Moscow (U.S.S.R.)
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VIABILITY OF RABBIT SKIN FROZEN IN LIQUID NITROGEN AFTER IMMERSION IN LIQUID PARAFFIN AS JUDGED BY ITS GROWTH IN TISSUE CULTURES

O. N. TIMOFEEVA, N. K. PIMAKINA

The storage or conservation of tissues for further use in transplantations is one of the problems of modern surgery. For this purpose various methods of conservation are used such as freezing at —70 °C and less.

After A. G. Lapchinsky and N. S. Lebedeva (1959, 1960, 1961, 1962) and A. G. Lapchinsky, N. S. Lebedeva and A. G. Aingorn (1962, 1961), A. G. Lapchinsky, M. L. Moin and A. G. Aingorn (1962), rabbit skin retains its viability after freezing and conservation in liquid nitrogen at —196 °C for 7½ months. After autoplastic transplantation such skin is capable of perfect ingrowth. The authors state that previous submerging of skin grafts into liquid paraffin causes preservation of their viability after freezing in liquid nitrogen.

The growing of tissue cultures appears to be a reliable method for testing the viability of tissue after submitting them to various experimental influences.

We intended in our paper to solve the question of whether rabbit skin after freezing to —196 °C in liquid nitrogen grows in cultures when previously treated with liquid paraffin after A. G. Lapchinsky, and also test the possibility of growing cultures from frozen skin without the above-mentioned previous treatment.

METHOD

We cut out pieces of skin throughout its whole thickness down to the subcutaneous connective tissue from the outer surface of the auricle and from the spine of rabbits weighing 1½ kg. The operation was carried out under aseptic conditions. The pieces of skin were rinsed in sterile Hank's solution with antibiotics (penicillin and streptomycin) and, depending on the experimental arrangement, immersed either into sterile liquid paraffin or into

liquid nitrogen after immersing them previously in liquid paraffin or into liquid nitrogen without previous immersion into paraffin.

In the first experimental series pieces of skin about 1 mm in size were grown in plasma-containing culture media without previous treatment in liquid paraffin and without freezing (these cultures served as controls). In the second series pieces of skin were rinsed in sterile Hank's solution after being immersed into liquid paraffin for 30—45 minutes and then grown on tissue cultures to ensure that treatment with liquid paraffin alone does not interfere with cell growth. In the 3rd series skin pieces, put into gauze sacs after treatment in liquid paraffin, were introduced into a Dewar flask with liquid nitrogen for various time intervals (from 20 minutes to 5½ days). The material was then transferred to warm Hank's solution at 38—40 °C, cut with sharp scissors to pieces about 1 mm in size and only after that cultivated in vitro. In the experiments of the 4th series the freezing in liquid nitrogen was carried out without previous immersion in liquid paraffin. After warming in warm Hank's solution the material was also cultivated in vitro.

The cultivation was performed in Karrel's flasks 6 cm in diameter. The bottom of the flask was covered with a thin layer of blood plasma from a young cock (the blood was taken from the heart with a syringe dipped in heparin). To the plasma we added 2—3 drops of embryonic chick extract. Three to five minutes after coagulation of the plasma we introduced 10—12 pieces into each Karrel's flask and added the medium 199 in 10 % normal bull's serum. The incubation of the tissue cultures was carried out at 37 °C.

RESULTS

First (control) series. Around the cut pieces of skin a narrow zone of multiplication and cell growth can be distinguished 24 hours after incubation. In the majority of pieces the growing cells are formed compactly like a flat membrane (epithelial character of growth) 24—28 hours after incubation. Already at that time radially directed protrusions form on the surface of the epithelial membrane consisting of spindle cells — fibroblasts. In the course of the second 24 hours the growth and migration of fibroblasts increases sharply and the epithelial central part of the explantate undergoes degenerative changes. Towards the middle of the third day the culture becomes purely fibroblastic (Fig. 1). In the stage of full development (3 days) as a rule three zones can be distinguished on the cultures: the inner one consists of necrobiotically changed cells, the middle of compactly arranged fibroblasts, the outer zone of large spindleform fibroblasts linked to each other by protrusions containing in the cytoplasm clearly visible granules and strongly refractive drops. Between the fibroblasts cells can be found which are in the process of mitosis.

Second series of experiments. The pieces treated with sterile liquid paraffin for 30—60 minutes (without previous freezing) show intensive growth on tissue cultures. As in the control series of experiments, a narrow edge is formed after the first 24 hours consisting of epithelial elements. On top of the epithelial zone there appear single protrusions of fibroblasts. After 2—3 days the explan-

tate assumes a purely fibroblastic character. Its division into a central necrobiotic zone, a growth zone, consisting of densely arranged radially directed fibroblasts, and an outer fringed zone formed by large fibroblasts with a coarsely granulated cytoplasmic structure can be distinguished. Thus the cultures from material treated with sterile liquid paraffin do not differ either in the time taken for the development or in the character of the growth from the control cultures of the first series.

Third series of experiments. The results obtained with the cultivation of pieces of rabbit skin after freezing in liquid nitrogen and previous immersion into sterile liquid paraffin were basically identical to those obtained in the control series. At the beginning of the second day there appeared a narrow zone of cells of epithelial character around the cultivated pieces and on the surface radially directed single groups of fibroblasts (Fig. 2). At the stage of full development of the culture three zones could be distinguished: a central zone with large numbers of necrobiotically changed cells, a middle zone consisting of compactly arranged spindleform fibroblasts, and an outer zone of radially arranged, fully grown cells linked to each other syncytially (Fig. 3, 4). In the cytoplasm of the fibroblasts in the growth zone numerous granules and strongly refractive drops are clearly visible. Many mitotically dividing cells can be observed. We found this picture after short periods in liquid nitrogen (from 20 minutes) as well as after periods of 5½ days in liquid nitrogen.

Fourth series of experiments. Completely different results were obtained when trying to cultivate rabbit skin after freezing in liquid nitrogen without previous immersion into liquid paraffin. We did not observe any growth of tissue cultures in this experimental series.

Our results testify to a protective action of sterile liquid paraffin on tissues submitted to freezing in liquid nitrogen (at —196 ^{0}C). The sharp contrast between the experimental results obtained in the 3rd and 4th series in especially noteworthy. In the last series, using freezing in liquid nitrogen, without previous immersion into liquid paraffin, the explantate was destroyed. In this respect our material is in accordance with literary data. Thus, for instance, according to Rey's observations (1962) freezing of heart tissue from a chick embryo in liquid nitrogen without previous immersion into a protective medium containing glycerine leads to cell destruction independent of the method of freezing or de-freezing. Smith (1963) was of the same opinion.

The protective action of glycerine on tissue cells, exposed to freezing, is based on the fact that after penetrating into the cell it prevents intracellular crystallization. The protective action of liquid paraffin on tissue has not yet been theoretically solved. We can only assume that the mechanism of its protective action is different from that of the action of glycerine and mehtylsulphoxide as liquid paraffin is not soluble in Hank's solution or in the medium 199. The study of this question should be the subject of a special investigation.

SUMMARY

We investigated the possibility of growing cultures of rabbit skin on a plasma-containing medium after freezing of the tissue in liquid nitrogen (—196 °C). We used for the cultivation blood plasma from a young cock, embryonic chick extract, and the medium 199 with 10 % normal bull's serum. We incubated at 37 °C.

Pieces of skin, after previous treatment with liquid paraffin according to A. G. Lapchinsky, and then exposure to liquid nitrogen for 20 minutes to 5½ days, grew on cultures without any significant difference from the growth in control experiments. Rabbit skin frozen in liquid nitrogen without previous immersion into liquid paraffin dd not show any growth on tissue cultures.

RÉSUMÉ

La vitalité de la peau du lapin gelée dans le nitrogène liquide après l'immersion dans la parafine liquide jugée d'après son accroissement

O. N. Timofeeva, N. K. Pimakina

Les auteurs ont subi à l'épreuve la possibilité d'accroissement des cultures de la peau du lapin dans un médium enrichi de plasma en suite de congélation des tissus dans la nitrogène liquide (—196 °C). Pour le but de cultivation, ils ont employé le plasma du sang d'un jeun coq, l'extrait embryonique du poulot de même que le médium 199 avec le sérum des boulles de 10 %. L'incubation était celle de 37 °C.

Les pièces de la peau, étant d'abord soumis au traitement de la parafine liquide d'après A. G. Lapchinsky et puis exposées pour la période de vingt minutes à cinq jours et demi, montrèrent un accroissement sans différence significative d'autres accroissements des tissus en contrôle. Au contraire la peau gelée dans le nitrogène liquide sans être d'abord soumise à l'immersion dans la parafine liquide ne montrait aucun accroissement dans les cultures des tissus.

ZUSAMMENFASSUNG

Die Lebensfähigkeit von Kaninchenhaut, die nach Eintauchen in flüssiges Paraffin in flüssigem Stickstoff gefroren wurde, beurteilt nach dem Wachstum

O. N. Timofeeva, N. K. Pimakina

Die Verfasserinnen untersuchten, ob es möglich ist, Kaninchenhaut in einem Plasma enthaltenden Medium nach Gefrieren des Gewebes in flüssigem Stickstoff (—196 °C) zu züchten. Für die Gewebekultur wurden Blutplasma eines jungen Hahns, Extrakt aus Hühnerembryo und das Medium 199 mit 10 % normalen Rinderserum gewählt. Die Inkubation erfolgte bei 37 °C.

Die Hautproben wurden nach vorheriger Behandlung mit flüssigem Paraffin nach A. G. Laptschinsky für 20 Minuten bis 5½ Tage in flüssigen Stickstoff gebracht und wiesen in den Gewebekulturen in ihrem Wachstum keine wesentlichen Unterschiede gegenüber dem Wachstum der Kontrollen auf. Kaninchenhaut, die ohne vorheriges Eintauchen in flüssiges Paraffin in flüssigem Stickstoff gefroren wurde, wies keinerlei Wachstum in der Gewebekultur auf.

RESUMEN

Vitalidad de la piel de conejos congelada en el nitrógeno líquido después de la sumersión en parafina líquida, como se puede estimar según su crecimiento en cultivos de tejido

O. N. Timofeeva, N. K. Pimakina

Examinamos la posibilidad del crecimiento de cultivos de la piel de conejos después de la congelación del tejido en el nitrógeno líquido (—196 °C), en el ambiente que contiene plasma. Para la cultivación utilizamos la plasma de sangre de un joven gallo, el extracto embrionario de pollo y el ambiente 199 con suero bovino normal de 10 %. Incubamos en 37 °C.

Los pedazos de la piel sometidos antes a la actividad de parafina líquida según A. G. Lapchinski y después expuestos a la actividad de nitrógeno líquido desde 20 minutos hasta 5½ días, crecieron en cultivos sin distinta diferencia del crecimiento en experimentos examinados. La piel de los conejos congelada en nitrógeno líquido sin sumersión anterior en parafina líquida no mostró crecimiento ninguno en cultivos de tejido.

REFERENCES

1. **Lapchinsky, A. G., Lebedeva, N. S.:** Transplantation of Rabbit Skin Frozen at —196 °C. Paper read at Third Scientific Session of the Institute of Experimental Surgical Instruments and Devices held in Moscow in 1959. 35 p.
2. **Lapchinsky, A. G., Lebedeva, N. S.:** Transplantation of Rabbit Skin Frozen at —196 °C in Liquid Nitrogen. Paper read at Second Symposium of Czechoslovak Plastic Surgery.
3. **Lapchinsky, A. G., Lebedeva, N. S.:** Transplantation of Rabbit Skin Frozen at —196 °C in Liquid Nitrogen. From the book „New Surgical Instruments and Devices and the Experience Acquired from Using Them", Moscow, 1960, 4 : 187.
4. **Lapchinsky, A. G., Lebedeva, N. S.:** To the Question of Tissue and Organ Conservation by Deep Freezing. From the book „New Surgical Instruments and Devices and the Experience Acquired from Using Them", Moscow, 1961, 5 : 221.
5. **Lapchinsky, A. G., Lebedeva, N. S.:** Transplantation of Rabbit Skin Frozen at —196 °C in Liquid Nitrogen, Acta Chir. Plast., Prague, 1962, 4, 2 : 77.
6. **Lapchinsky, A. G., Lebedeva, N. S., Einhorn, A. G.:** Transplantation of Skin and Kidney Conserved by Deep Freezing at —196 °C in Liquid Nitrogen. Paper read at Second All-union Conference on Tissue Incompatibility, Conservation and Transplantation of Tissues and Organs held in Odessa in 1961. 61 p.
7. **Lapchinsky, A. G., Lebedeva, N. S., Einhorn, A. G.:** Experiment with Transplantation of Skin Preserved by Freezing at —196 °C in Liquid Nitrogen, Ann. N. Y. Acad. Sci., 1962, 99 : 891.
8. **Lapchinsky, A. G., Moin, M. L., Einhorn, A. G.:** Capacity for Regeneration of Skin Transplanted after Conservation by Deep Freezing at —196 °C. From the book „Proceedings of Third Conference on the Problems of Regeneration and Cell Proliferation", Moscow, 1962, p. 94.
9. **Lapchinsky, A. G., Moin, M. L., Einhorn, A. G.:** Experiments with Suppressing Incompatibility Reaction to Homogenous Skin Graft by Deep-freeze Conservation at —196 °C. Paper read at XIVth Scientific Session of the Institute of Surgery held in Moscow in 1962. 60 p.
10. **Rey, L.:** Preservation of Life by Cooling, Moscow, 1962.
11. **Smith, O.:** Biological Processes Taking Place on Cooling and Freezing Moscow, 1963.

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REACTION OF BONE, MUSCLE AND SUBCUTANEOUS TISSUE TO LYOPHILIZED CARTILAGE GRAFTS

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The durability of tissue transplants used in reconstructive surgery for cosmetic purposes is still the subject of experimental studies and clinical observations. Among others, it was found that survival of transplants in environments foreign to those tissues depended on various factors, such as the kind and morphology of the transplanted tissue, its capacity of eliciting immunological reactions, the histological structure of the recipient tissue, the age and state of health of the recipient organism, but mainly on the method of conservation of the tissue to be transplanted (2, 4, 15, 16, 21, 25).

According to numerous authors (9, 11, 12), the mode of conservation is decisive for the preservation of tissue viability. Although the take of a viable transplant to the recipient tissue encounters great difficulties, the graft, as long as it keeps alive, does not undergo absorption. The opinion as to the durability of lyophilized tissue grafts and the extent to which they may be utilized in reconstructive and cosmetic surgery, differs a great deal with the various authors (1, 3, 5, 6, 7, 8, 10, 13, 14, 18, 20, 22, 23, 24).

In order to find out whether certain transplants may be used for reconstructive surgery in the face, we carried out experiments in rabbits by implanting lyophilized allogenous and xenogenous cartilage grafts into the mandible and the muscle and subcutaneous tissue of the back. In the controls, fresh autogenous cartilage grafts were used and these then taken as the measure of utility by comparing their histological changes with those of the non-autogenous transplants.

The plastic material (cartilage) was taken from the sternal ends of ribs. Lyophilization of the allogenous and xenogenous tissue was carried out at the tissue bank of the VIth Committee of the Polish Academy of Sciences in Warsaw. A total of 36 rabbits divided into three groups, were used for the experiment. In the first group, the grafts were introduced into an artificial defect in the mandible deep enough to involve cancellous bone. In the second and third groups, the transplants were implanted into pockets made in the dorsal muscle or subcutaneous tissue of the animals.

The animals were subjected to close observation for 60 days after operation. Sequestration of the implanted tissue could not be registered, only in

three rabbits an inflammatory reaction of the soft parts surrounding the graft developed which slowly receded within six days. This reaction was probably due to a secondary infection developing in the soft parts after operation and remained without influence on the further course of the experiment, since absorption of the transplant was not accelerated by it which could be verified on histological examination.

Both macro- and microscopically, it could be ascertained that autogenous, allogenous or xenogenous cartilage grafts underwent absorption faster or slower in dependence on the nature of the recipient tissue (quoted 19, 25).

In soft tissue, such as muscle or subcutaneous tissue, xenogenous cartilage was absorbed fastest while autogenous cartilage slowest (fig. 1a, 1b, 1c). — Implanted into bone, xenogenous cartilage underwent focal degeneration and calcification faster than allogenous and autogenous cartilage (fig. 2a, 2b, 3a, 3b). Ultimate filling and bridging of the bone defect in the mandible took place — apart from slight deviations — at the same time which proves that absorption took almost the same time in all transplants used.

After implantation of the transplant, lymphocyte, plasmocyte and other cell infiltrations characteristic for the presence of a foreign body, appeared in the recipient tissue (fig. 2a, 2b). In soft tissues, the reaction slowly increased in intensity up to the 30th day; afterwards its intensity remained unchanged (fig. 6a). In bone tissue, the reaction to allogenous cartilage was of slight intensity, but to xenogenous cartilage — similar as in soft tissue — it was most intensive in the vicinity of the transplant (fig. 1b, 2a). In none of the experimental animals, did the immunological reaction of bone tissue in the vicinity of the transplant ever cease. Gradual recession of the immunological reaction, however, was observed in muscle and subcutaneous tissue surrounding autogenous grafts (fig. 1a, 4a).

From the histological examinations of cartilage grafts, it becomes evident that the transplant induces regeneration of the recipient tissue and that it continues to act in this way until it is finally absorbed (1, 3, 10, 22, 23). — In the mandible, the osteogenetic process proceeded on a connective tissue basis and within the cartilage graft presenting the scaffold, in dependence on the blood supply of the recipient tissue surrounding the transplant and the forces acting upon it (fig. 5a, 5b). It was found that the little differentiated connective tissue which had replaced the transplant after its absorption (4, 17), underwent metamorphosis to muscle, bone or fibrous tissue in dependence on the nature of the recipient tissue (fig. 1a, 4c, 5b).

Regeneration of the recipient tissue took place earliest in cancellous bone, somewhat later in muscle and latest in subcutaneous tissue in which the graft also remained preserved longest (fig. 5a). Autogenous cartilage — similar as all the other cartilage grafts — was also slower or faster absorbed in dependence on the nature and blood supply of the recipient tissue.

Our investigation proved that cartilage grafts implanted into three different tissues, all behaved in a similar manner, although, in soft tissue, they had become enveloped in a capsule of connective tissue which, however, was unable to save them permanently from absorption.

It must be pointed out that the immunological reaction of the tissues investigated never reached an intensity sufficient to eliminate the transplant and that, after a time, it even completely ceased in the soft tissues surrounding autogenous grafts. The absorption time of the transplants was — among others — dependent on the blood supply of the recipient tissue [2, 21]. In a tissue well supplied with blood, the cell elements originated from the lymphatic system reached the transplant quicker and thus led to its faster absorption than in poorly vascularized tissue.

In our opinion, the most important discovery which we have made in our investigation is the fact that cartilage grafts implanted into cancellous bone of the mandible induce regeneration of bone, while those implanted into muscle or subcutaneous tissue lead to regeneration of muscle or connective tissue fibres respectively (fig. 4b, 5a, 5b, 6b).

The results of our investigation prove that lyophilized cartilage grafts, as used in plastic operation for filling or bridging defects in tissue incapable of regeneration, can never permanently replace lost or missing tissue and, therefore, can never bring about durable results. These transplants always undergo absorption and only induce regeneration in the recipient tissue. Implantation of lyophilized cartilage into bone is expedient inasmuch as it induces regeneration of bone tissue. In some cases, such as open fractures, or in the treatment of bone defects after osteomyelitis or trauma, etc., this is of great significance. Lyophilized cartilage is a suitable plastic material for the surgical treatment of not too large bone defects.

SUMMARY

The authors implanted autogenous as well as lyophilized allogenous and xenogenous cartilage grafts into artificial bone defects in the mandible and artificial pockets made into muscle and subcutaneous tissue of the back. They used rabbits as experimental animals and observed the behaviour of the transplant and the recipient tissue surrounding it.

This investigation demonstrated why lyophilized cartilage, as used in plastic operation, would never give durable results. In the experiments, the cartilage grafts underwent absorption and only induced regeneration of the recipient tissue. This reaction continued until the graft was completely absorbed. The speed of regeneration of the recipient tissue stands in dierect proportion to the speed of absorption of the transplant.

RÉSUMÉ

La réaction cellulaire des tissus osseux, musculaires et sous-cutanés en face du transplant cartilagineux lyophilisé

J. Stadnicki, J. Krajnik, A. Maliszewska

Les auteurs ont implanté dans des défauts artificiels de l'os de la mandibule de même que dans des défauts artificiels des muscles et des tissus sous-cutanés dans le dos des lapins des transplants cartilagineux lyophilisés autogènes, allogènes et même xénogènes et, ensuite, ils ont subit a l'observation la conduite du tissus en transplantation de même que du tissu des allentours du transplant en question.

A la base des données obtenues les auteurs ont montré que les transplants cartilagineux lyophilisés dont se sert la chirurgie plastique ne présentent point des résultats attendus. Les transplants en question ont été ablis par la résorbtion et, en même temps, ils exerçaient sur le tissu des allentours une influence au sens de l'inducteur tout en invoquant la régénération du tissu respectif jusqu'au moment de leur résorbtion achevée. Le procès de la régénération du tissu est en proportion directe avec celui de la résorbtion du transplant respectif quand à la vitesse du procès.

ZUSAMMENFASSUNG

Knochen-, Muskel- und Unterhautzellgewebsreaktion auf lyophilisierte Knorpeltransplantate

J. Stadnicki, J. Krajnik, A. Maliszewska

Autoren führten in künstlich gesetzte Knochendefekte der Mandibula und in künstlich auf dem Rücken von Kaninchen gebildete Muskel- und Unterhautzellgewebstaschen autologe sowie lyophilisierte allogene und xenogene Knorpeltransplantate ein, und beobachteten das Verhalten des transplantierten Gewebes und des das Transplantat umgebenden Empfängergewebes.

An Hand durchgeführter Untersuchungen konnte nachgewiesen werden, dass die bei plastischen Operationen verwandten lyophilisierten Knorpeltransplantate nicht die erwarteten Ergebnisse liefern. Die Transplantate erlagen nämlich der Resorption und wirkten auf das Empfängergewebe lediglich als Induktoren, indem sie die Gewebsregeneration solange anregten bis sie gänzlich resorbiert waren. — Der Regenerationsprozess der Gewebe ist der Geschwindigkeit der Transplantatresorption direkt proportional.

RESUMEN

Reacciones de huesos, musculos y células del tejido subcutáneo a los injertos cartilaginosos liofilizados

J. Stadnicki, J. Krajnik, A. Maliszewska

Los autores introdujeron los injertos cartilaginosos, tanto autólogos como liofilizados, alógenos y xenógenos, en los defectos artificiales de huesos mandibulares y en las bolsas formadas artificialmente de los músculos y las células del tejido subcutáneo, en los lomos de los conejos; después observaron el comportamiento del tejido transplantado y el del tejido alrededor del transplante.

Los exámenes realizados comprobaron que los injertos cartilaginosos liofilizados, usados en las intervenciones plásticas, no ofrecían los resultados esperados: estos injertos dieron paso a la resorción y actuaban solo como inductores en el tejido recibidor, incitando la regeneración del tejido hasta su resorción completa. El proceso regenerador guarda proporción directa a la velocidad de la resorción del injerto.

REFERENCES

1. **Axhausen, G.:** Allgemeine Chirurgie in der Zahn-, Mund- und Kieferheilkunde (General Surgery in Dental, Oral and Maxillary Medicine), München, Carl Hauser, 1949, 140 p.
2. **Crawford, J., Campbell, Hirotomo Oshida, Hideaki Takahashi, Kelly, Fr.:** J. Bone Jt. Surg. 45-A, 1963, 8 : 1579.
3. **Delic, M.:** Rev. Chir. Orthop., 47, 1961, 4 : 32.

4. **Dumas, P.**: Greffes Implantatione Inclusions. Paris, 1957, 79 p.
5. **Efimov, M. I.**: Acta Chir. plast., 4, 1962, 2 : 81.
6. **Fiedotenko, A. G.**: Probl. Gemat., 1965, Vol. 1—3 : 55.
7. **Florez, B.**: Rev. Esp. Estomat., 1961, 1 : 48.
8. **Filatov, A.**: Vestn. Khir., 81, 1958, 10 : 3.
9. **Gibson, T.**: Fortschr. Kiefer- u. Gesichtschir., 1958, Vol. IV, 124 p.
10. **Ginestet, Solas, Merville**: Rev. Stomat. 55, 1954, 4 : 234.
11. **Held, A. J., Sprigi, M.**: Parodontologia, 1960, 1 : 9.
12. **Held, A. J., Sprigi, M.**: Schweiz. Mschr. Zahnheilk. 69, 1959, 8 : 54.
13. **Kowalski, J.**: Chir. Narz. Ruchu i Ortop. Polska, XXII, 1961, 5 : 531.
14. **Krajnik, J.**: Pozn. Tow. Przyj. Nauk, Wydzial Lek. Prace Komisji Medycyny Doswiadcz., 23, 1962.
15. **Kukulska-Goscicka, T.**: Postępy Hig. Med. Dosw., 1959, Vol. 13 : 531.
16. **Kukulska-Goscicka, T.**: Postępy Hig. Med. Dosw., 1959, Vol. 13 : 665.
17. **Limberg, A.**: Plast. reconstr. Surg., 28, 1961, 6 : 649.
18. **Limberg, A.**: Acta Chir. plast., 4, 1962, 4 : 59.
19. **Novak, V.**: Acta Chir. plast., 4, 1962, 2 : 113.
20. **Oster, W. R.**: Exp. Chir., 1959, 1 : 58.
21. **Pap, K., Krompecher, S.**: J. Bone Jt. Surg., 43-A, 1961, 4 : 523.
22. **Röhling, G.**: Chir. Narz. Ruchu i Ortop. Polska, XXVII, 1962, 2 : 235.
23. **Schaefer, J.**: Handbuch der mikroskopischen Anatomie des Menschen (Manual of Microscopic Anatomy of Man), Springer Verlag, 1930, Vol. II, Part II, 210 p.
24. **Sielowski, T., Koprowski, J., Przybylski, J., Kawczyk, E.**: Chir. Narz. Ruchu i Ortop. Polska, XXVI, 1961, 5 : 585.
25. **Trauner, R.**: Fortschr. Kiefer- u. Gesichtschir., 1961, Vol. VII, 40 p.

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mented by diagrams of surgical procedures. These diagrams were drawn on hand of Burian's sketches, he himself had originally made in case papers. Burian refuted the usual smooth ideal drawings in which everything fits so well to each other. The drawings of the Atlas were made by an artist and doctor in one person (who was one of the team of doctors at Burian's department) and under the direct participation of the author.

The first volume of the Atlas (200 pages) is divided into two parts. The first deals with the general principle of plastic surgery, among them the physiological procedure in handling living tissue as especially stressed by the author. Already in 1936, these principles were summed up by Burian in a special monograph dealing with the basic methods of plastic surgery, starting with the careful way of suturing tissue, continuing with the so-called local transposition and ending with the transplantation of various living tissues and the implantation of alloplastic material.

The second part of the first volume informs the reader about the problems connected with the treatment of benign and malignant tumours developing on the surface of the body and with the stand point of the plastic surgeon to the removal of skin scars and tottoos.

The special part of the Atlas comprises two volumes. The second volume (509 pages) deals with congenital and acquired deformities of the head. The third volume (224 pages) contains information about the deformities and defects of the neck, the thorax, the genitals and extremities. Each part is dealt with so that the conge-

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PLASTIC OPERATIONS OF ULCERS AND OSTEOMEYLITIC FISTULAE UNDERGOING MALIGNANT CHANGES

V. I. PETROV, M. V. GRINEV

It is known that long-lasting ulcers, osteomyelitic fistulae or ulcerating scars can undergo malignant changes. According to A. P. Shanin, 39 out of 1692 patients, hospitalized in the oncological institute of the Academy of Medical Sciences of the USSR, suffered from carcinoma of the skin which developed after burns.

The malignant transformation of osteomyelitic fistulae is observed even less commonly. A little more than 100 similar observations have so far been published in Soviet literature (S. S. Tkachenko). Henderson and Swart (Mayo's Clinic) discovered carcinoma in 5 (0.208 %) of 2396 patients suffering from chronic osteomyelitis. The highest number of cases of malignant transformation of osteomyletic fistulae (1) have been observed by I. I. Groshin.

Separate observation of carcinoma development out of osteomyelitic fistulae is described by E. V. Mazurik, Devas, Denham et al., Stoytsheft, Wiesner and others.

In the majority of cases there is unfortunately just one method of treatment of malignantly changed ulcers and fistulae localized in the lower extremities, i.e. amputation. We present the following argument against this crippling operation. 1. Metastases in this form of carcinoma are very rare (8—10 % of cases) and appear at a late period of time. 2. The surgeon is forced to perform tissue-sparing operations which have a quite satisfactory result when the carcinoma develops in other parts of the body than the extremities.

This fact makes us in some cases doubtful whether the amputation of the extremity in the case of carcinoma is really advisable. This operation is indicated for large tumours undergoing destruction and inflammation, in new formations which destroy the bone extensively or when the tumour affects the end of a stump.

We think that the amputation of the extremity can be avoided in patients with a form of carcinoma which has not been neglected and it could be replaced by a more conservative plastic operation.

Our clinical observations included 11 patients — 10 men and 1 woman. All were suffering from a squamous cell carcinoma which was confirmed by histological examination of the material acquired by biopsy and after the

removal of the tumour. The age of the patients ranged from 35 to 69 years. The majority of carcinomas developed in the distal end of the lower extremity: in 6 patients on the foot, in 1 patient on the shin and in 1 in the area of the knee joint. Of the remaining 3 patients one developed a carcinoma of the lumbar region. In the others the tumour was localized in the region of the pelvo-femoral joint and the third on the neck.

Fig. 1. Patient S. Carcinoma as a result of gunshot wound

Fig. 2. The same patient after the operation

Some investigators explain the localization of the carcinoma in the distal parts of the lower extremities by disturbances of the normal blood circulation, particularly noticeable in older patients. According to these investigators age is supposed to predispose them to malignant changes.

The duration of the illness, i.e. the time interval between the formation of the ulcer or fistula and the malignant degeneration may vary from 10 to 53 years (the average 26 years). Sometimes the carcinoma develops earlier, as

O. N. Timofeeva and N. K. Pimakina

VIABILITY OF RABBIT SKIN FROZEN IN LIQUID NITROGEN AFTER IMMERSION IN LIQUID PARAFFIN AS JUDGED BY ITS GROWTH IN TISSUE CULTURES

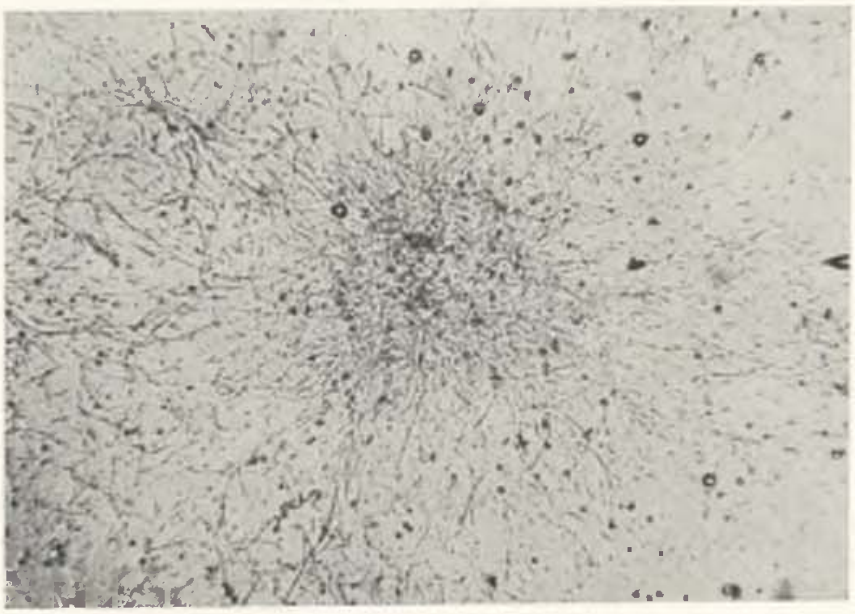

Fig. 1. Control experiment. Growth of fibroblasts on tissue cultures of rabbit skin from the auricle after 2 days of explantation.

Fig. 2. Tissue culture of rabbit skin from the auricle. The skin was treated with liquid paraffin and then frozen in liquid nitrogen for 24 hours. Beginning of growth of epithelial cells and fibroblasts 26 hours after explantation.

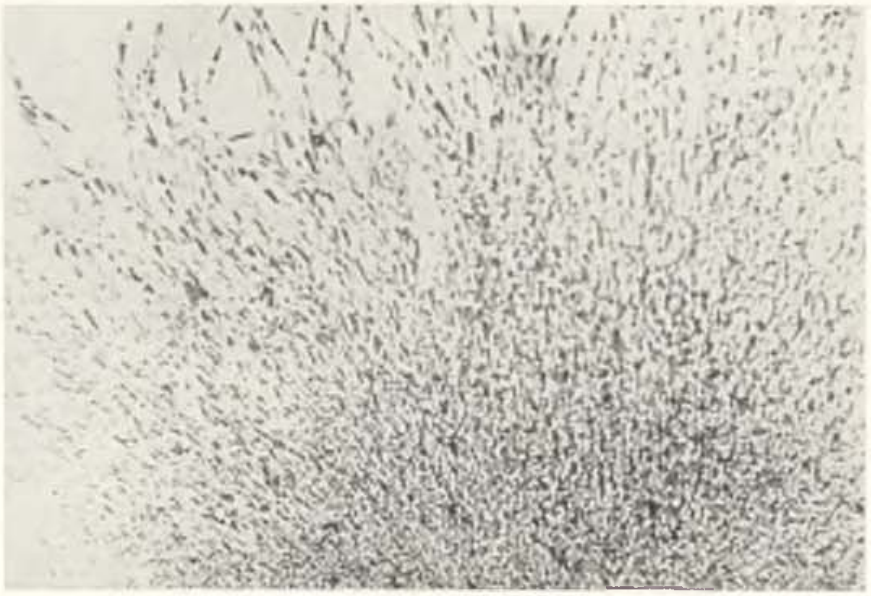

Fig. 3. Tissue culture of rabbit skin from auricle. The skin was treated with liquid paraffin and frozen in liquid nitrogen for 24 hours. Fibroblastic character of growth three days after explantation.

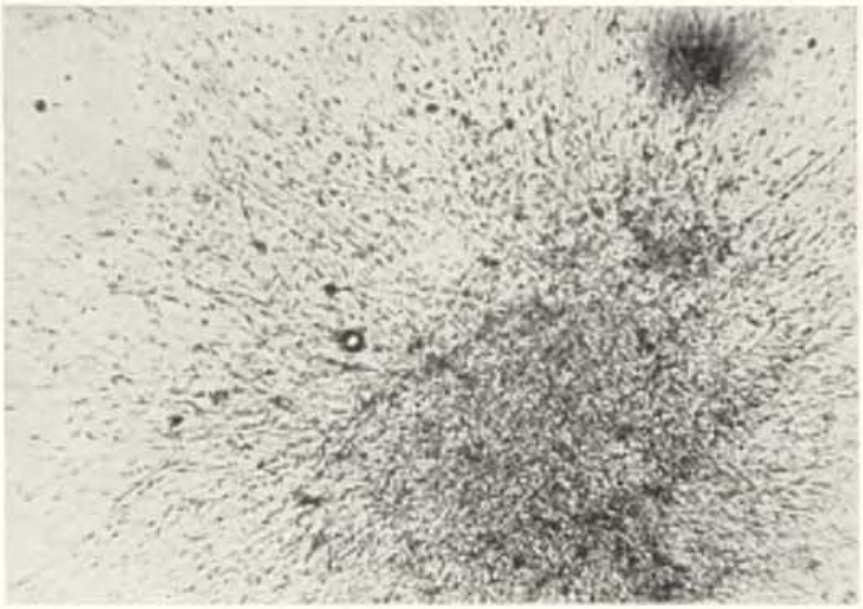

Fig. 4. Tissue culture of rabbit skin from auricle. The skin was treated with liquid paraffin and frozen in liquid nitrogen for 5½ days. Growth of fibroblasts 3 days after explantation.

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REACTION OF BONE, MUSCLE AND SUBCUTANEOUS TISSUE TO LYOPHILIZED CARTILAGE GRAFTS

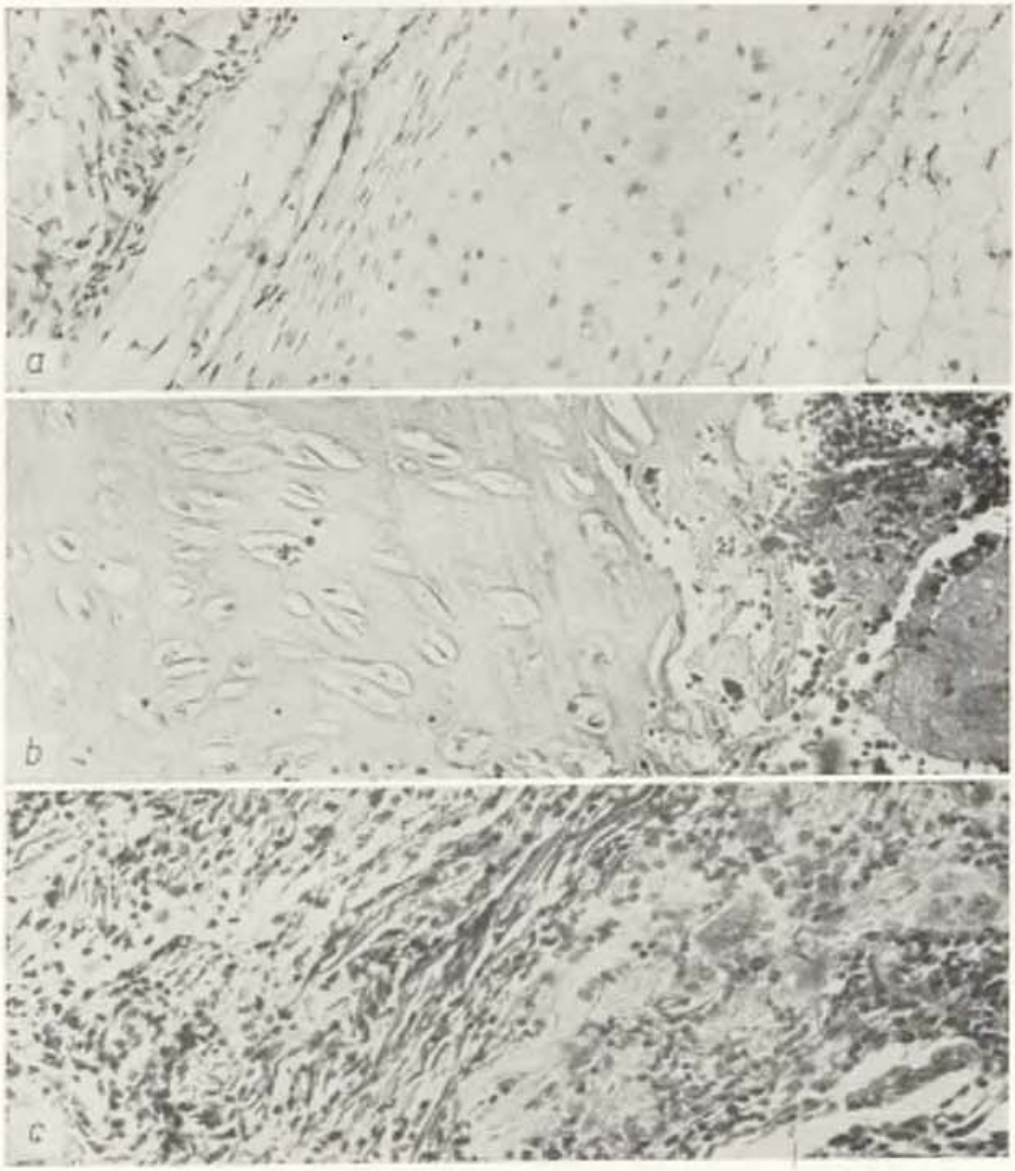

Fig. 1a. Fragment of autogenous cartilage. Fatty tissue and regenerating muscle fibres in immediate vicinity of graft. Magn. 160×. — Fig. 1b. Large lymphocyte and plasmacyte infiltrate around well preserved xenogenous cartilage fragment implanted into muscle tissue. The transplant is invaded by elements of connective tissue leading to fragmentation. Magn. 160×. — Fig. 1c. Xenogenous cartilage tissue can no more be detected in muscle tissue. Tissue defect has been filled with connective tissue rich in fibres and between them muscle fibres and lymphocyte infiltrates with giant cells of foreign body type can be seen. Magn. 160×.

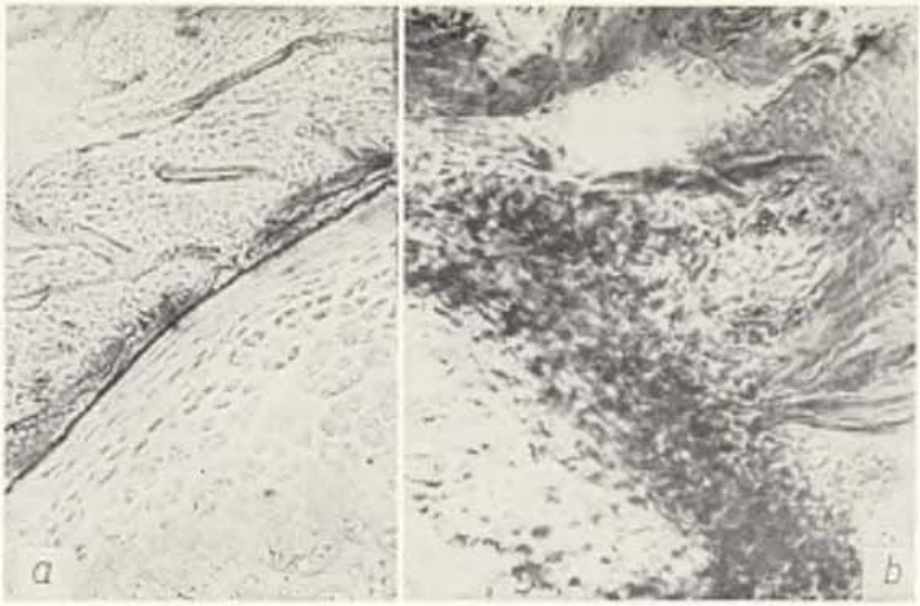

Fig. 2a. Fragment of allogenous cartilage graft implanted into bone surrounded by slight reaction of connective tissue. Chondrocytes on periphery of graft have the shape of fibroblastoid elements. Magn. 160×. — Fig. 2b. Remnant of xenogenous cartilage graft implanted into bone surrounded by reaction of connective tissue with large number of lymphocytes. Collagenous fibres and fibroblasts invading cartilage graft from periphery. Magn. 120×.

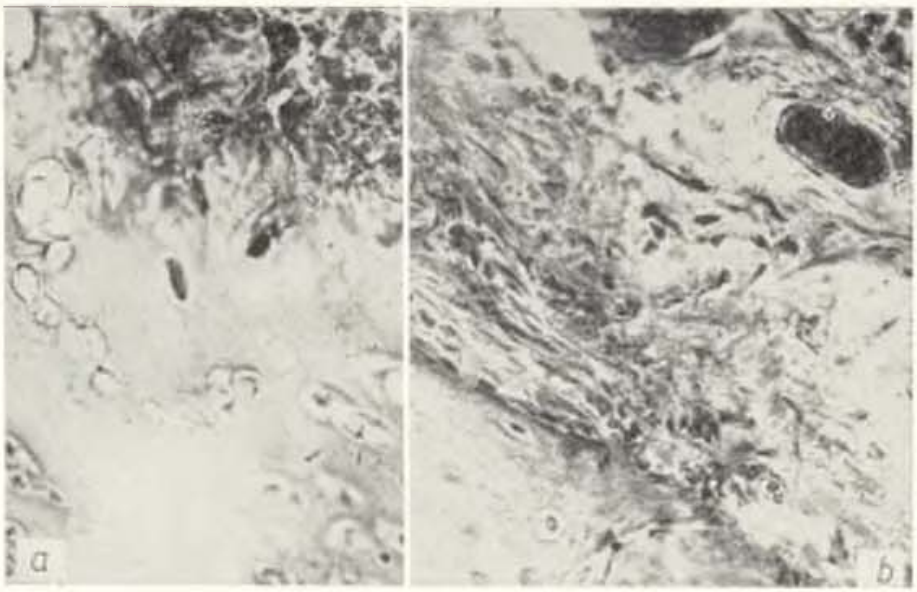

Fig. 3a. Connective tissue elements originated within recipient bone invading autogenous cartilage graft from periphery and causing absorption. Magn. 300×. — Fig. 3b. Connective tissue consisting of thick fibre bundles and fibroblasts replacing xenogenous cartilage graft implanted into bone. Within network of connective tissue, vessels filled with blood can be seen. Magn. 160×.

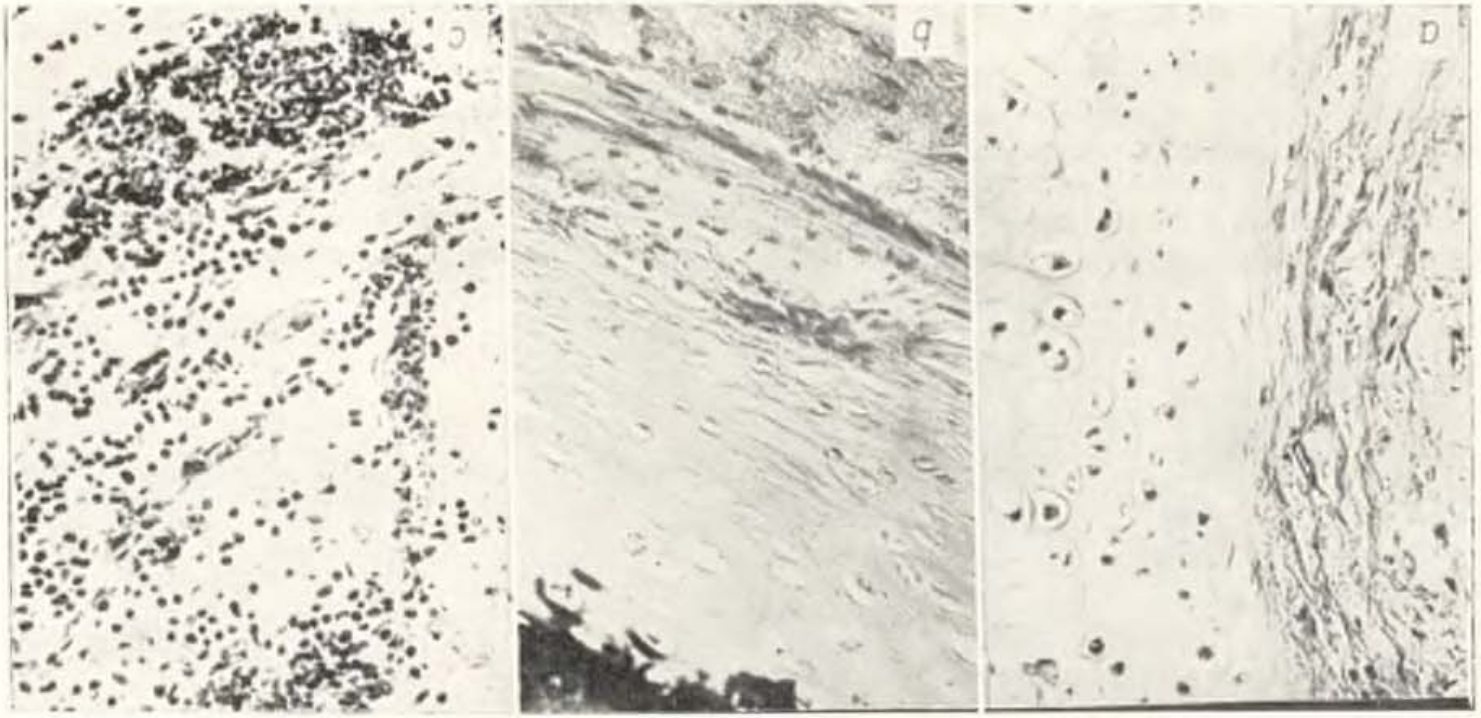

Fig. 4a. In periphery of autogenous cartilage graft implanted under skin, collagenosis of matrix can be seen. Chondrocytes take on the shape of fibroblastoid elements. Magn. 160×. — Fig. 4b. Xenogenous cartilage graft 20 days after implantation under skin with central part disintegrated. In periphery of graft, connective tissue proliferation and slight small-cell reaction can be observed. Magn. 160×. — Fig. 4c. No trace of cartilage tissue belonging to xenogenous cartilage graft implanted under skin can be detected. Tissue defect is filled with connective tissue well vascularized and richly infiltrated with lymphocytes. Magn. 160×.

The following operative methods were used: a large subcutaneous vein of the thigh was resected and simultaneously the femoral, inguinal and sometimes also the retroperitoneal lymphatic nodes were removed. The operation was carried out under general anaesthetic. The entire ulcer, including the edges and the bottom, was resected as one preparation 4—5 cm into the healthy tissue. Aseptic measures were strictly adhered to (such as covering the ulcer with napkins, washing of the wound after the resection of the ulcerating tumour). The large wound from the resection was covered with the split skin

Fig. 4. The same patient. Osteomyelitic focus in the under-trochanteric area

graft. In cases where the tumour was developing out of osteomyelitis the soft part was resected as far as the bone and nectrectomy of the bone was then performed over a wider area, as usual. The wound is repeatedly washed out with a solution of furacilin followed by muscular plastic operation of the bone cavity. The dermatom graft is placed over the whole wound and also on top of the muscular flap which covers the wound.

The six patients in which Duken's operation was performed previous to the resection of the tumour showed no signs of metastases in the lymphatic nodes. This is further proof that the conservative operation should be preferred for this type of patient. Short summaries of the case histories of 2 patients should serve as an illustration of our statement:

1. Patient I., 50 years old. Wounded in the knee joint area in 1919. The wound healed with a coarse scar. An ulcer appeared in the scar region 37 years after the injury. The ulcer did not respond to treatment over three years. A few months before admission to the hospital in 1960, the ulcer pains increased and a large amount of granulation with a fould-smelling discharge was observed. Some areas af keryatinization of the edges of the ulcer were present

(Fig. 1). Diagnosis: cancer following a gunshot ulcer. The operation was performed (V. I. Petrov). The tumours ulcer was widely resected, ranging into the healthy tissue, after previous removal of the inguinal, femoral and retroperitoneal lymph glands. The wide wound surface which was formed was then covered by skin graft. The skin grew in completely (Fig. 2). Histological examination of the preparation: squamous cell carcinoma. No relapse of the tumour after 7 years.

2. Patient K., 45 years old. Received a fragmentation shell wound of the right side in 1944. Had no complaints for 20 years. A fistula appeared in the upper part of the thigh in 1964. Three months before admission to the hospital the pain increased and the amount of discharge from the fistula also augmented. The patient was forced to leave his job.

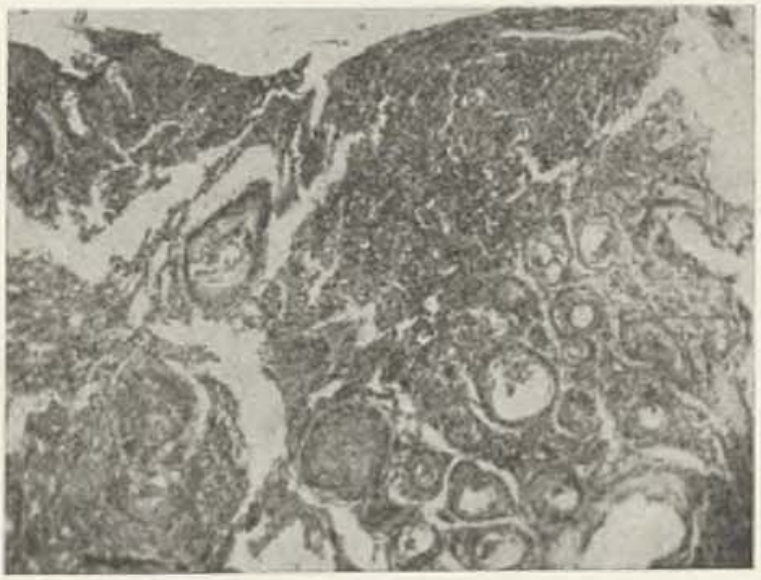

Fig. 5. Photograph of the histological preparation of the osteomyelitic fistula. Squamous cell carcinoma

Local findings: in the area of the trochanter major on the right side there was a fistula ulcer with keryatinized averted edges (Fig. 3) and a foully-smelling discharge. A few fistulae were discovered in the neighbourhood. The skin was thickened and infiltrated. The X-ray showed a focus of destruction in the under-trochanteric area (Fig. 4).

Presumed diagnosis: carcinoma arising from an osteomyelitic fistula.

The operation was performed in December 1966 (M. V. Grinev). Histological examination of the bioptic material obtained from the edge of the fistula was performed immediately during the operation and confirmed the diagnosis. The inguinal and femoral lymphatic nodes, which showed no metastases were removed too. A large area of changed skin with fistulae into the bone was resected into healthy tissue. Necrectomy of the femural bone was carried out. Abundant and repeated washing of the extensive wound by a solution of furacilin was performed. The naked bone and the cavity due to trepanation were covered by a muscular graft cut out of the m. tensor f. latae. and turned by

90°. A part of the wide wound was covered with meeting triangular grafts. The other part was covered by skin graft which was put on top of the muscular graft. The healing was uneventful. The histological diagnosis was squamous cell carcinoma (Fig. 5).

The patient examined after an interval of 7 months, and found healthy. The skin transplantate and the skin of the neighbourhood showed no pathological changes and were soft (Fig. 6). The X-ray control showed smooth contours of the post-operative cavity of the femural bone.

Fig. 6. The same patient 7 months after the operation.

The immediate results of the operation in our patients were encouraging with the exception of one patient who apart from carcinoma of the stump suffered also from carcinoma of the breast with mestastases into the bone. The remaining ten patients were released from the hospital with healed wounds.

Later results are known only in five patients out of seven, in which the conservative plastic operations were performed (the address of one patient was lost during the long time interval after the operation, the other patient died of metastases of carcinoma of the breast). No mestastases or relapse of the carcinoma were discovered in the 3 patients who were under observation for 7 to 9 years. The same applies to two patients who have been under observation for one to two years.

On the basis of our experiences, described in the present paper, we arrived at the conclusion that conservative plastic operations of carcinoma arising from ulcers and osteomyelitic fistulae of the extremities can be considered as sufficiently radical and therefore their performance is justified in a number of patients.

SUMMARY

The experience acquired while treating 11 patients suffering from carcinoma of ulcers and osteomyelitic fistulae is described in this paper. The authors are in favour of conservative surgery whenever possible, in contrast to the generally accepted method of amputation of the extremities. Resection of the tumour, followed by skin or skin-muscle plastic operation and completed by Duken's operation have been recommended. The authors performed 7 operations using the above-described method. The early and late results were very satisfactory (patients under observation from one to 9 years).

RÉSUMÉ

Les opérations de la chirurgie plastique touchant les ulcerès et les fistules de l'ostéomyelite en état des changements malignes

V. I. Petrov, M. V. Grinev

Les auteurs décrivent leurs expériences avec le traitement des cancers de provenance des ulcères de même que des fistules d'origine ostéomyelitiques. Les auteurs préfèrent le traitement conservatif aussi longtemps que possible, malgré la favorisation générale du traitement chirurgical sous forme d'amputation des extrémités respectives. Ils recommendent la résection du tumour, suivi d'une couverture en forme du transplant cutané libre ou du transplant combiné musculo-cutaneux, qu'ils complètent par l'opération de Duken. Ils ont en somne fait sept des interventions cités ci-dessus. Les résultats précoces de même que ceux tardifs ont été très favorables, les malades étant en état d'observation d'une période d'une à neuf années.

ZUSAMMENFASSUNG

Plastische Operation von Geschwüren und osteomyelitischen Fisteln, die maligne entarten

W. J. Petrow, M. W. Grinew

In der vorliegenden Arbeit wird über die Erfahrungen mit der Behandlung von 11 Patienten berichtet, die an karzinomatös entarteten Geschwüren und osteomyelitischen Fisteln litten. Die Verfasser befürworten die konservative chirurgische Behandlung, wo immer sie möglich ist, im Gegensatz zu der allgemein geübten Praxis, die die Amputation der Extremitäten für unerlässlich hält. Es wurde Tumorresektion mit nachfolgender Haut- oder Haut-Muskel-Plastik und Dukenscher Operation empfohlen. Die Autoren führten auf diese Weise 7 Operationen mit sehr zufriedenstellenden Früh- und Spätergebnissen aus. Die Patienten stehen nunmehr bereits 1 bis 9 Jahre unter Beobachtung.

RESUMEN

Operaciones plásticas de úlceras y fístulas osteomyelíticas que convierten en malignas

V. I. Petrov, M. V. Grinev

En este trabajo se describen las experiencias ganadas con once pacientes que sufrieron de carcinoma de úlceras y de fístulas osteomielíticas. Los autores se inclinan, en caso de que sea posible, hacia la cirugía conservador, al contrario del método en general aceptado, de amputación de las extremidades. Se recomienda la resección

del tumor seguida por la operación plástica de la piel o la de piel — músculo y completada con la operación de Duken. Los autores realizaron siete operaciones, usando el método de arriba mencionado. Los resultados prontos así como los posteriores fueron muy satisfactorios (los pacientes se hallaron bajo del control desde una hasta nueve años).

REFERENCES

1. **Groshin, I. I.**: Khirurgia, 1966, 10 : 59.
2. **Mazurik, Y. V.**: Nov. Khir. Arkh., 1962, 2 : 70.
3. **Petrov, V. I.**: Vestn. Khir., 1960, 3 : 138.
4. **Petrov, V. I.**: Vestn. Khir., 1963, 9 : 110.
5. **Petrov, V. I.**: Free Skin Transplantation, Leningrad, 1964. 69 p.
6. **Tkachenko, S. S.**: Vestn. Khir., 1963, 4 : 95.
7. **Shashin, L. P.**: Malignant Tumours, Leningrad, 1952, V 2, p. 10.
8. **Denham, R. H., Dingley, A. F.**: J. Bone Jt. Surg., 1963, 45-A : 384.
9. **Devas, U. B.**: Brit. J. Surg., 1952, 40 : 140.
10. **Henderson, M. F., Swart, H. A.**: J. Bone Jt. Surg., 1936, 18 : 56.
11. **Stoytsheft, K.**: Beitr. Orthop. Traum., 1961, 8 : 798.
12. **Weisner, H.**: Zbl. Chir., 1954, 79 : 271.

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nital malformations of the respective region are discussed first, then fresh injuries, posttraumatic conditions and finally tumours. The extent of each chapter of the special part has been determined by the great variety of pathological conditions of the head, especially of the face, on the one hand, and on the other by the author's personal interest which made him dedicate most of his clinical and research activities to the congenital malformations of the face.

In this part of the Atlas, the original surgical methods of treatment of the various congenital and acquired deformities of the face, orbit, nose and particularly of cleft lip and palate as well as introduction of new surgical methods of treatment of some congenital malformations of the female brest and the male or female genitals, must especially be pointed out. In the chapter dealing with the extremities, the author brings together his life-long experience gathered in four wars and after World War II in the period characterized by the rapid development of motorism and mechanization.

The work of academician Burian demonstrates the way in which the sequelae of pathological conditions, which evoke the attention of plastic surgeons, ought to be dealt with. The author intended to save from disappointment those surgeons who wanted to try their hand in plastic surgery and landed themselves in difficult and confused situations, because they let themselves be guided by the beautiful pictures in the current text books. Plastic operations require a special study apart from the knowledge of general surgery. The work of academician Burian shows the manifold approach in the surgical procedure when treating pathological conditions in the different parts of the body. This was, however, not intended to disencourage the beginner. The author himself pointed out that "the plastic surgeon need not be a great artist by birth. Any surgeon with enough creative talent which is an integral prerequisite of every good surgeon, may acquire the knowledge and craft of a plastic surgeon".

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PLASTIC OPERATIONS IN TISSUE DAMAGED BY IRRADIATION*)

G. GRIMM

It is a well known fact that treatment by ionizing irradiation not only has a therapeutic effect, but also gives rise to some undesirable side reactions. In properly executed actinotherapy, these side reactions hardly ever become manifest clinically or if they do, they mostly retreat in the further course. If, however, the permissible limit dose of irradiation has been exceeded, reactions develop which then are irreversible. This may occur both in a single overdose of after small doses applied for a considerable time and in their total exceeding the permissible limit. These irreversible changes are called radiation damage which may be unavoidable, constituting a calculated risk of certain therapeutic aims or regrettable, presenting a consequence of overdosage due to ignorance or negligence. There is a difference between early and late, i.e. acute and chronic radiation damage, both constituting an indication for surgical treatment. The early radiation damage is characterized by ulcerous radiodermatitis with inflammatory reactions dominating the clinical picture. The typical macroscopic signs of chronic radiation damage, on the other hand, are atrophy of the skin with areas of sclerotic induration, irregular pigmentation and telangiectases.

It must be borne in mind that in a thus scaling, hyperkeratotic skin with its inadequate blood supply, radiation necrosis or radiation carcinoma may develop any time.

In order to understand the difficulties met with in the surgical treatment of the thus altered tissue. I should like to recall the histological picture of radiotrophic skin. The connective tissue shows signs of sclerotization with hyalinosis and scanty nuclei in the collagenous fibres. Hair follicles and sebaceous glands under the atrophic epithelium have been completely destroyed, while sweat glands, which are more resistant against irradiation, have partly survived. The small arteries show subendothelial proliferation of fibrous tissue leading to considerable narrowing and sometimes even to complete oblitera-

*) According to paper read at Meeting of Plastic and Reconstructive Surgery with international participation held in Leipzig on 26 Oct., 1967.

Fig. 1a. Foci of ulceration in X-ray dermatosis of left cheek after X-ray treatment of lupus. — Fig. 1b. Planning of tissue replacement by transposition flap from neck. — Fig. 1c. Result of operation immediately after removal of suture

tion of their lumina. The vessels are not only narrowed, but also decreased in their total number (Heite and Macher).

The clinical effect of radiation damage, which must always be taken into account on surgical treatment, is inadequate blood supply of the tissue linked up with a poor tendency for healing on the one hand, and complete break-down of the natural resistance against skin infection due to the lack of sweat and sebaceous glands on the other.

In addition, the uneven surface full of scabs and recesses encourages intensive growth of microorganisms which threatens the result of any surgical interference with local infection.

Yet, these difficulties and the experience with skin damaged by irradiation badly tolerating any surgical treatment, must not give ground to denying the value of surgery in such cases. Surgical treatment, though difficult, still presents the only hope for cure. It is, however, important to consider the above-mentioned difficulties mainly in the following three points:

1) in the preoperative treatment,
2) in the surgical technique and
3) in the planning of plastic reconstruction.

Preoperative treatment must be regarded both from general and local aspects. In the foreground are measures aimed at improving the general condition of the patient, such as compensating protein losses by blood and plasma transfusions, administration of vitamins, psychological guidance, etc. Local measures are centered on defence against infection; it is, however, impossible to cope with the surface flora by mechanical means or disinfectants, because the affected skin is too tender, delicate and prone to injury. The microbial

flora can be identified from smears taken from the irradiation ulcer and its sensitivity to antibiotics tested, so that specific local and general antibiotic treatment may be induced. Mild antiphlogistics — but no ointment — may also be applied preoperatively.

Fig. 2a. X-ray necrosis of skin and bone above bridge of nose after repeated X-ray treatment of basiloma

We, at our Unit, agree with Zoltán that excision of samples for histological examination before operation is neither requisite nor expedient. No reliable findings can be obtained without the histological investigation of the entire ulcer, and then, in any case, an X-ray ulcer, because it is always suspect of malignancy, must be removed like a tumour far into healthy tissue. In order to improve the chances for the take of a transplant, excision of the ulcer should, if possible, be extended to where the tissue is free of the damage induced by radiation. Though there is, in this respect, no limit as to the area of excision, there may be limits as to the depth to which the ulcer can be removed. Trying to spare nerves, vessels and other important organs requires decision whether some fibrous tissue could be partly left untouched or whether is should be sacrificed without compromise as potentially neoplastic tissue. When in doubt,

Fig. 2b. Coverage of secondary defect resulting from excision of X-ray-damaged skin and bone with transposition flap from forehead. — Fig. 2c. The result of plasty.

the decision should be checked by cryostat microtome histological examination technique during operation.

With regard to surgical technique, it should be pointed out that only removal of all X-ray-damaged tissue creates a recipient bed with good blood supply for transplantation.

If the X-ray dermatoma is spreading but superficially, excision should not be limited to precancerous and cancerous tissue only, but should, as far as possible, include the entire X-ray-damaged skin, because one has to reckon with the possibility of its subsequent malignant degeneration, though, at operation, nothing may yet indicate it.

Fig. 3a. Basiloma of forehead repeatedly treated with X-rays and recurrent on forehead hair line. Condition after elimination of radiogenous bone sequestrum and healing by scar producing accretion of skin and dura mater. — Fig. 3b. Bridging of bone defect with outer table bone graft from skull above lesion.

On principle, atraumatic surgical technique with scalpel and scissors is required; diathermy should be avoided because of the poor viability of the tissue (Routledge). This may particularly become necessary on controlling haemorrhage, which is difficult in any such operation, because the small vessels are encased in scar tissue and cannot contract sufficiently. The surgeon will just have to be patient and use pressure and thrombin locally for the purpose. Apart from atraumatic technique, strictest asepsis is imperative and can in no detail be overdone. Inspite of the most meticulous removal of all pathological tissue, some decrease in blood supply and resistance against infection must be accounted for in the marginal areas of the surgical wound which cannot even be compensated immediately by a covering flap graft with very good blood supply (Schuchardt).

Prophylactic administration of antibiotics has but a limited effect which — as is well known — depends on the local blood supply to the tissue.

Due attention should also be paid to suture technique. Simple interrupted or mattress stitches easily cut through X-ray-damaged tissue and should not be

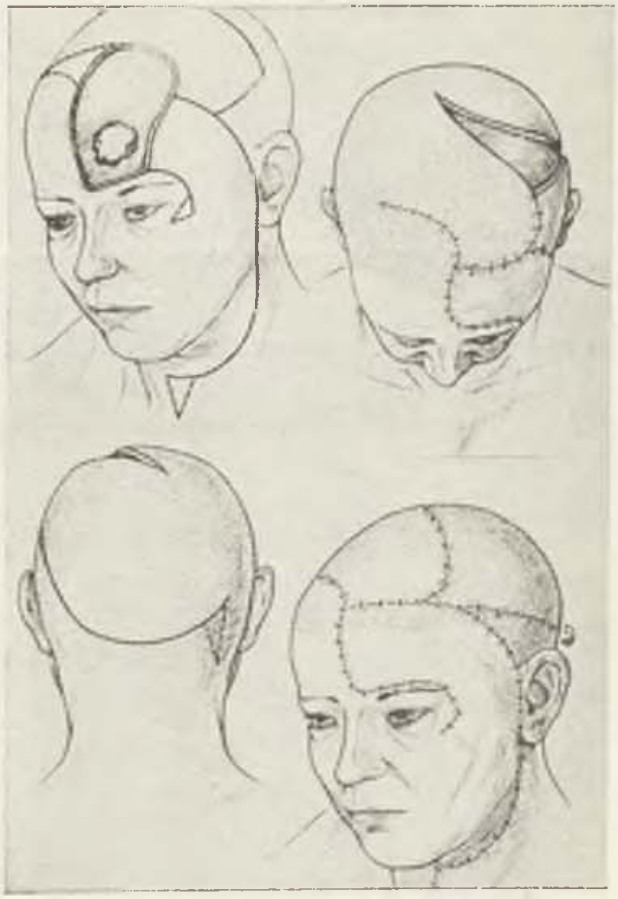

Fig. 3c. Diagram of combined soft tissue coverage

left for too long, because of the danger of infection entering the tissue from the surface. We, at the Unit, prefer intracutaneous suture at any operation in the face for cosmetic reasons, but here particularly for avoiding undesirable suppuration of the stitch hole. Another advantage of intracutaneous suture is that the thread may be left without risk for ten, even 14 days in a case of poor tendency for healing. Single approximation stitches of finest (5—0) silk can already be taken out three to five days after operation.

The choice of graft material and the amount required should be carefully planned before operation with regard to coverage of the defect immediately after the excision of the damaged tissue. So for instance, if one plans a deep excision which makes coverage of the resulting defect by tissue mobilized from the neighbourhood impracticable, the flap or flaps formed on remote sites should already be prepared for implantation into the defect at the time radical operation is carried out. If, however, inevitable circumstances should force the surgeon not to proceed in this sequence, the wound should be temporarily covered by a splitskin graft in order to gain time for forming and transposing remote flap grafts.

A free-skin graft may, however, be used as permanent measure with good result in cases where there is no ulcer or infection and in which tissue damage is but superficial. In the face, preference is given to full-thickness skin grafts, because they are more resistant, tend less to shrinkage and give better cosmetic results than any other free-skin transplant (Schmid et Widmaier). Since the take of a full-thickness skin graft, particularly on a bed with poor blood supply, may become risky, Krüger recommends, in some cases, to let the wound surface first granulate freely. The wound is covered with a moist dressing until a dense layer of granulations has formed, on which the graft is applied after preceding antibiotic treatment. This ensures much better results.

Fig. 3d. Condition at conclusion of operation. — Fig. 3e. Ultimate result of plasty. Note natural hair line in forehead

Employment of free-skin grafts is, of course, limited to suitable cases only. When the skin can only be shifted with difficulty, which is a sure sign of the deeper layers being involved, the surgeon should look for the possibility of covering the calculated defect by a flap graft with good blood circulation. In this respect, the best choice are flaps formed in the immediate neighbourhood of the defect. Generally, the advantages of proximate flaps are well known, and in the face they cannot be surpassed by any other material, because they are of the right thickness, elasticity and colour, and also have the right kind and amount of hair characteristic of facial skin. In addition, they are ideally supplied with blood, provided they are the type of rotation or transposition flaps with broad bases and themselves show no or very little changes from irradiation.

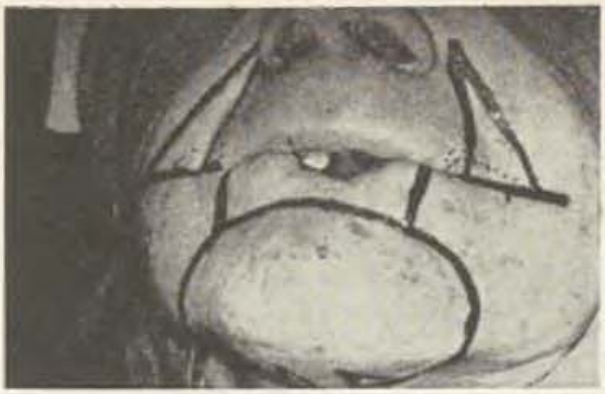

Fig. 4a. Recurrent spinocellular carcinoma of lower lip after X-ray treatment of 14,400 r total dosage. — Wound dehiscence after partial excision in section of lip suspect of malignancy. — Fig. 4b. Planning of operation for replacement of entire X-ray-damaged lower lip.

Z o l t á n rightly points out that the employment of a skin flap with intact neurovascular supply may lead to improvement of blood supply and thus of viability of the tissue at the site of implantation and in a rather wide area surrounding it. Since proximate flaps also have the persuasive advantage in making it possible to cure a deleterious disease in one or two surgical stages, they are sovereign in the replacement of X-ray-damaged tissue.

Fig. 4c. The result of plasty.

I am now going to explain our procedure on hand of a few examples:

The patient shown in fig. 1a suffered from a flat X-ray dermatosis mainly on the left cheek which had developed 30 years after X-ray treatment of lupus. Because of multiple ulcers, suspect of malignancy, a large area of skin was

excised and the defect covered by a transposition flap from the neck autonomized before operation (fig. 1b and 1c).

To the bridge of the nose, viable tissue for transplantation can be procured by rotation or transposition flaps from the cheek or forehead. If necessary, both sites may be used simultaneously. Bone necrosis underneath the floor of an ulcer should be removed sparingly (fig. 2a, 2b and 2c) and large defects resulting from this excision repaired by a plasty.

This is particularly important in X-ray necrosis of bones of the skull. The patient depicted in fig. 3a suffered from a recurrent basiloma in the region of the frontal hair line just left of the sagittal plane intersection. Immediately underneath it and covered by atrophic skin badly damaged by previous irradiation, there was a circular bone defect which had developed after elimination of a sequestrum and subsequent healing by scar. Cicatrization had baked skin and dura mater together inseparably into one slab. In this case, the bone graft for covering the defect in the frontal bone was taken from the parietal region (fig. 3b) consisting of outer table only, and because of its curvature, it perfectly fitted to the region applied. Homogenous bone from a tissue bank seems less

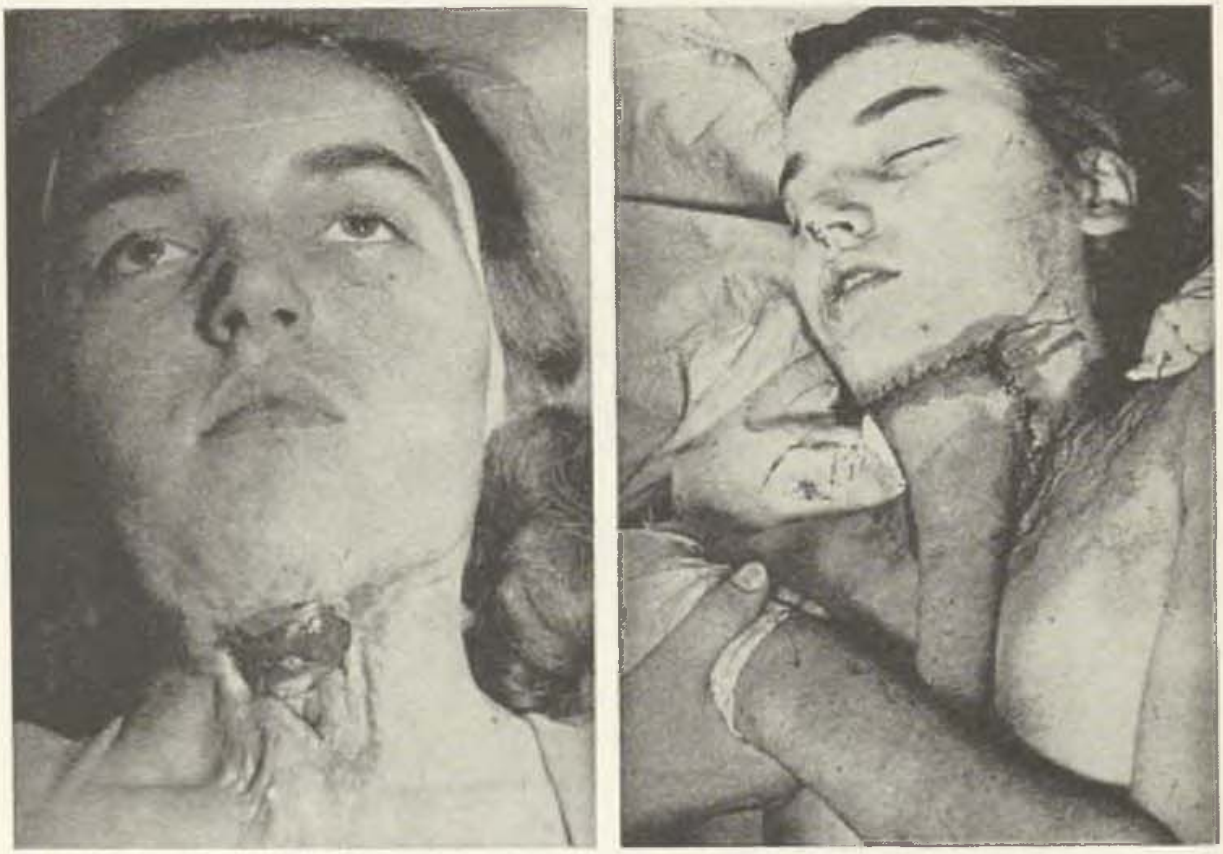

Fig. 5a. Fibrotic encasement by scar tissue of anterior aspect of neck with central ulcer due to repeated surgical and X-ray treatment of mentosternal neck fistula. — Fig. 5b. Coverage of large tissue defect resulting from excision of massive fibrosis with tubed pedicle flap from abdomen.

Fig. 5c. Ultimate result of plasty. Head movements are free. — Fig. 5d. Condition at completion of last-stage operation (pedicle flap completely unrolled).

suitable for implantation into X-ray-damaged skin and Dufourmentel et Mouly reported that failure of homotransplantation under these circumstances was not at all rare. In the above case, coverage of the soft tissue defect was carried out according to diagram 3c, i.e. with rotation flaps from cheek and neck as well as with flaps transposed from the parietal region. Closing the secondary defect by rotation of the scalp (fig. 3d), effected uninterrupted hair cover of the scalp (fig. 3e). Ten days after operation, the patient was discharged home.

The patient depicted in fig. 4 shows how important it is to remove all tissue damaged by irradiation. This was a case of spinocellular carcinoma of the lower lip which had recurred after treatment by 14,400 r irradiation. Anticipating a small operation to be sufficient, the surgeon had excised the suspect area into all layers and had closed the secondary defect without any tension by the method of Burow. However, a few days after operation the whole suture cut through due to marginal necrosis in the wound and a wedge shaped defect resulted from it (fig. 4a). Only after resection of the entire lower lip and replacement of the removed tissue by my own method (fig. 4b and 4c), brought about a permanent result which convincingly proved that it was imperative to remove all X-ray-damaged tissue without compromise.

Remote flaps are only used, if the tissue in the vicinity of the defect is insufficient in amount or if taking the tissue from that region would mean intolerable sacrifice to the donor area. This will particularly be valid in young patients. In such cases a tubed pedicle flap from a remote site is preferable.

The following case should serve as an example of the said:

The girl, aged 16, had been operated on altogether seven times at different departments, some of them quite famous, for congenital mentosternal neck fistula (fig. 5a). Every time after removal of the scar band running from the chin to the sternum, the defect had been covered with a split-skin graft and subsequently treated with X-rays. The given total dosage, which could never be exactly ascertained, probably exceeded many thousand r. This evidently led to the massive fibrosis of the operation field which greatly impeded movement of the head. The relatives of the girl, who, after so many failures, had reconciled themselves to her condition, only assented to a new operation after an ulcer had developed which proved resistant to any conservative treatment.

We first formed a tubed pedicle flap on the left side of the abdomen and transposed it to the left forearm. After excision of the massive fibrosis under the chin, the flap, partly spread out, was implanted with one pedicle into that region (fig. 5b). Three weeks later, the fibrotic tissue was removed from the neck down to the sternum, the flap freed from its attachment to the forearm, completely unrolled and implanted to cover the entire defec (fig. 5c). Though the cosmetic effect of the plasty does not meet all requirements mainly in view of the difference in pigmentation between autochthonous and transplanted skin, the functional result is optimal (fig. 5d). We regard it as a success that no additional scarring was caused on the neck and thorax, the skin of which had an evident tendency toward formation of keloids.

In conclusion, it may be said that operations in areas damaged by irradiation, inspite of many an impediment, are, nevertheless, quite a profitable field of activity for the plastic surgeon. The proximate-flap plasty is to be preferred in these cases before any other method of tissue replacement.

SUMMARY

The author explains the conception of tissue damage after irradiation and its sequelae, and discusses the difficulties met with in the surgical treatment of these conditions. These are based on the poor tendency for healing of the wound due to inadequate blood supply and the break-down of natural resistance against infection. He defines the indications for operation and, with regard to ensuring good results of the treatment, he draws attention to the following three points: 1) to the treatment preparing the patient for the operation, 2) to the basic problems of surgical technique and 3) to the choice and planning of plastic replacement of the excised tissue. These three points are discussed into detail and examples of cases treated by approved methods of plastic tissue reconstruction described. Proximate-flap plasty is considered sovereign in these cases.

RÉSUMÉ

Les opérations plastiques dans le tissu endommagé par les rayons X

G. Grimm

La mise-en point de dommages causés par les rayons X vient d'être présentée par les auteurs de même que l'état général des tissus endommagés à l'égard des difficultés qu'il présente en face du traitement opératoire. Ces difficultés reposent sur la tendence maligne du proces de guérison, se basant sur la vascularisation appauvrit de même que sur la protection naturelle abolie de l'organisme respectif envers l'infection.

L'indication de l'intervention chirurgicale vient d'être donnée et l'attention est tirée sur trois points principaux quand à l'assurance du résultat opératoire:

1. les préparatifs du malades précédant l'intervention,
2. les questions fondamentales de l'intervention respective,
3. les indications de l'intervention plastique.

Une discussion très détaillée est donnéée par les auteurs sur les trois points cités si-dessus et une déscription des méthodes respectives de la chirurgie plastique les plus convéniantes est présentée. La méthode du lambeau par glissement semble être la meilleure.

ZUSAMMENFASSUNG

Plastische Operationen im strahlengeschädigten Gewebe

G. Grimm

Der Begriff des Strahlenschadens wird erläutert und nach Darlegung der Folgezustände am Gewebe die einer operativen Therapie in den Weg tretenden Schwierigkeiten besprochen. Sie gründen sich auf die schlechte Heilungstendenz, bedingt durch mangelhafte Durchblutung und Darniederliegen des natürlichen Infektionsschutzes.

Die Indikation zum operativen Vorgehen wird begründet und bezüglich der Erfolgssicherheit des Eingriffs die Aufmerksamkeit auf drei Punkte gelenkt:

1. die Vorbereitung des Patienten auf die Operation,
2. grundsätzliche Fragen der operativen Technik,
3. die Indikation des zu planenden plastischen Ersatzes.

Die genannten drei Grundfragen werden in allen Einzelheiten erläutert und an Hand von Behandlungsbeispielen über bewährte Methoden des plastischen Gewebsersatzes berichtet. Unter ihnen besitzt die Nahlappenplastik vorrangige Bedeutung.

RESUMEN

Operaciones plásticas en el tejido dañado por la radiación

G. Grimm

Se aclara el concepto del daño resultante de la radiación y después de explicar lor estados subsiguientes en los tejidos, se discuten las dificultades que se ponen en camino de la terapia operatoria. Se basan en tendencia desfavorable a la curación, que es condicionada por la insuficiente presencia de sangre y por la disminución de la defensa natural contra la infección.

Se explica la indicación para la operación y en vista de un resultado garantizado de la intervención se advierte a los tres puntos siguientes:

1. preparación del paciente para la operación,
2. cuestiones principales de la técnica operatoria,
3. indicación del planificado reemplazo plástico.

Estas tres cuestiones principales se aclaran con todos los detalles y se informa, a base de algunos ejemplos del tratamiento, sobre los métodos probados de reemplazo plástico del tejido. Entre ellos tiene importancia de primer orden la plástica de lóbulo inmediato.

REFERENCES

1. **Dufourmentel et Mouly:** Chirurgie plastique, Paris, Flammarion 1959.
2. **Grimm, G.:** Zbl. Chir., 1966, 91 : 1621.
3. **Heite, H. J., Macher, G.:** Strahlentherapie (Actinotherapy), 1960, 114 274.
4. **Krüger, E.:** Fortschr. Kiefer- u. Gesichtschir. 1962, 8 : 122.
5. **Routledge:** Brit. J. plast. Surg., 1954, 7 : 134.
6. **Schmidt, M. A.:** Die freie Verpflanzung flächenförmiger Hautlappen (Free Transplantation of Flat Skin Flaps), Stuttgart, Enke, 1965.
7. **Schmidt, E., Witmaier, W.:** Fortschr. Kiefer- u. Gesichtschir. 1962, 8 : 115.
8. **Schuchardt, K.:** Fortschr. Kiefer- u. Gesichtschir. 1962, 8 : 100.
9. **Zoltán, J.:** Chirurgia Plastica et Reconstructiva, V 2 Berlin, Springer, New York, Heidelberg, 1966.

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The Department of Plastic Reconstructive Surgery in Barcelona in announcing the 4th postgraduate training course from 20th till 29th January 1969 in Barcelona under the directorship of Mr. Mir y Mir with co-workers. Dr. Benedito Ramón, A. Brualla Planes, J. Lerma Gonce, Prof. Nosny from Marseille, Prof. S. Teich Alasio from Torino and Dr. Raoul Tubiana from Paris. The Program:

I. 20—22 January 1969: The conception of Plastic Surgery. Basic methods of Plastic Surgery (biology and classification of skin grafts). Local plasties and rotation, Z plasty, tubed flaps.

II. 23—29 January 1969: Plastic surgery and trauma (treatment of wounds, urgent plastic operations, tendon injuries, burns, traumatology of head and face, neck, trunk, genital and limes).

Demonstration of operations, visits of hispital, films.

Attendance will be limited. Registration on the following address: Curso de cirurgia plastica. Secret. del Instituto Policlinico calle Platón, 21, Barcelona, Spain.

Surgical Department, Medical Faculty, University of São Paulo (Brazil)

PROMINENT EARS: CORRECTION WITH BURIED MATTRESS SUTURES.

J. M. PSILLAKIS

The correction of prominent ears has lately been undergoing modifications concerning the technical principles employed, with the purpose of attaining better aesthetic results and simplifying the surgical performance.

The tendency of modern techniques is not to make incisions in the ear cartilage in order to reduce its elasticity.

Thus, Mustardé (1963) applies three to four U-shaped stitches horizontally, whereas Davenport and Bernard (1965) utilize various singles vertically.

In the operation of vides. 3 patients of ours, we have adde to Mustardé's technique, the abrasion of cartilage with wire brush, as used by Converse et al. (1955—1963).

The first data on this technique were presented by Cardoso and Psillakis in 1964, at the Latin-American Congress of Plastic Surgery — Southern Region.

SURGICAL TECHNIQUE

Upon demarcation and incision according to the technique described by Mustardé, we perform with a wirebrush device the abrasion of the cartilage, thinning it so as to feel a decrease in its elasticity. This abrasion should not be made at the sites of the stitches, but in the intermediate areas only (fig. 1).

We insert the mattress sutures according to the demarcation, and the knots are progressively and partially tightened to produce the desired reshaping of the antihelix — fold. The skin wound is then closed.

When the deformity does also result from a conchaset widely apart from mastoideum, we resort to bridge-stitches between concha and mastoideum. When the deformity resides in the large size of concha, we perform the excision of a small crescentic fragment of cartilage in the area of biggest projection.

Small plastered gauze bands are used for padding, (Fig. 2) and a pressure dressing in employed. The latter is withdrawn after two days and the plaster, after 15 to 20 days.

DISCUSSION AND CONCLUSIONS

With the above described technique, no reccurrence of the deformity was observed in any the subjects, and the results have been quite satisfactory, both from the aesthetic and psychological viewpoints.

Fig. 1a

Fig. 1b

Fig. 1c

Fig. 1d

The principles established by Mustardé have brought a great deal of progress to this branch of surgery, not only for the extreme simplicity of the surgical technique required, but for the complete absence of signs in the lateral surface of the ear, which were unavoidable in the formerly described

Fig. 1 c

Fig. 1. a), b) — Preoperatively; c), d) — Details of the operation; e) — Postoperative aspect

Fig. 2. Plastered gauze bands maintained during 15 to 20 days

procedures. The only criticism that could be considered here, would be the reccurrence of the deformity due to the wearing off of the stitches and the loosening of the scar tissue in the posterior face of the ear.

Fig. 3. a), b) — Preoperatively; c), d) — Result one year after the operation

The thinning of the cartilage — specially in patients having a very thick one — contributes significantly to a decrease of tension in the suture sites, thus replacing with great advantage the surgical incisions. Nevertheless, this process proves unfitted in areas where sutures are to be inserted, for it reduces the resistance of the cartilage as well, bringing about its easy rupture. Therefore, strict criteria should be observed for a careful thinning of well delimited areas in between the spots marked for the siting of sutures.

These cares, added to the padding of the ear with plastered bands for 15 days, afford the surgeon good and safe results. Due to its simplicity and absence of risks, we do prefer the plastered dressing which, furthermore, produces no scaring of the capitonnage sites.

In those patients exhibiting a very accentuated concha-mastoideum angle, we have utilized the fastening of the concha to mastoideum, by means of various unabsorbable sutures, sings. In case where the concha was of too large a size, however, we had to practise the ressection of small crescentic portions in those areas of largest projection, in order to get the ear into an adequate proportion.

SUMMARY

In the surgery of prominent ears, the practice of incisions in the cartilage with the purpose of attaining a good reshaping of the ear through a decrease in the cartilage elasticity, is no longer prevailing today.

We have added to Mustardé's technique a slight modification that contributes in preventing the reccurrence of the deformity in some cases. It represents an advantageous replacement of the incisions formerly employed with the same purpose, and has led to satisfactory results in the twelve patients afore mentioned.

RÉSUMÉ

L'oreille en anse: correction à l'aide des suttures en capiton à points perdus

J. M. Psillakis

Dans la chirurgie des oreilles en anse de nos jours le pratique des incisions dans le cartillage ayant pour le but la correction de l'oreille en question par l'élasticité du cartillage diminuée n'est plus en vogue. L'auteur nou présente une petite modification de la méthode de Mustardé qui lui sert de prévention quand à la récidive du défaut dans certain cas. Il s'agit d'un remplacement avantageux des incisions employées jusqu' alors menant au but identique lequel, étant pratiqué chez 12 des malades cités dans le travail, a donné des résultats très favorables.

ZUSAMMENFASSUNG

Korrektion abstehender Ohren

J. M. Psillakis

Heute kommt man in der chirurgischen Behandlung abstehender Ohren von der früheren Methode der Inzisionen in den Ohrknorpel, die mittels Herabsetzung der Knorpelelastizität die Rekonstruktion der Ohrmuschelform gestatteten, immer mehr ab.

Wir verwendeten die Technik nach Mustardé mit einer bestimmten Modifikation, die in manchen Fällen die Wiederkehr der Missbildung verhindern kann. Diese Modifikation ersetzt vorteilhafterweise die früher für den gleichen Zweck verwendeten Inzisionen und zeitigte günstige Resultate bei 12 Patienten, die in der vorliegenden Arbeit beschrieben werden.

RESUMEN

Orejas resaltadas: Corrección con sutura de colchón escondido

J. M. Psillakis

En la cirugía de orejas resaltados ya no predomina hoy ey método que aplica las incisiones del cartílago de la oreja, cuya tarea era conseguir una corrección de la forma de la oreja a través de la disminución de la elasticidad del cartílago.

Hemos agregado una pequeña modificación a la técnica de Mustardé que ayuda a que las deformaciones en algunos casos no vuelvan a aparecer. En lo substancial se trata de un ventajoso reemplazo de incisiones aplicadas antes con el mismo fin, que nos dio resultados muy satisfactorios con los 12 pacientes arriba mencionados.

REFERENCES

Cardoso, A. D., Psillakis, J. M.: Congresso da Sociedade Latino Americana de Cirugia Plástica — Regional Sul Paraguai, 1964.

Converse, J. M., Nigro, A., Wilson, D. W., Johnson, N.: Plast. reconstr. Surg., 1965, 15 : 411.

Converse, J. M., Smith, D. W.: Plast. reconstr. Surg., 1963, 31 : 118.

Davemport, G., Bernard, F. D.: Plast. reconstr. Surg., 1965, 36 : 91.

Mustardé, J. C.: Brit. J. plast. Surg., 1963, 16 : 170.

Mustardé, J. C.: in Thomas Gibson, Modern Trends in Plastic Surgery. London, Butterworths. 1964.

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New Medical Periodical

The Czechoslovak Association of Plastic Surgery was informed that the Sociedad Española de Cirugía Plástica y Reparadora is publishing a new periodical named Revista Española de Cirugía Plástica. Director is Dr. M. Lazo Zbikowski. President of the Society. Editors are Dr. U. Hinderer Meise and Dr. J. Quetglas Moll, the editorial board has 16 members.

The Address of the Editorial Office: Av. Gen. Franco. 90 — 2º Izq., Madrid 16 (Spain).

Frank Pais Orthopaedic Hospital, Habana (Cuba)
Director Dr. R. Lorié R.

TRANSPLANTATION OF FOUR TOES TO HAND*

K. KARCHINOV, R. LORIÉR

Reconstruction of fingers by the transplantation of toes is an operation which is not very popular because of the difficulties connected with it. However, in our opinion it is the only method of almost complete reconstruction of fingers both from a cosmetic and functional point of view.

Nicoladoni, in 1898, operated on the first case. He transplanted the second toe for replacement of the thumb. Since 1900, this operation is known as the "method of Nicoladoni".

In 1964, Davis reported on 42 cases of successful transplantation of toes to the hand carried out by 30 different surgeons; for complete or partial reconstruction of the thumb only the big or second toe was transplanted.

Usually only one toe is transplanted; rarely two or more are transplanted at the same stage (Esser-Clarkson).

In 1917, Johannes reported on the transplantation of four toes to the hand. The toes together with their metatarsal heads were transferred to a hand amputated through the middle of its carpus. The author maintained that it was imperative to replace the fingers lost by injury on the very day of accident. Bidet reconstructed four fingers of one hand using pedicle flaps of skin with bone grafts. The results, however, was unsatisfactory both from a cosmetic and functional point of view.

In a case of a girl who had lost all four fingers of her right hand by traumatic amputation at the level of the bases of their first phalanges, we transplanted the second and fifth toes of the right foot including suturing their tendons and nerves. This case is the first to be operated on in Cuba and the first of simultaneous transplantation of four toes to one hand performed on the entire American Continent.

Reconstruction of fingers by transplantation of toes has the advantage of giving the reconstructed organs a shape as near to normal fingers as possible, i. e. including nails, and of achieving satisfactory movements as well as sensitivity.

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*) Paper read at IIIrd Latin American Congress of Plastic Surgery held in Mexico in Sept., 1966.

Fig. 1 and 2. Traumatic amputation of four fingers of right hand. — Fig. 3. Function of thumb unchanged

Fixation of the hand to the foot for any length of time is a very uncomfortable position, but in our case, due to the young age of the patient, is was tolerated much better. The donor foot should be of the same side as the recipient hand, because this facilitates the fitting of the transplanted toes to the respective bone stumps in the hand.

The skin flap on the dorsum of the foot with its basis at the level of the metatarsal heads of the toes to be transplanted, should have an oval shape and be sufficiently long. If it is too large at its basis, there is a risk of necrosis. On suturing the flap to the hand in the above case, we did not excise the skin surplus, because we intended to use it for later lengthening of the interdigital commissures.

Fig. 4. X-ray shows amputation of all four fingers at bases of the first phalanges. — Fig. 5. X-ray picture after completion of first stage of transplantation of toes to hand

The stump end of metacarpals or phalanges of the fingers are freshened up sparingly so as to lose as little of length as possible to make just fit them to the proximal bone ends of the toes.

The best method of joining these bone ends is by axial introduction of a Kirschner wire, because is gives the best stability both in the longitudinal and transverse axis.

Then it is important to suture the interdigital nerves of the foot to the respective nerve stumps in the hand. This is effected by two very fine stitches enough to permit coaptation of the two ends. Renewal of sensitivity and trophicity may be perfect, if primary suture was exact.

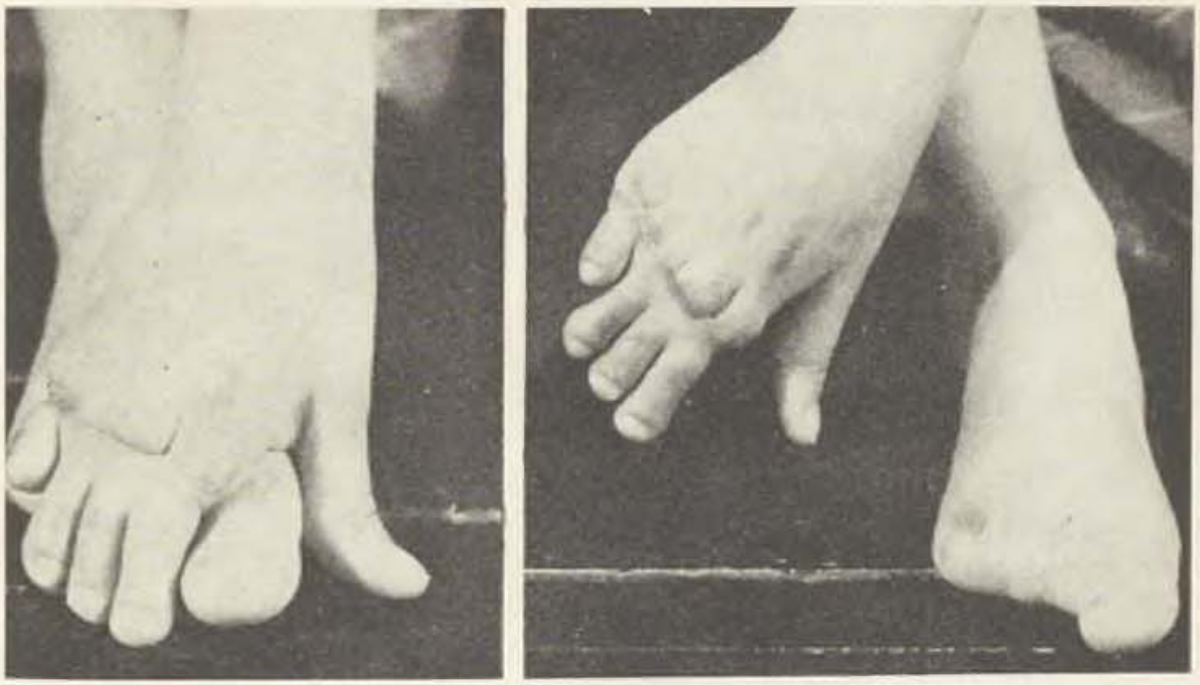

Fig. 6 and 7. Separation of hand from foot

After nerve suture the stumps of the extensor tendons of the hand are sutured to the proximal ends of the extensor tendons of the foot. The operation is concluded by the skin suture of the flaps. This completes the first stage of reconstruction.

Immobilization must be firm; the plaster cast includes the thorax and both operated on limbs. A window is cut over the operation field for inspection and treatment of the wound.

After three weeks, the plaster is removed and any subsequent pull on the operated on hand is prevented by proper positioning of the limbs in bed using pillows.

Six weeks after operation, the hand may be separated from the foot. Before we start this second stage of reconstruction, we prefer to carry out a biological test by incising and immediately suturing the skin on the sole of the foot in order to make sure that the toes to be transplanted are viable.



Fig. 8 and 9. View of palm and dorsum of right hand. — Fig. 10. X-ray of four fingers reconstructed by transplantation of toes. Index, middle and ring fingers show bony union, while little finger non-union

When separating the hand from the foot, the flexor tendons of the toes may be joined by suture with the respective tendon stumps of the fingers. Should this imply any danger to the blood supply of the transplanted toes, this can also be done at a later stage.

The four transplanted toes are- if compared to fingers- too short, but they can be lenghtened in the same way as in the operation for incomplete congenital syndactyly. Sensitivity and the capacity for growth may be restored by nerve suture in the first stage. This prevents degeneration of the peripheral nerve ends. Without nerve suture, sensitivity is restored slowly and incompletely.

We do not consider it necessary to use a nerve graft as recommended by Clarkson.

Movements of the transplanted toes are usually limited. Protracted rehabilitation is required for even partly regaining mobility.

The cosmetic result is better than with any other method of finger reconstruction.

Transplantation of toes to the hand has better changes of achieving good results in cases of traumatic loss of fingers than of congenital malformations, because the former possess better trophicity and blood supply.

Below, we report on our own case:

E. L. P., a girl aged eight, was a case of traumatic amputation of the four fingers of the right hand and of the ring and little fingers of the left hand. At the age of six, an electric cable had fallen on her hands causing amputation of these fingers. She had been first given treatment at the polyclinic and than admitted to hospital, where she had stayed for two weeks. She came to us with the request for plastic operation.

The orthopaedic examination disclosed a condition after amputation of the four fingers of the right and the last two fingers of the left hand, all at the level of the basis of the first phalanx (fig. 1, 2 and 3). With the right hand, therefore, she was only able to make a pinch between the thumb and the palm.

The X-ray examination (fig. 4) showed a condition after amputation at the basis of the first phalanx of all four fingers.

On Oct. 25, 1965, formation of a skin flap on the dorsum of the right foot and another on the right hand and osteosynthesis between the finger stumps and toes with Kirschner wires (fig. 5), was carried out as the first stage of reconstruction. At the same time, the stumps of extensor tendons and some of the interdigital nerves of the hand were sutured to their counterparts on the foot.

The surplus skin of the flaps was not excised, because is was intended to be used later for deepening of the interdigital webs. This then made it possible to achieve an evident lengthening of the reconstructed fingers. After the first stage, immobilization in a plaster cast lasted three weeks.

On Jan. 18, 1966, the biological test was carried out by incising and suturing the skin of the sole of the foot which showed that the blood supply of that region was adequate for transplantation of the toes.

On March, 3, 1966 (i. e. 3 months after the first operation), the hand was separated from the foot. The transplanted toes preserved their viability and soon even renewed their sensitivity to touch (fig. 6, 7, 8 and 9).

Five months after operation, the girl was able to distinguish objects by touch (stereognosia) and make a pinch between the thumb and fingers. The nails were growing normally.

On X-ray, union of the bones at the level of osteosynthesis could be seen in the index, middle and ring fingers, but there was non-union in the little finger (fig. 10).

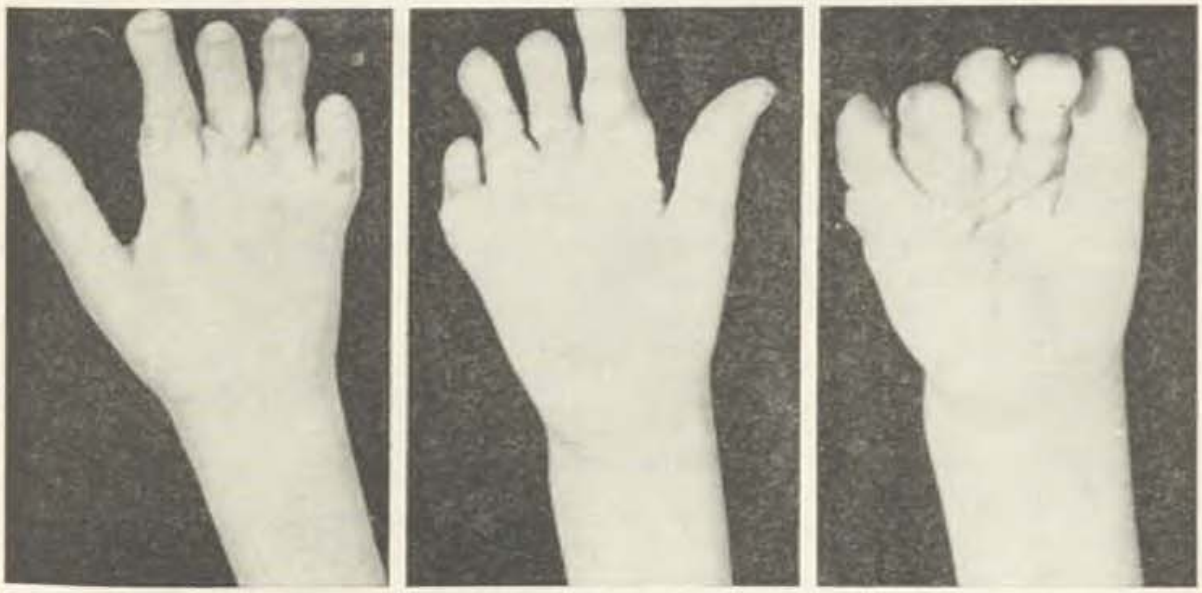

Fig. 11, 12 and 13. Volar and dorsal aspect of hand and view of reconstructed fingers on flexion after deepening of interdigital webs

The right foot, inspite of the loss of four of its toes, did not show any functional handicap.

On Sept. 20, and Oct. 19, 1966, the reconstructed fingers were further separated and interdigital commissures were formed at the level of normal webs. Thus lengthening of the fingers was achieved (fig. 11, 12, 13).

CONCLUSIONS

Transplantation of toes to the hands is not sufficiently popular because of the difficult surgical technique and the lack of sensitivity in the reconstructed fingers.

There has rarely been any report in the literature about transplantation of four toes.

Reconstruction of fingers by transplantation of respective toes gives the best cosmetic results, while from a functional point of view the results are equal to those of any other method of reconstruction.

Sensitivity of the reconstructed fingers is sufficiently renewed by suture of the respective interdigital nerves of the finger stumps and toes as well as sufficient movement by the suture of the respective flexor and extensor tendons. Renewal of sensitivity in the reconstructed fingers depends on the primary suture of nerves in the hand.

SUMMARY

A case of a nine-year-old girl with amputation of all fingers (with the exception of the thumb) of her right hand has been described, in whom four toes of the right foot were transplanted to the hand, their tendons and nerves sutured and their bones joined by Kirschner wires. The cosmetic and functional results of this operation were good.

RÉSUMÉ

Une transplantation des doigts du pied à la main

K. Karchinov, R. Lorié R.

On décrit un cas d'une fillette de 9 ans ayant subi l'amputation des 4 doigts (de l'index au petit doigt) de la main droite, ou les auteurs ont entrepris la transplantation des quatres doigts respectif du pied à la main, ont réalisé la sutture des tendons, de nerfs et, finalement, une ostéosynthèse selon Kirschner. Le résultat en était une main estétique, a là fonction parfaite.

ZUSAMMENFASSUNG

Der Ersatz von Fingern durch Zehen

K. Karchinov, R. Lorié R.

Es wird der Fall eines neunjährigen Mädchens beschrieben, wo wegen Amputation der letzten vitr Finger (Zeigefinger bis Kleinfinger) der rechten Hand vier Zehen auf die Hand übertragen wurden; die Sehnen und die Nerven wurden vernäht und eine Osteosynthese nach Kirschner durchgeführt. Das erzielte Ergebnis ist sowohl in ästhetischer als auch in funktioneller Hinsicht zufriedenstellend.

RESUMEN

Transplante de cuatro dedos del pie a la mano

K. Karchinov, R. Lorié R.

Se presenta una niña de nueve años de edad con amputación de los cuatro últimos dedos de la mano derecha, en la que se transplantaron cuatro dedos del pié a la mano, suturándo los tendones, nervios y osteosintesis ósea. El resultado es una mano estética y funcional.

REFERENCES

1. **Bidet, P.**: Reconstruction autoplastique de quatre doigts.
2. **Borisov, M. V.**: Reconstrucción de los dedos de la mano porlos del pié. Khirurgia URSS. 1945.
3. **Bunnell, S.**: Surgery of the hand. 1949.
4. **Byars, L. T.**: Toe to finger trasplant. Plast.-reconstr. Surg. 1952. 9.
5. **Clarkson, P.**: Reconstrucción de los dedos de la mano por transferencia de los dedos del pié. J. B. J. S. 37-A, 1955.
6. **Clarkson, P.**: On making thumbs. Plast. reconstr. Surg. 1962. 29, 4.
7. **Davis, J. E.**: Toe-to-hand Plast. reconstr. Surg. 1964. 33, 5.
8. **Dzbanovsky, K. A.**: Trasplante de los dedos del pié a la mano. — Rev. de Khirurgia URSS. 55, 1938.
9. **Esser, J. F. S., Ranschlurg, P.**: Reconstruction of a hand and — four fingers by transplantation of the middle part of the foot and four toes. Ann. Surgery. 111, 1940.
10. **Freeman, B. S.**: Reconstruction of the thumb by toe transfer. — Plast. reconstr. Surg. 1956, 17.
11. **Gillies, H., Millard, R.**: The principles and art of Plastic Surg. Vol. 2 : 1957.
12. **Karchinov, K., Lorié, R.**: Trasplante de cuatro dedos del pié a — la mano. Revista Cubana de Cirurgia. 1966, 5.
13. **Matzen, P.**: Zum Thema Daumenersatz.
14. **Nicoladoni, C.**: Daumenplastik und organischer Ersatz der Fingerspitze. Anticheiroplastik und Daktyloplastik, Arch. F. Klin. 61, 1900.

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First Meeting of European Section of the International Confederation for Plastic Surgery is organised by the British Association of Plastic Surgeons in Brighton, Sussex, from 15th—19th June 1969.

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Department of Plastic Surgery, Medical School of Hygiene, Charles University, Prague (Czechoslovakia)
Director: Prof. V. Karfík, M. D., DrSc.

SUBCUTANEOUS SILICONE GRANULOMA

V. KARFÍK, J. ŠMAHEL

Lately, great attention is paid to the employment of liquid silicone substances for the augmentation of soft tissue. As to their chemical composition, silicone substances have the character of polymeric organo-silicon compounds with a basic chain of alternating silicon and oxygen atoms. In many respects, they fulfil the demands made on ideal material for substitution. Numerous experimental and clinical studies (e. g. Sternberg et al., 1964; Rees et al., 1965; Ben-Hur et al., 1965; Andrews, 1966, etc.) have proved that silicone is well tolerated by the recipient organism and provokes but a slight inflammatory reaction in the connective tissue. Adverse reactions after injection of silicone, such as the development of a foreign body granuloma, have only been reported upon occasionally. Blocksma et al. (1965) and Ashley (1967) have summed up the latest experience made with silicone used in plastic surgery. They described the chemical composition of silicone substances, their different types and indications.

Apart from their experimental studies, Ashley et al. (1965) and Rees et al. (1966) also reported on the favourable results in the treatment of facial hemiatrophy with silicone injections. They did not observe development of granulomas or tumours after it.

We have met with one single case of foreign body granuloma which had developed after an injection of silicone into the region of the face, and we, therefore, consider it important to report on it.

CLINICAL PICTURE OF CASE

A. O., a woman of Arab origin aged 29, had been given an injection of silicone under the wrinkles between her eye brows. This operation had been carried out in Egypt two years previously. A year later, she had felt unrest accompanied by occasional itching, and observed gradual bulging of that region.

CONDITION ON ADMISSION

Above the glabella, there was a reddened and soft swelling the size of a walnut which was adherent to the skin, but well mobile over the underlying tissue(fig. 1 and 2). Apart from widened follicles, the skin showed no changes.

Fig. 1

Fig. 2

On the left side of the nose — though the patient also complained of unrest in that region — no changes could be detected on palpation.

The operation was carried out on May 16, 1966: A transverse incision was made over the bridge of the nose. The swelling consisted of a fibrous tissue proliferation the size of a large bean which could well be distinguished and thus easily removed by separating it from the surrounding tissue, so that neither a large defect in the subcutaneous tissue nor a depression of the glabellar region resulted from the operation. — The skin was sutured by a continuous subcutaneous stitch and a capillary drain was inserted.

The histological sections only showed proliferated fibrous tissue; no foreign substance was found.

Healing was uneventful; the drain was removed on the second and the stitches on the fourth day after operation.

HISTOLOGICAL FINDINGS

The excised specimen consists of collagenous tissue invaded by striated muscle fibres. All through the specimen, numerous granulomas (fig 3), more-or-less marked infiltrations and pseudocysts are found. Lymphocytes and histiocytes predominate among the cell elements of granulomas and infiltrations, while plasma cells are found less frequently. The pseudocysts are of various sizes and appear in great numbers. In the slides, they are quite empty. Most of them possess a distinct fibrous capsule and are lined with macrophages and giant cells (fig. 4). The cytoplasma of the macrophages has a foamy con-

sistence, while the plasma of giant cells is basophil and contains numerous bright vacuoles (fig. 5). Apart from these structures, isolated groups of macrophages and giant cells are found in the evidently hypertrophic connective tissue. Some giant cells are completely vacuolized, so that they actually consist but of a thin capsule of plasma enveloping an optically empty space.

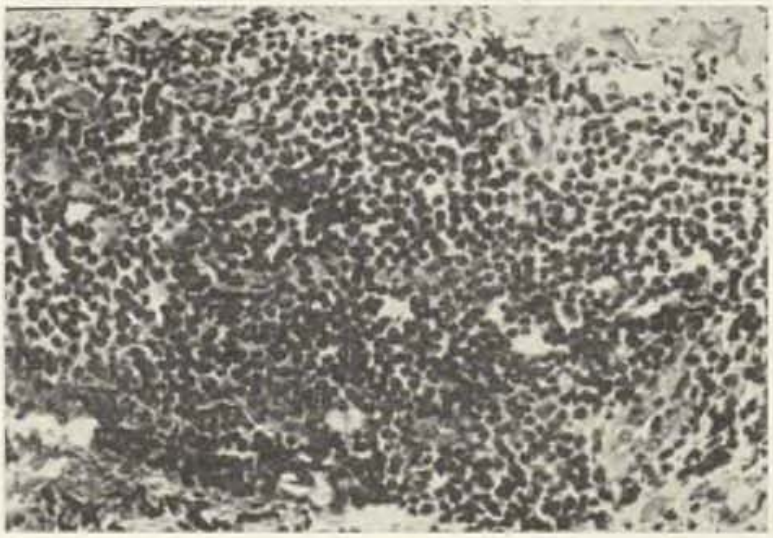

Fig. 3. Subcutaneous granuloma, stained with haematoxilin-eosin-saffron, magnified 750×

Fig. 4. Detail of pseudocyst wall and lining, stained with haematoxilin-eosin-saffron, magnified 400×

CONCLUSION

In the case described above, we had to rely on the history of liquid silicone having been introduced to the region above the glabella by a simple injection in order to fill up the space between two wrinkles which had molested the patient from a cosmetic point of view. We know neither the composition nor the trade mark of the substance injected.

During the evolution of cosmetic surgery, certain substances were repeatedly tried for injection into tissue. Sooner or later, these methods invariably led to the development of granulomas. The worst of these substances proved to be paraffin (Karfík, 1937) and Humenol as well as other oily substances which, after a time, gave rise to serious changes causing disfigurement at the site of injection in the face or elsewhere on the body. In the extreme case, fistulae, chronic ulcers and even malignant growths developed at the site of chronic foreign body irritation. Each of these substances was repeatedly

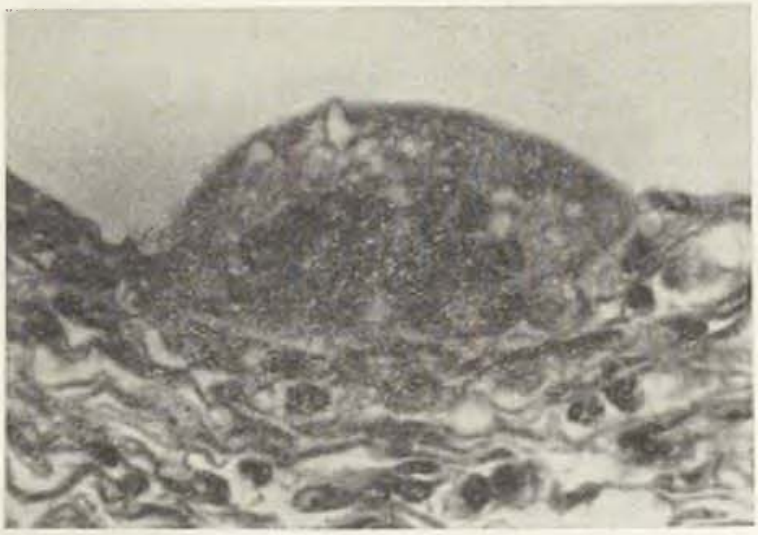

Fig. 5. Detail of giant cell in pseudocyst lining, stained with haematoxilin-eosin-saffron, magnified 750×

tried out, and it took a large series of failures, before their usage in surgery was finally abandoned. This is the reason why we think it suitable to report on our first case of granuloma which had developed around a deposit of silicone injected under the skin for cosmetic purposes.

Although we do not know the exact data about the chemical composition of the substance used, we, nevertheless, consider it justified to warn — for the time being — against the employment of liquid silicone for injection into tissues. From the entire course of the case and the slow development of the swelling, it may be assumed that the granuloma was caused by the effect of silicone alone and not by the injection technique or any postoperative complication.

SUMMARY

The authors described a case of granuloma which had developed at the site of injection of silicone given for cosmetic purpose.

RÉSUMÉ

Le granulome en silicon dans le tissu sous-cutanée

V. Karfík, J. Šmahel

Les auteurs décrivent un cas de granulome en silicon en suite d'injection du silicon faute des raisons esthétiques.

ZUSAMMENFASSUNG

Ein Silikongranulom im Unterhautzellgewebe

V. Karfík, J. Šmahel

Es wird ein Silikonom beschrieben, das nach Injektion von flüssigem Silikon aus kosmetischen Gründen auftrat.

RESUMEN

Granuloma subcutáneo de silicona

V. Karfík, J. Šmahel

Descripción de siliconoma después de la inyeccion de silicona líquida por razones cosméticas.

REFERENCES

1. **Andrews, J. M.:** Cellular behavior to injected silicone fluid: a preliminary report. Plast. reconstr. Surg. 38, 1966, 581—583.
2. **Ashley, F. L., Rees, T. D., Ballantyne, D. L., Calloway, D. V., Machida, R. C., Grazer, F. M., McConnell, D. V., Edgington, T., Kiskadden, W.:** An injection technique for the treatment of facial hemiatrophy. Plast. reconstr. Surg. 35, 1965 : 640—648.
3. **Ashley, F. L., Braley, S., Rees, T. D., Goulian, D., Ballantyne, D. L.:** The present status of silicone fluid in soft tissue augmentation. Plast. reconstr. Surg. 39, 1967 : 411—420.
4. **Ben-Hur, N., Neuman, Z.:** Siliconoma — another cutaneous response to dimethylpolysiloxane. Plast. reconstr. Surg. 36, 1965 : 629—631.
5. **Blocksma, R., Braley, S.:** The silicones in plastic surgery. Plast. reconstr. Surg. 35, 1965 : 366—370.
6. **Karfík, V.:** Paraffin Injections, Čas. lék. čes. 20, 1937 : 1—20.
7. **Rees, T. D., Ashley, F. L.:** Treatment of facial atrophy with liquid silicone. Amer. J. Surg. 111, 1966 : 531—535.
8. **Rees, T. D., Platt, J., Ballantyne, D. L.:** An investigation of cutaneous response to dimethylpolysiloxane (silicone liquid) in animals and humans. A preliminary report. Plast. reconstr. Surg. 35, 1965 : 131—139.
9. **Sternberg, T. H., Ashley, F. L., Winer, L. H., Lehman, R.:** Gewebereaktionen auf injizierte flüssige Siliciumverbindungen. Hautarzt 15, 1964 : 281—285.

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