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NEW FACTS ABOUT THE PATHOGENESIS OF DUPUYTREN'S CONTRACTURE

I. E. Mikusev

There are still a number of aspects of the aetiology and pathogenesis of Dupuytren's contracture of fingers that require clarification. Proceeding from clinical research extending from Dupuytren's time (1832) to this day medical scientists have advanced many ideas concerning the causes of this condition. In the present report, rather than wishing to refute this or that theory, we intend to draw the reader's attention to some of the well established facts arrived at by many authors as a result of their observations of patients with Dupuytren's contracture regardless of what actual causes of the disease they had in mind. Clinical research shows that Dupuytren's contracture of fingers is encountered in 10 to 15 times as many men as women, and that digits 4 and 5 of the hand are the most likely to be involved. According to literary data, patients aged 30 to 60 years are by far the largest group. The right hand is more likely to be involved, though bilateral involvement clearly predominates. The above facts arise from clinical research and are hardly ever questioned, though in our study of the relevant literature and that even in the monograph "La malaide de Dupuytren" compiled by 20 famous specialists of Europe, America and Australia in Paris in 1972 (second edition), we failed to find an answer to questions raised by those clinically established facts.

Why then should the fingers of the ulnar side be affected the most frequently by Dupuytren's contracture regardless of the patient's sex and age and side of the body? An explanation of this might, in our opinion, give us a clue to the detection and understanding of the aetiological moments and pathogenesis of Dupuytren's contracture of fingers. As we see it, a logical answer to this question can only be derived from a thorough topographical study of the palmar aponeurosis — the anatomical substrate of Dupuytren's contracture. It should be pointed out that similar studies of the palmar aponeurosis are often crowned with success or can give answers to these and other disputed questions. Thus, for instance, the Krogius constitutional theory of the cause of this pathological condition (1920) held good for fifty years.

According to the Krogius theory, the development of Dupuytren's contracture is due to the atavistic invasion of the palmar aponeurosis by muscular elements of the m. palmaris brevis. Yet Dylevski (1970), studying serial sections of the hand of human embryos and foetuses under an electron microscope, never found any such invasion, which led him to the complete rejection of the Krogius theory.

According to A. P. Nadein and M. G. Krasilnikova (1953) and Stilwell (1957), the palmar aponeurosis is innervated from branches of the n. medianus, n. ulnaris, n. lateralis et n. cutaneus antebrachii medialis and n. musculocutaneus. Our research centered on studies of the histotopographic deployment of the terminal branches of those nerves in the palmar aponeurosis with the use of the neurohistological methods of Bilshovski-Gross and Habonero. The research material consisted of 70 hands of human embryos and foetuses aged from two months of development in utero up to birth, and 14 adult hands. With regard to the small size of the hand and the difficulties involved in the dissection of embryonic and foetal palmar aponeurosis by

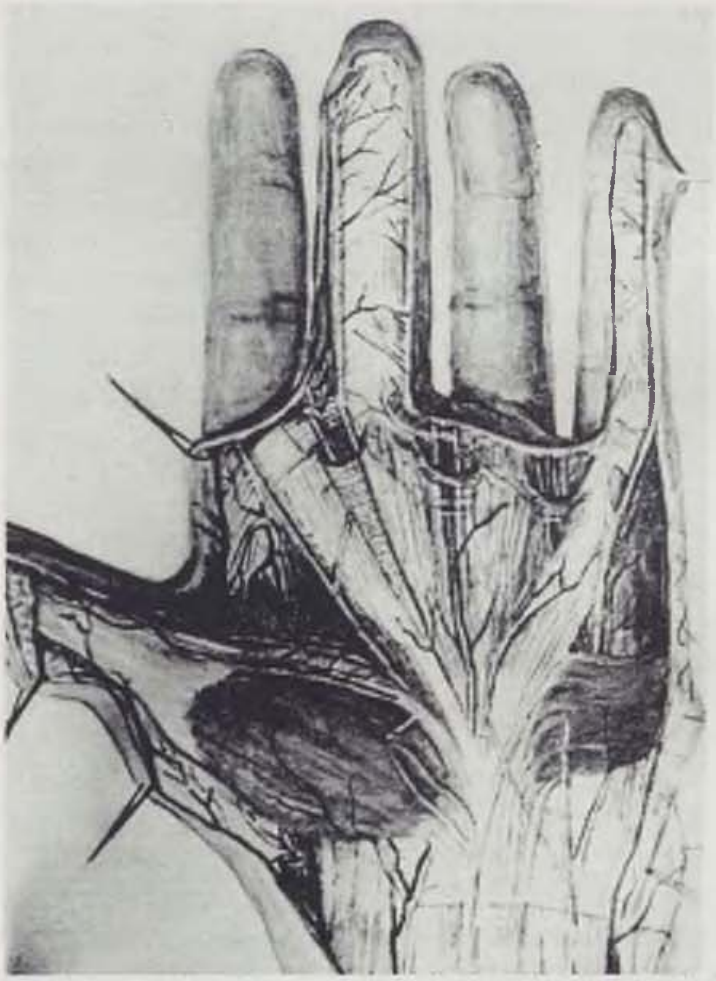

Fig. 1 Palmar aponeurosis — the norm (according to Kovanov and Travina, 1965)

means of the cryostat, cross sections of the whole hand were made. Work with this material was conducted so as to preserve the same topographical and anatomical relations on the palmar surface of the hand. To study the palmar aponeurosis of adults (Fig. 1) and of foetus 8 to 10 lunar months old we divided the structure into three parts: the proximal part (between the thenar and hypothenar), the middle and the distal portions of palmar aponeurosis. The distal portion of foetuses was then divided into the ulnar and radial parts, and — in adults — into ligaments to digits 2, 3, 4 and 5.
What did we find?

1. We found no difference whatsoever in the anatomical structure of the male or female palmar aponeurosis regardless of the side of the body or of the presence or absence of the m. palmaris longus.

2. We failed to prove any difference in the sensory innervation of the palmar aponeurosis between men and women, or between the right and left hands.

At the same time, we found out quite accurately that the central portion of the palmar aponeurosis has more thinly distributed receptors as has the connective tissue of the palmar aponeurosis of digit 3. Not only that, the most frequently demonstrated receptors in the palmar aponeurosis of the Vater-Pacini corpuscle type as much as in its deep layers reach a length of 1 to 1.5 millimetres, while in the other parts of the structure, particularly so in its superficial layers as much as 4 mm (Fig. 2). Another finding is that beginning with 4.5 to 5 months of embryonic development the ulnar margin in the distal part of the palmar aponeurosis (i. e., ligaments of digits 4 and 5) is more abundantly supplied with encapsulated receptors of the type of Vater-Pacini corpuscles. This characteristic pattern of deployment of receptors (their histotopography) is a life-long feature. According to our data, the ulnar margin of the palmar aponeurosis has a maximum supply of sensitive nerve endings, especially Vater-Pacini corpuscles. As already mentioned with reference to literary reports, Dupuytren's contracture most frequently affects the ring and little fingers, i. e., the ulnar marging of the palmar aponeurosis, independently of the patient's sex.

Next, beginning with the 5th month of embryonic development, we studied the interrelationship between the platelet-like Vater-Pacini corpuscles, the most widely represented in the palmar aponeurosis, and blood vessels (Fig. 3). Unfortunately, we failed to obtain a complete idea of the blood supply of the Vater-Pacini corpuscles from that material. This is probably due to the fact that the tissue of palmar aponeurosis is cut in serial surface sections while the Vater-Pacini corpuscles are also cut superficially into parts.

With regard to the fact that a study of the relationships between blood vessels and the receptors of the human palmar aponeurosis could be of great importance to account for some of the mechanisms of the pathogenesis of Dupuytren's contracture, we decided to study the palmar aponeurosis in great detail with the method of silver injection according to Ranvier. As material, we used ten hands of practically healthy persons who died in accidents, which we received within 24 hours of the fatal injury.

Fig. 2 Vater-Pacini corpuscles in the middle portion of palmar aponeurosis (a), near the ulnar margin of distal part (b, c)

Fig. 3 Incipient Vater-Pacini corpuscle in intricate interrelationship with a blood vessel (with erythrocytes seen inside). Stained after Benda Spilmmer, × 40. Here and next = microphotographs

Fig. 4 Blood vessels of palmar aponeurosis (norm). × 8 — here and next. Fig. 4—10 — silver nitrate injection acc. to Ranvier

Using the ulnar and radial arteries, the hands were washed with distilled water and subsequently injected with 1—2% solution of silver nitrate. This was followed by dissecting the aponeurosis into three parts with exposure of the tendons of digits 2, 3, 4 and 5 as already described. The proximal, medial, parts of the aponeurosis and the tendons of the distal portion (separately) were cut into sections 350 microns thick and left in distilled water exposed to daylight for one up to 2 days. After staining with carmine, the sections were embedded in Canada balsam with the use of routine methods.

The palmar aponeurosis is one of the bradytrophic tissues supplied, according to Damcha Bayanbeleg (1978), by penetrating vessels arising from the superficial palmar arch of arteries and common digital arteries. In the author's view, the proximal portion of the palmar aponeurosis — as distinct from the distal part — has the most favourable conditions for vascularization because of the proximity of the radial and ulnar arteries. These data seemed to warrant the conclusion that even the Vater-Pacini corpuscles in the distal part would be less well supplied with blood than in the proximal part. However, we found no evidence of this in our material. The capillaries supplying the large (up to 4 mm) Vater-Pacini corpuscles of the superficial layers of the palmar aponeurosis were clearly found to constitute a more densely ramified network that those supplying the corpuscles of its deep layers. Surface sections of the palmar aponeurosis along with parts poorly supplied with blood vessels (Fig. 4) show areas of abundant capillaries (local microvascular networks — Fig. 5) interspersed with avascular zones. The vessels mostly reach the corpuscle from one pole, as a rule, with a nerve fibre (axial

Fig. 5 Local microvascular bed in palmar aponeurosis (norm)

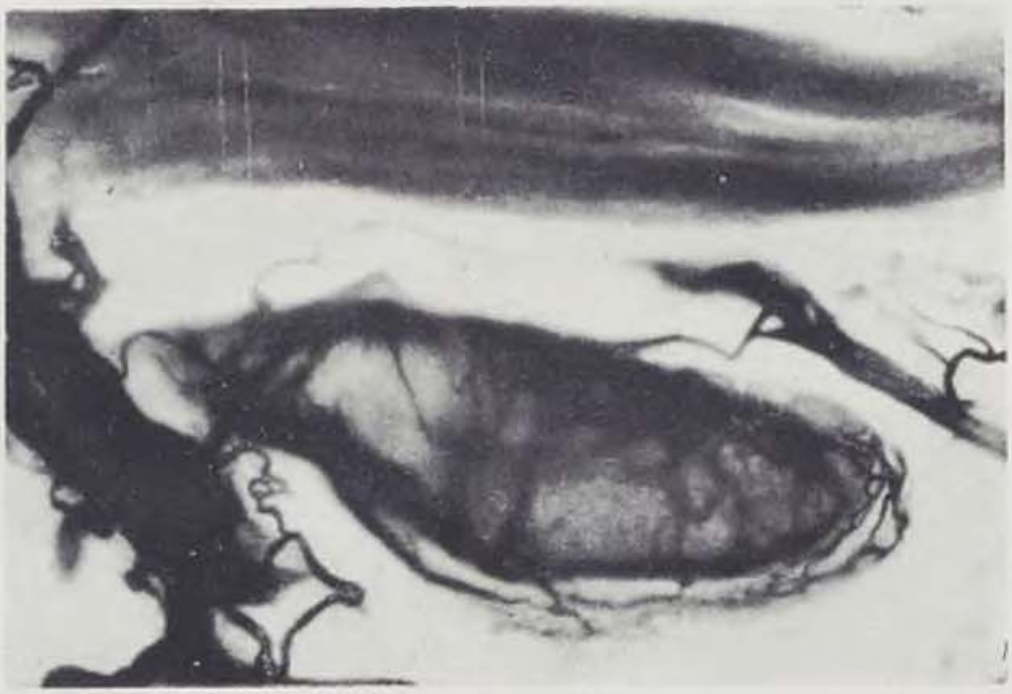

Fig. 6 Middle portion of adult human palmar aponeurosis. Capillary network on the surface of a Vater-Pacini corpuscle (ramifications of arterioles)

Fig. 7 Group of Vater-Pacini corpuscles (3) and a network of blood vessels on the surface and between corpuscles in deep layers of proximal palmar aponeurosis of an adult

cylinder) to form a capillary network inside the receptor and on its surface (Fig. 6, 7). Occasionally, the blood vessels (arterioles) approach the corpuscle from different poles or from the side to ramify on its surface in the form of dense capillary network enveloping the corpuscle in a net-like fashion (Fig. 8, 9). As a rare occurrence, there may be groups of 2 to 3 corpuscles supplied with blood from one source with the branches of a single artery supplying the tissue, bundles of nerve fibres and Vater-Pacini corpuscles of palmar aponeurosis (Fig. 10).

Fig. 8 Blood vessels on the surface of a large (4 mm) corpuscle of the surface layer of aponeurotic tendon of digit 4

DISCUSSION AND CONCLUSIONS

Our material concerning the receptor innervation of the human palmar aponeurosis beginning with prenatal ontogenesis stands to prove the complex structure and abundance of the nervous system located in it. The characteristic pattern of distribution and the uneven size of the receptors (Vater-Pacini corpuscles) most frequently found there apparently keep the CNS supplied with a wide range of different signals from the whole palmar aponeurosis and, in particular, from those of its parts which are exposed to the strain and pres-

Fig. 9 Digit 3 tendon of palmar aponeurosis. Blood vessels (ramification reaching the corpuscle) on the pole of a Vater-Pacini corpuscle

Fig. 10 Digit 5 tendon of palmar aponeurosis. Two Vater-Pacini corpuscles running parallel to a nerve fibre (above and below) in intricate interrelationship with the branches of a single blood vessel

Fig. 11 Acid phosphatase distribution in a Vater-Pacini corpuscle of palmar aponeurosis (norm.)

Fig. 12 Incipient Dupuytren's contracture. Acid phosphatase distribution in a Vater-Pacini corpuscle

Fig. 13 Dupuytren's contracture — stage 1. Deformed Vater-Pacini corpuscle and degenerated nerve fibres running parallel

sure of physical manual work. As already mentioned, beginning with the 4.5 to 5th months of embryonic development the ulnar side in the distal portion of palmar aponeurosis (i. e., tendons of digits 4 and 5) is more amply supplied with receptors of the Vater-Pacini corpuscle type. This characteristic pattern of receptor distribution (histotopography) is a lifetime feature. Clinical experience alone shows that regardless of the patient's sex and age the 4th and 5th digits of the hand, i. e., the ulnar margin of the palmar aponeurosis which, in accordance with our findings, is the most abundantly supplied with sensitive nerve endings is also the most likely to be affected by Dupuytren's contracture. In addition to that, we were able to note intricate interrelationships between the blood vessels and the Vater-Pacini corpuscles of the palmar aponeurosis as well as the existence of a dense capillary network on the surface of those receptors independently of the actual part of the aponeurosis.

Referring to his anatomical study of the palmar aponeurosis blood supply system, Bayanbeleg describes the distal portion of the aponeurosis as having less favourable conditions of blood supply, which, in his view, accounts for the intensive process of sclerotization in this particular part of the structure. However, the question arises of why the sclerotic processes in the distal portion of the palmar aponeurosis should develop the most frequently in the tendons of digits 4 and 5, i. e., on the ulnar side of the aponeurosis, rather than in the tendons of all the fingers. On the other hand, advocates of the traumatic theory of the development of Dupuytren's contracture point out that in hard manual work there is impaired blood circulation as a primary feature due to the permanent oppression of the palmar aponeurosis between the tool and the bones of the hand. Like others, Frydland (1954) believes that Dupuytren's contracture may arise from locally impaired blood supply due to a variety of causes: chronic trauma, prolonged strain, e. g., in pianists, violinists, etc.

In connection with the fact that Dupuytren's contracture is most likely to affect digits 4 and 5 of the hand, i. e., the ulnar side of the aponeurosis with its ample supply of nerve endings, mostly Vater-Pacini corpuscles, we attribute the pathogenetic causes of Dupuytren's contracture to a primary impairment of microcirculation in the proprioreceptors of the palmar aponeurosis which again may be due to different causes. Quite possibly, microcirculatory changes in the aponeurosis may have a role to play there. To give substance to this idea we studied the histophysiology of the Vater-Pacini corpuscles using the histochemical methods of Gomori, Kelli-Friedenwald in Gomori's modification for assays of alkaline and acid phosphatase, cholinesterase. As material for this study, we used the palmar aponeurosis of practically healthy persons and degenerated aponeurosis obtained from surgical operations with the removal of "healthy" part in 12 patients with Dupuytren's contracture of different stages of development.

What were the findings?

A prominent increase in acid phosphatase compared with the norm (Fig. 11, 12) and a decrease in alkaline phosphatase activities in the Vater-Pacini

corpuscles were noted already in the initial stages of Dupuytren's contracture while cholinesterase levels remained unaltered. In our view, these phosphatase activity changes are due to a primary marked disruption of metabolic processes in the Vater-Pacini corpuscles. Similar changes in the nervous system were found in the skin of lower extremities in cases of obliterating endangiitis (Golikova, 1962). Moreover, already in the initial stages, a degenerated palmar aponeurosis shows the presence of deformed Vater-Pacini corpuscles and degenerative dystrophic changes in the nerve endings (Fig. 13). In severe cases of Dupuytren's contracture, no Vater-Pacini corpuscles are present any more in the dense tissue of a degenerated aponeurosis.

The blood capillaries, so abundantly present in the proprioreceptor structures, have the same role to perform as those in other organs and tissues, namely to supply oxygen and nutrients in large quantities as required by the function concerned. Local hypoxia invariably drives tissue metabolism to the anaerobic side with an accumulation of underoxygenized metabolities and acid mucopolysaccharides. Oxygen supply is known to be indirectly proportional to the tissue content of mycopolysaccharides.

As shown by I. I. Rusetski (1950), there are six basic localizations of pathological processes related to dystrophy, all of them due to disorder in any of the structures of the autonomous nervous system (beginning with nerve ending receptors). Another source of dystrophy can be traced to the sympathetic terminal and spinal ganglia closely connected with the lateral horns of spinal cord, the lateral horns themselves and the autonomous structures of the medulla oblongata. The diencephalic region, too, has a role to play there. Clearly then, depending on the degree of primary autonomous nervous system involvement and on the intensity of stimulation, vegetative dystrophy of various degree is likely to develop, a process which we were able to see in our own patients, too.

Dupuytren's contracture of fingers should then be seen as a polyaetiological condition, in the genesis of which both exogenous and endogenous factors act in interdependence.

SUMMARY

A histotopographical study is presented of the innervation of the palmar aponeurosis in human embryos and foetuses of both sexes and in adults. Beginning with the 4.5 to 5th months of embryonic development and later on in adults, too, the ulnar margin of the distal part of palmar aponeurosis (i. e., tendons of digits 4 and 5 most likely to be affected by Dupuytren's contracture) is the most abundantly equipped with encapsulated receptors of the type of Vater-Pacini corpuscles. With reference to a study of the microcirculation of palmar aponeurosis proprioreceptors in the norm and to the histophysiology of Vater-Pacini corpuscles in the norm and in Dupuytren's contracture the author presents the view that primary impairment of microcir-

culation in the proprioreceptors of palmar aponeurosis due to a variety of causes is part of the basic pathogenesis of the condition.

Key words: contracture, Dupuytren, pathogenesis

RESUME

Nouvelles connaissances en pathogenèse de rétraction Dupuytren

Mikoussef, I. E.

Effectuée l'étude histotopographique de l'appareil nerveux de l'aponévrose palmaire chez les embryons, les foetus humains des deux sexes et chez les adultes. On a constaté qu'à partir de 4,5 à 5 mois du développement embryonnaire (aussi chez les adultes), le bord cubital de la partie distale de l'aponévrose palmaire (c'est-à-dire des tendons de 4ème et 5ème doigts, le plus souvent atteints de la rétraction Dupuytren) est au maximum pourvu en récepteurs incapsulés, corpuscules de Vater Pacini en principe. S'appuyant aux études de la microcirculation des propriocepteurs de l'aponévrose palmaire chez les sujets normaux et aux études de l'histophysiologie des corpuscules Pacini chez les sujets normaux et chez les sujets atteints de rétraction Dupuytren, les auteurs présentent l'hypothèse que les troubles primaires de microcirculation aux propriocepteurs de l'aponévrose palmaire, dus aux diverses origines, constituent l'élément de la notion de pathogenèse de cette maladie.

ZUSAMMENFASSUNG

Neue Erkenntnisse zur Pathogenese der Dupuytren'schen Kontraktur

Mikusev, I. E.

Es wurde das histotopographische Studium der Nervensystems der Handflächenaponeurosis bei Embryos, Früchten von Menschen beiden Geschlechts sowie bei Erwachsenen durchgeführt. Es wurde festgestellt, dass bereits seit dem 4,5. bis 5. Monat der embryonalen Entwicklung ebenso wie bei Erwachsenen der Ellenrand im distalen Teil der Handflächenaponeurosis (d. h. der Sehne des 4. und 5. Fingers, die am häufigsten von einer Dupuytren'schen Kontraktur betroffen wird) am reichhaltigsten von eingekapselten Rezeptoren versorgt wird, im Grunde von Körperchen Vater Pacini. Auf Grund der Studie der Mikrozirkulation der Propriorezeptoren der Handflächenaponeurosis bei der Norm und der hystophysiologischen Körperchen Vater Pacini bei der Norm und bei einer Dupuytren'schen Kontraktur wurde die Erwägung in Betracht gezogen, dass ein Bestandteil der Grundlage der Pathogenese dieser Erkrankung eine primäre Störung der Mikrozirkulation an den Propriorezeptoren der Handflächenaponeurosis sei, die aus verschiedenen Gründen entsteht.

RESUMEN

Una contribución al conocimiento sobre la enfermedad de Dupuytren

Mikusev, I. E.

Se presenta un estudio histotopográfico de la inervación de la aponeurosis palmar en los embriones y fetos de ambos sexos y también en los adultos. Comenzando con 4,5—5. mes desde el desarrollo embriónico y más tarde también en los adultos, fué observado que el margen ulnar de la parte distal de la aponeurosis (es decir,

los tendones del dedo 4 y 5 los que están principalmente afectados por la enfermedad de Dupuytren) está abundantemente proveído por los receptores encapsulados, en primer lugar, por los corpúsculos de Vater-Pacini. A base del estudio de la microcirculación de la aponeurosis palmar de los propioreceptores en la norma y de la histofisiología de los corpúsculos de Vater-Pacini en la norma, el autor es de opinión que el perjuicio primario de la microcirculación en los propioreceptores de la aponeurosis palmar, debida a diferentes causas, toma parte en la patogenesis de esta enfermedad.

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PLASTIC OPERATIONS OF BURNS USING CULTURED EPITHELIUM

V. P. Tumanov, A. A. Pal'tsyn, D. S. Sarkisov

Starting from the fifties of this century, biologists and clinicians have shown enhanced interest in the problems of tissue transplantation, particularly skin grafting. Medawar (7) was the first to point out the possibility of culturing epithelial cells of human skin. However, cultivation of a large mass of epithelial cells, which is indispensable, e. g., for the covering of surfaces of burns, still presents considerable difficulties. This accounts for the fact that, regardless of the obvious therapeutical importance of tranplantation of cultured epidermis, there are only a few clinical departments worldwide, practicing this method of treatment in patients with burns (3, 10). Essentially, the difficulties consist in the fact that the growth of epidermocytes slows down after 4—5 days incubation and the cells are subject to differentiation. Several stimulators and approaches to cultivation have been proposed for the intensification of epidermocyte proliferation (4, 5, 8, 9), but the problem has so far not been cardinally solved. For this reason, the search for stimulators of division and inhibitors of differentiation of cells is going on. Hennings et al (6) have demonstrated that reduction in the concentration of calcium ions in the culture medium to 0.04—0.05 mM enhances the division of epidermocytes obtained from the skin of newborn mice. In experiments with epidermocytes isolated from the skin of adult humans, we succeeded in stimulating proliferation of cells in a medium with a higher concentration of calcium. The results of our experiments are presented in the following report.

METHODS

Small bits of split skin sheets, obtained during autodermoplastic operations on patients with burns, were used as material. The bits were treated with 0.25% trypsin solution for 18 h at 2—4 °C. Using the tweezers, we separ-

ated the epidermis from the dermis and both layers were repeatedly washed in the medium. A concentrated suspension of basal and other differentiated skin cells was obtained. After determining the content of the cells in Goryayev's chamber, we seeded the cells in plastic dishes, adjusting their concentration to 10^4. The incubation took place in a thermostat, absolute humidity and CO_2 content being 5 %. In Series I, the following culture medium was used: minimum Eagle's medium (MEM) with the addition of 10 % of the volume of the medium of embryonal calf serum and 2 % of the volume of the medium of 3% glutamine solution. Calcium content 1.5 mM. Series II contained MEM, Ultroser (product of LKB) — 2 % of the volume of the medium, and glutamine. Calcium content 1.46 mM. Series III: hypocalcic MEM with the addition of 10 % of embryonal calf serum and glutamine. Calcium content 0.28 mM. Series IV: hypocalcic MEM, 2 % Ultroser and glutamine. Calcium content 0.15 mM. Calcium concentration was determined by means of an ionized calcium analyser supplied by "Radiometer" (Denmark). The cultures were examined daily in phase-contrast. The medium was changed twice a week.

Two hours before fixation, ^{3}H-thymidine in a dose of 10 μCi/ml was introduced into the culture medium for electron-radiographic examination of the cultures. The cells were fixed with 2.5% solution of glutaraldehyde and 1% solution of osmium tetroxide, and embedded in epon. For autoradiographic examination of the initial cell suspension, an amount of 0.5 ml of this suspension was incubated immediately after isolation for a period of 2 h in test-tubes with ^{3}H-thymidine in the same concentration. Then the suspension was washed in the culture medium, smears were prepared and fixed in ethanol. Light-microscopic and electron-microscopic autoradiograms of the smears and cultures were produced by means of emulsion M using the method described by D. S. Sarkisov et al. (1, 2).

RESULTS

The suspensions isolated from the skin for seeding contained mainly basal cells, but differentiated cells and even horny scales were also encountered. The content of ^{3}H-thymidine-labelled basal cells varied from 1 to 5 % (Fig. 1). According to morphological marks, the cultures hardly differed from each other 24 h after seeding in media with different calcium content. A considerable part of basal cells adhered to the bottom of the dish. Basal cells in the smears were round in shape with a narrow zone of cytoplasm while the adherent cells were considerably enlarged, assuming a polygonal shape with a wide zone of cytoplasm. A considerable number of cornified cells floated on the surface of the medium and were removed from the dish when the medium was changed.

During further cultivation, morphological differences in the cultures growing on nutrient media with a low and a high content of calcium showed up and gradually became more pronounced. After 5—6 days, the cultures in Series I and II of the experiments formed separate colonies not connected

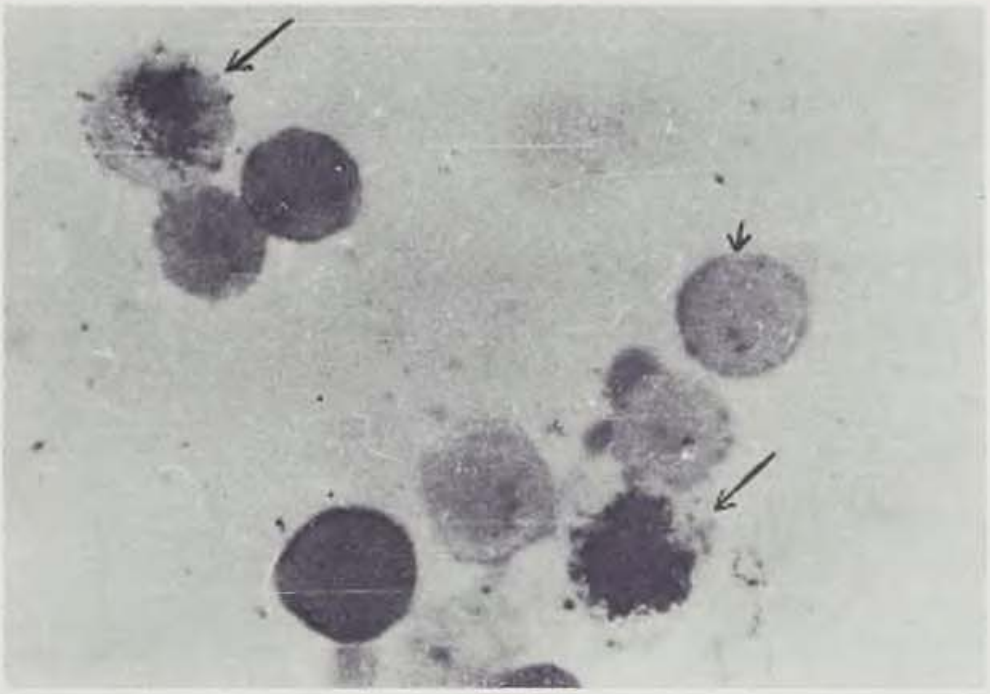

Fig. 1. Suspension of epidermocytes isolated from the skin. Basal cells, round in shape (short arrow) Two of them are labelled (long arrows). Magn. × 2000

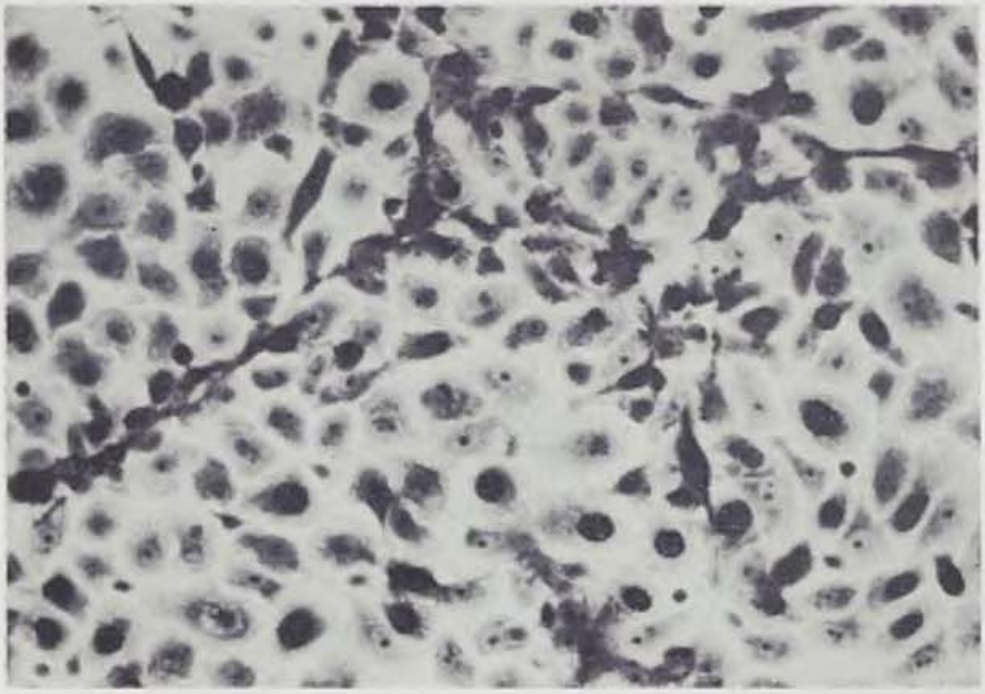

Fig. 2. Culture of epidermocytes in calcium-free medium. Considerable spaces can be seen between the cells forming a monolayer. Large number of labelled cells (arrows). Magn. × 1000

with each other or connected with narrow cell bridges. The colonies in medium No. 1 were larger. The central parts of the colonies were covered with a layer of cornified cells. Labelled cells were encountered extremely rarely and were always situated on the periphery of the colony. No labelled cells at all were found in many cultures on examining the whole surface of the dish. Large colonies, merging in many parts, were formed in medium No. 3 during the same period of cultivation. A large number of isolated cells were found in the space between the colonies. The colonies consisted of large, often binuclear, cells. The cells situated within the colonies often included ^{3}H-thymidine (4—11 %) and labelled cells could be found in any part of the colony. The isolated cells between the colonies were never labelled. Cornification was manifest by the formation of small clusters of horny cells over some parts of the colonies (not always in the centre).

There were no colonies in the culture medium No. 4. Considerable parts of the dishes were occupied by a monolayer of large cells separated by intercellular spaces wider than in medium No. 3 (Fig. 2). The number of labelled cells in such parts varied from 12 to 22 % (see Fig. 2). Electron-autoradiographic examination has shown that labelling with ^{3}H-thymidine is possible in cells which have already been through the initial stages of differentiation; a net of tonofibrils has formed in their perinuclear zone, sporadic granules of keratohyaline can be observed (Fig. 3).

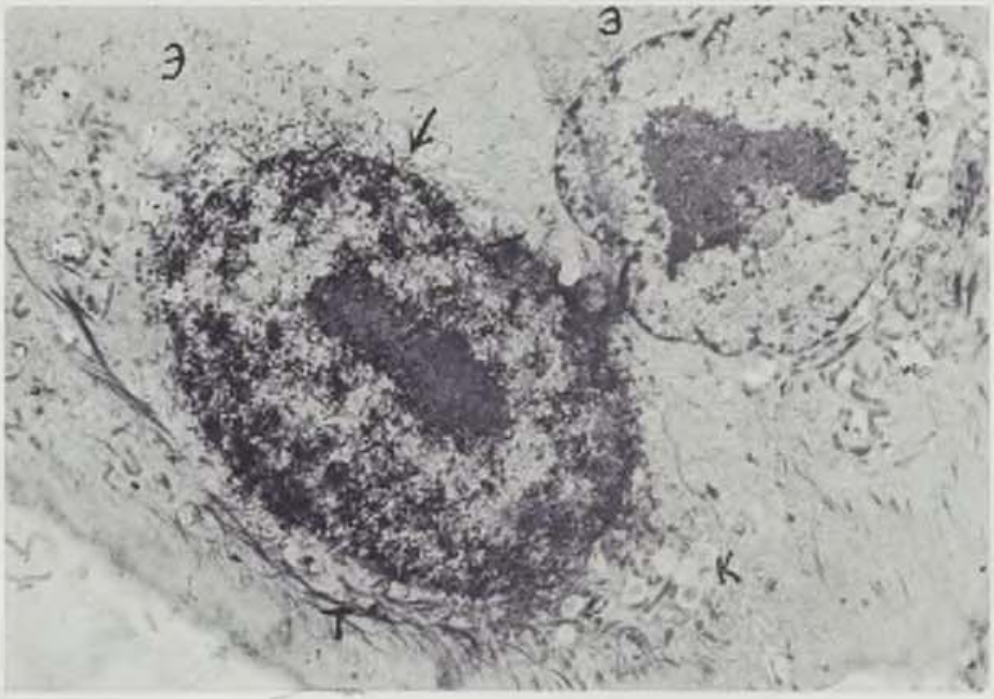

Fig. 3. Electron-microscopic radioautogram of epidermocytes (E) grown in medium with a low content of calcium. DNA synthesis can be observed in the cell (arrow) with starting differentiation indicated by the presence of tonofibrils (T) in the perinuclear region and a negligible number of keratohyaline granules (K). Magn. X 10 000

Some parts of the described cultures, smaller in size, contained smaller cells, did not form monolayers and did not include ^{3}H-thymidine. Cornification was expressed by the presence of a small quantity of horny cells.

Thus the cultivation of adult human epidermocytes in a medium containing 0.15 mM of calcium suppresses their differentiation and stimulates cell division. One day after seeding, such cultures essentially fill the dish. The large number of dividing cells in the cultures permits their use both for grafting on wound surface and further cultivation.

Epidermal cells, cultured on various semisynthetic media, were used for autoplastic grafting in patients with burns.

The layer of epidermis grown in the culture was transplanted in 9 patients. It was applied to granulating burned wounds after spontaneous rejection of the scab or after chemical necrectomy. The age of the operated subjects ranged from 20 to 53 years, the surface of the injury from 25 to 65 % of body surface, deep injuries embracing 2—60 %.

Transplantation of the culture of epithelial cells was carried out in the operating theather. Parts of the anterior surface of the body were chosen for the purpose, exhibiting clean, pink, fine-grained granulations without islets of epithelization and not less than 4—5 cm away from the wound edges to preclude epithelization of the edges. Lateral and posterior body surfaces were

Fig. 4. A dressing by means of which the process of epithelization of burn wounds can be followed up. Monolayer of epidermocytes can be seen under vaseline-impregnated gauze

not used because the cultured epidermis layer slips down. We applied the tissue culture starting from the edges of the wound and did not consider rapid growth from the edges (epithelization of the edges) to be a positive result. The layers of cultured epidermis sized 2—2.5 cm × 5—7 cm in the shape of strips were applied to the wounds, one after the other, from 2 to 25 strips. The area was covered with moist-drying dressing with an antiseptic (sol. Furacillini 1 : 5000). The dressing was applied on the 3rd to 4th day after transplantation. Epithelization was controlled by means of a special dressing (Fig. 4).

SUMMARY

Autoradiographic and electron-microscopic methods were used for the study of cultures of human skin epidermocytes in media with a low calcium content. It has been demonstrated that the culturing of epidermocytes in a medium containing 0.15 mM of calcium suppresses differentiation and stimulates division of cells. The considerable number of dividing cells in the cultures permits their use both for grafting on wound surfaces and further cultivation.

Key words: epidermocytes; tissue culture; culture media; electron-microscopic autoradiography; dermoplasty.

RÉSUMÉ

Plastie des brûlures par l'épithélium cultivé

Tumanov, V. P., Paltsyne, A. A., Sarkisov, D. S.

Le processus de culture d'épidermocytes de peau humaine a été soumis aux examens par la méthode radioautographique et par la microscopie électronique, dans un milieu de culture à la basse teneur en calcium. Il était prouvé qu'une culture d'épidermocytes, cultivée au milieu de teneur 0,15 mM en calcium, étouffe la différentiation et stimule la division cellulaire. Un volume considérable de cellules en train de division dans ces cultures rend possible leur utilisation tant pour les greffes à la surface des plaies que pour une autre culture.

ZUSAMMENFASSUNG

Die Plastik von Verbrennungen mit kultiviertem Epithelgewebe

Tumanow, V. P., Palcyn, A. A., Sarkisow, D. S.

Der Prozess der Kultivierung von Epidermozyten der menschlichen Haut wurde mit Hilfe der Methode der Radioautographie und Elektronenmikroskopie auf einem Nährboden mit geringem Kalziumgehalt untersucht. Es wurde erwiesen, dass die Kultivierung von Epidermozyten auf einem Boden von 0,15 mM Kalziumgehalt die Differenzierung unterdrückt und die Zellenteilung stimuliert. Der erhebliche Gehalt an sich teilenden Zellen in den Kulturen gestattet ihre Verwendung sowohl bei der Transplantation auf die Oberfläche von Wunden als auch bei der weiteren Kultivierun.

RESUMEN

La operación plástica por medio del epitelio cultivado

Tumanov, V. P., Pal'cyn, A. A., Sarkisov, D. S.

El proceso de la cultivación de los epidermocitos de la piel humana fué investigado por la radioautografía y microscopía electrónica en el medio de cultivo con el contenido bajo de calcio. Fué comprobado que la cultivación de los epidermocites en el medio con el contenido do 0,15 mM de calcio suprime la diferenciación y estimula la mitosis. El contenido considerable de las células que se dividen en los medios de cultivo facilita su aplicación tanto en la transplantación sobre la superficie de las heridas como en la nueva cultivación.

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CARDIAC SUPPORT IN BURNED PATIENTS WITH HEART DISEASE

K. Szabó

INTRODUCTION

The main function of the circulatory system is to meet the metabolic demands of the organism. Following thermal injury phasic changes of metabolism occur:

1. "ebb" phase — hypometabolism, hypothermia, decreased O_2 consumption, hypovolemic circulation. 12—24 hours later it is transferred into the
2. "flow" phase — which is characterized by hypermetabolism, hyperthermia, increased O_2 consumption and hyperdynamic circulation (10).

The problem of cardiac support in burned patients arises at every internist consultation. At first sight this question seems extremely simple. According to the data of hemodynamic studies, the depression of cardiac output in burns reaching sometimes 40—60 %, precedes the plasma loss and is more pronounced compared to the latter (fig. 1), (1, 2). This effect was explained

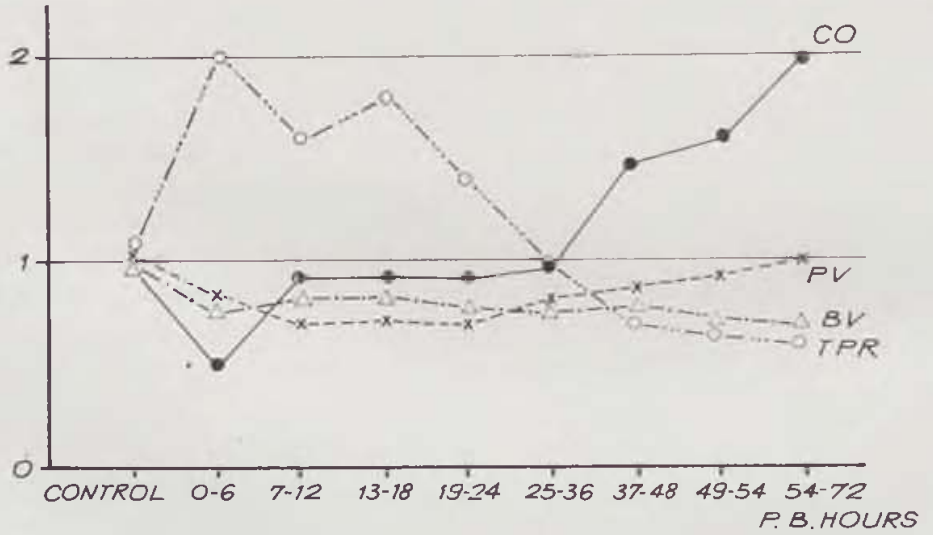

Fig. 1. Dynamics of cardiac output (CO), plasma volume (PV), blood volume (BV) and total periferic resistance (TPR) in burn shock. 1 — normal value

by a decrease of myocardial contractile force and the effect of the myocardial depressing factor (MDF) (2). Unfortunately, conclusions concerning the practice of treatment were accordingly simplified, the internist as a rule left his burned patient without feeling anxiety after having treated him with positive inotropic drugs, digitalis derivatives. However, due to the potassium loss the heart muscle is inclined for arrhythmias, cardiac glycosides applied under these conditions without appropriate indications may bring the burned patient to death (2, 10). The existence of this danger at burn units is to be emphasised, for at the present moment as a rule there are no ECG-monitoring facilities and the surgeon (nurse) are rather unexperienced at diagnosing arrhythmias at bed-side.

Generally there is no use of treating these patients with cardiac glycosides, for the occuring development of cardiac output is not due to the decrease of its contractile force.

M-mode ECHO studies prove an increase of Vcf and EF in burn shock, but in spite of that the stroke volume (SV) is low (4). Moreover the cardiac index may be high but stroke index is diminished in patients with septic shock (3).

Interrelations between stroke volume and preload

The explanation of this mentioned inconsistency is that the stroke work is determined by a number of factors, such as preload, afterload, heart rate and contractility. Following burn the total periferic resistance (TPR) immediately increases, which is a crucial event in burn shock leading to the diminishment of SV and cardiac output (1, 2, 8) and the elevation of afterload.

The depression of SV results in a decrease of external stroke work, for SV is a basic value for its calculation. The increased afterload, however, elevates the stretch work and contractility (10) thus enhancing the myocardial O_2 consumption and inducing a deterioration of the efficiency of stroke work (2, 10).

Using non-invasive methods in our observations, we found inverse changes between cardiac index and TPR values. The decrease of external stroke work occured at elevated values of left ventricular dp/dt_{max} (10).

Desynchronization of the two heart ventricles

We should like to stress the importance of the synchronized periodical pump-function of the two ventricles in maintaining normal circulation after burn. The right ventricle is a volume-generator providing the optimal preload for the left ventricle by continuous pumping of adequate volumes of blood. This preload is crucially important for the maintaining of left ventricular function, the latter being a pressure generator. At thermal injury the synchronized function of the two ventricles is upset. In extensive burns there is a pronounced elevation in pulmonal resistance and TPR (1, 7, 8).

However, while the left ventricle is capable to overcome the increased vascular resistance by a disadvantageous elevation of O_2 demand, the right

ventricle having thin walls fails to compensate. Thus the left ventricular preload is decreased not only by the plasma loss but also due to an increase of PVR (6, 7).

Shock therapy requires large fluid replacement reaching in severe cases 1 l/h throughout the first 8 hours (4, 8). This fluid dilates the right ventricle, leading to 180 ml/m² right ventricular end-diastolic volume index in case of high PVR values (7).

Due to the unextensible pericardial volume the dilated right ventricle pushes the septum into the left ventricular cavity thus decreasing the end-

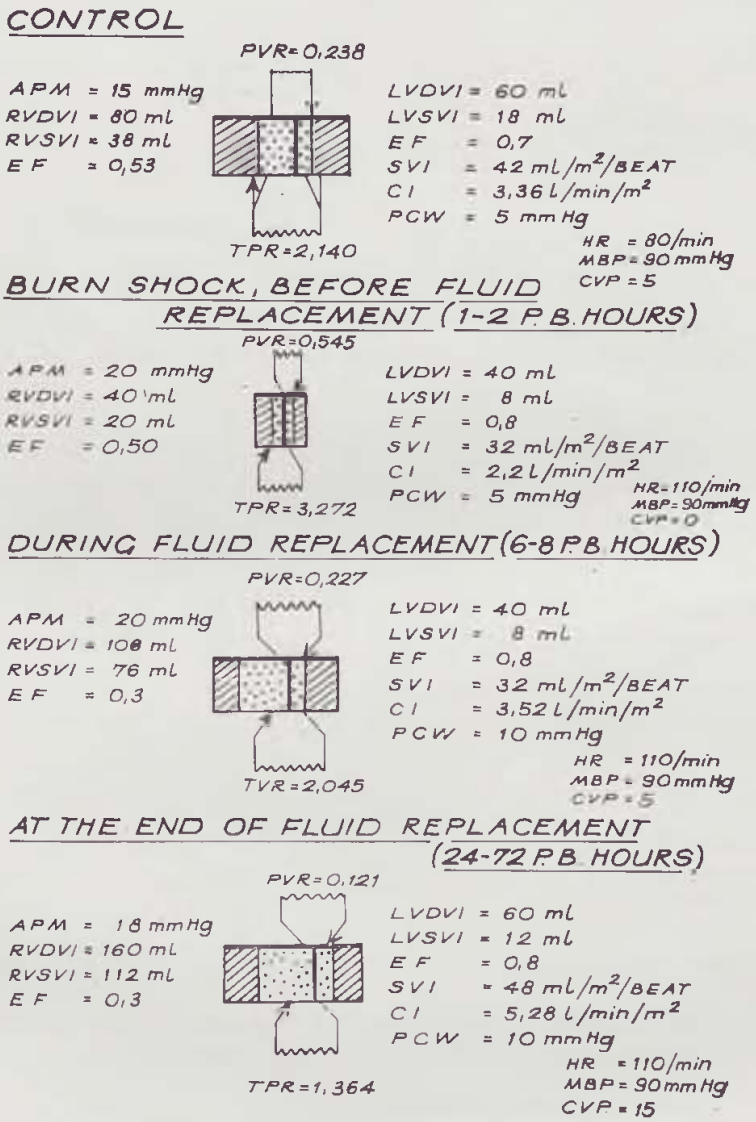

Fig 2. Blood pressure and ventricular volumes in burn shock according to hemodynamic measurements (1, 2, 4, 5, 7) APM — mean arterial pulmonal pressure, RVDVI — right ventricular end-diastolic volume index
EF — ejection fraction, L — left, SVI — stroke volume index, CI — cardiac index, PCW — pulmonal capillary wedge pressure, HR — heart rate, MABP — mean arterial blood pressure, CVP — central venous pressure, PVR — pulmonal vascular resistance, TPR — total periferic resistance

diastolic volume of the latter (fig. 2). Such a decrease of left ventricular preload also deteriorates its performance (6). At the same time the compliance of the dilated right ventricle decreases (9).

The analysis of the Sarnoff-curves supports the functional importance of the above-mentioned events. Preload values at PCW < 10 mmHg at normal left ventricular volumes (60—80 ml/m^2) maintain normal SV (40 ml/m^2): the point at the ascending part of the Sarnoff-curve before its flattening.

At low values of the left ventricular volume SV is insufficient due to absence of adequate preload. (Starling law.) Increased contractility typical of the intact myocardium even at low preload (fig. 3) shifts the Sarnoff curve to the left, thus improving cardiac performance.

Hypercatecholaminaemia observed in burned patients is a sufficient stimulus for inducing this shift, so there is no need in application of positive inotropic agents; naturally electrolite disturbances and acidosis should be corrected (2).

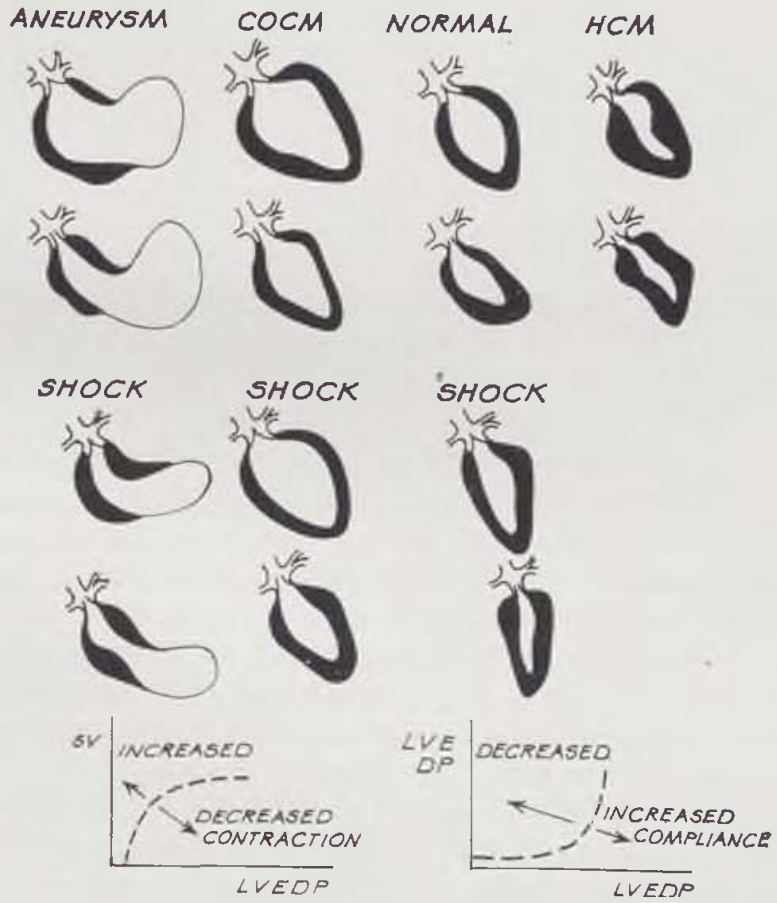

Fig. 3. Left ventricular profiles of normal heart and at various pathologies (upper line — diastole, lower line — systole). Insufficient left ventricular filling occurs in shock due to the diminished pulmonal venous return
LVEDP — left ventricular end-diastolic pressure, LVEDV — left ventricular end-diastolic volume

Importance of the compliance of ventricles and preload

A poorly investigated function of the heart, namely its "compliance" plays an important role in normal response to stress. According to the above mentioned the left ventricular compliance decreases with subsequent elevation of left ventricular end-diastolic volume at normal or even at decreased left ventricular volumes (fig. 4). It means that the high PCW does not necessarily indicate heart failure during shock therapy (9), or in patients treated with mechanical ventilation (6), thus the appropriate treatment is the elevation of "compliance" and not the application of positive inotropic drugs,

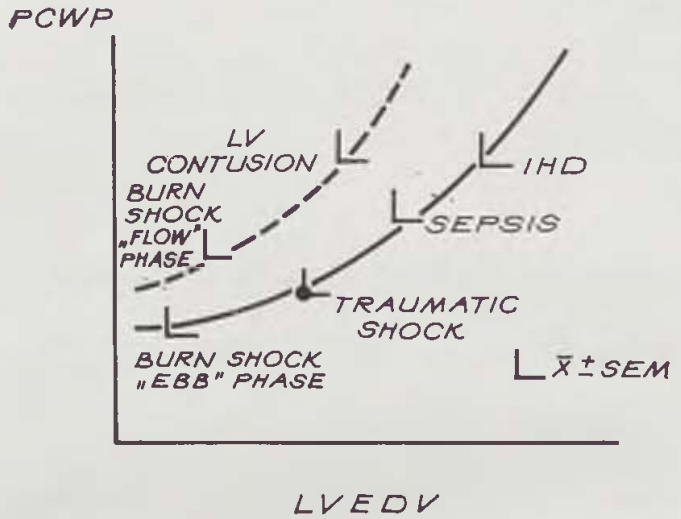

Fig. 4. Left ventricular compliance at different pathologic states. IHD — ischemic heart disease

except in some reasonable cases (2). These hemodynamic data indicate that the heart of the cardiac patients will endure fluid replacement at shock therapy. Moreover, the dilated heart of patients with COCM (congestive cardiomyopathy) and ischemic heart disease suffers from insufficient preload more than the normal cardial muscle. The lack of the contractile reserve as well as diskynesis reduce the adaptation possibilities of myocardium by shifting the Sarnoff-curve to the left. Only an adequate fluid replacement can maintain the reduced stroke work at some constant, probably reduced level.

However, due to the low "compliance" a higher filling pressure is required for maintainance of adequate preload (6, 9) (fig. 5).

At most intensive care units there are no other possibilities of the invasive study but the registration of CVP. I should like to emphasise the utter necessity of this method in treatment of shock, still it is also important to give some critical remarks concerning the method of CVP registration.

CVP depends on the flow rate of the venous return, the distensibility of the venous vascular bed and the volume (pressure)/flow relationship in the right ventricle. CVP depends on the function of the left ventricle only if the

latter affects those factors. Thus the CVP changes are not relevant to the function of the left ventricle (6, 7, 9).

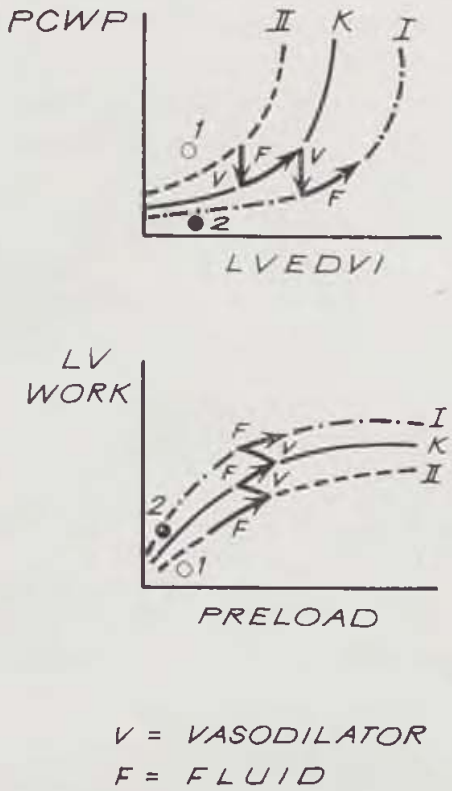

Fig. 5. Left ventricular stroke work and compliance after fluid replacement and vasodilator treatment. "K" — normal myocardial curve
Changes of the curves: I — myocardium with increased performance, II — myocardium with decreased performance after fluid replacement
1. pretraumatically decompensated patients (COCM, ischemic heart disease) in shock,
2. pretraumatically non decompensated ischemic heart patients in shock

According to Sibbald a common RVEDP/CVP curve characterizing the "compliance" function of the right ventricle is typical of the patients with traumatic shock, ischemic heart disease and normotensive sepsis. Basically it shows normal right ventricular distensibility in various cases. In chest-injured patients the contusion of the right ventricle leads to its increased "compliance" due to the damage of myofibrilles. In spite of an extremely large right ventricular volume CVP remains low. In these cases overfilling represents a real danger (9) (fig. 6).

Low CVP and a small right ventricle are typical of untreated burn shock (1). Due to fluid replacement the right ventricular volume greatly increases as a consequence of high "compliance" and PVR values (7). In cases of pathologically altered "compliance" a small right ventricle with high intraventricular pressure develops in spite of high CVP values leading to subendocardial

ischemia in the zones supplied by the right coronary artery (7, 10). Fluid replacement based only on the CVP values is sometimes misleading. At standardized volume load the obtained CVP changes may give valuable information: 200 ml Dextran given during a 20 minutes' time interval won't elevate significantly the CVP of a hypovolemic patient, except in cases with depressed "compliance". As far as I know no "compliance" measurements were performed in burned patients: in experimental models, however, 15 % total burned surface injury already induces relaxation (-dp/dt) and "compliance" decrease (cit in 10).

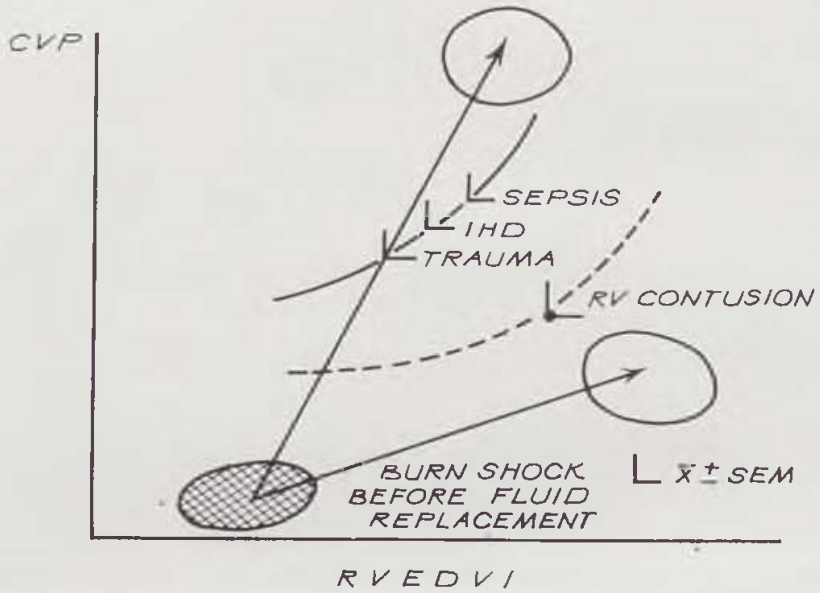

Fig. 6. Right ventricular compliance at different pathologic states
CVP — central venous pressure, RVDVI — right ventricular end-diastolic volume index

The studies of the right and mainly left ventricle indicate depressed "compliance" at: progressive ventricular filling, ischemia, right ventricular overload, pericardial fluid accumulation, high arterial pressure (afterload), PEEP-respirator therapy and shock. The "compliance" increases at: improvement of ischemia, the effect of some drugs (Nitroglycerin, Nitroprusside, Ca-entry blockers) (9).

I should like to emhasise the role of Nifedipin (fig. 7) which normalizes the "compliance" by decreasing also the PVR.

Left ventricular "compliance" values were plotted against the end-diastolic volume (LVDV) and PCW. These values determined at various diseases belong to the same curve. Left ventricular "compliance" decreases in burn, right ventricular dilation HCM, left ventricular contusion, and during PEEP therapy. So the high PCW values do not primarily reflect the disturbances of contraction, but an increased end-diastolic pressure in a normal or relatively small ventricle (7, 9).

THERAPEUTICAL CONCLUSIONS

Considering the afore mentioned, besides fluid replacement the improvement of "compliance" values is the most important step in treatment of burn shock. One of such possibilities is a vasodilator treatment. The "K"-curve reflecting the myocardial contractility and "compliance" relationship in normal heart locates between the I (hypercontraction) and the IInd (hypocontraction) curves. In injured patients with intact myocardium fluid replacement is the best cardiac treatment (fig. 5). It is worth mentioning, that the use of glucose, K^+ and insuline is reasonable from the viewpoint of maintenance of energetic balance (5). Our own investigations proved the necessity of additional treatment with Ca-entry blockers in order to protect the developing Ca-overload (10), apart to these agents decrease TPR, and increase CI (cit in 10). Considering subcellular protection carnitine and fructose-1-P treatment improving oxidative phosphorilation (cit in 10) and glycolysis (cit in 10) should be of beneficial effect.

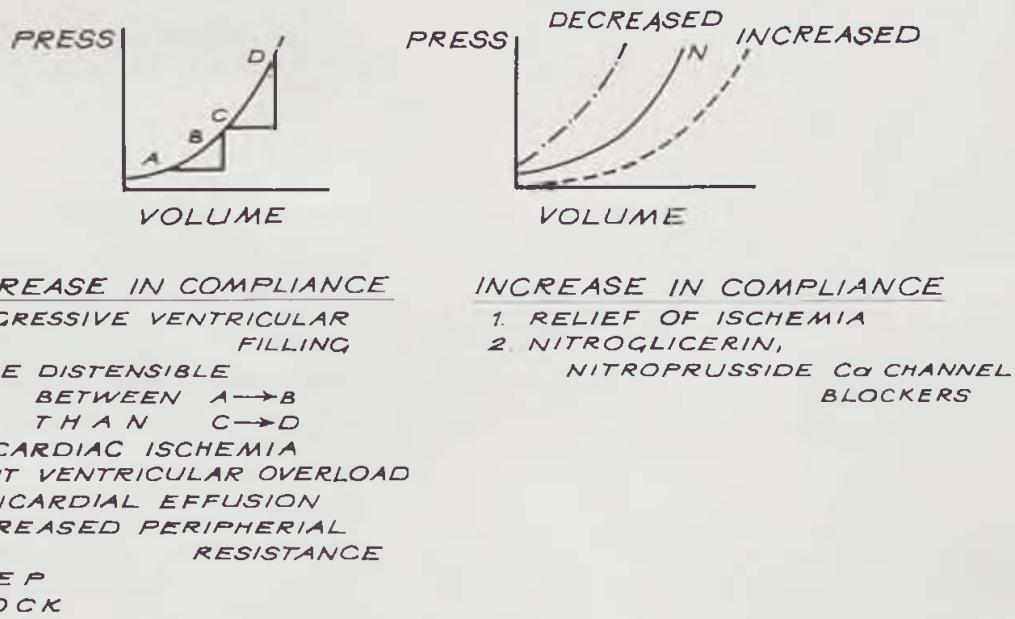

Fig. 7. Factors (drugs) affecting the dynamics of the left ventricular compliance

It is worth to mention that both the coronary blood flow and the consumption of oxygen and substrates (except glucose) is diminished in the ebb phase of burn shock (cit in 10). In septic shock, which emerges frequently in the later period of burn disease (2) against an enhanced coronary flow the extraction of substrates and myocardial oxygen is inhibited (3). So the improvement of heart muscle metabolism should be a crucial point of the cardiac support (10). If the injured was pretraumatically a heart cardiac patient (COCM, ischemic heart disease) the observation of the function of both ventricles is of utmost importance in cardiac therapy.

It is quite clear that the reduction of the adequate amount of fluid in shock treatment is a serious error. It is especially important in aged patients, for according to the data of Moore the aged are apriori hypovolemic (cit. in 10). At slight depression the right ventricular performance improves (fig. 8) from "b" to "c", while at marked depression deterioration takes place: "d". In these cases the decrease of the right ventricular afterload proves to be effective (Nitroglycerin, alfa-adrenergic blocking agents, in some case Nifedipin, Diaphillin). If there is no improvement, positive inotropic drugs can be applied (Dobutrex 2—10 μg/kg/min, Digoxin). The decreased right ventricular stroke volume diminishes the left ventricular preload, thus depressing the left ventricular stroke volume. Left ventricular preload is also decreased due to the elevation of right ventricular afterload, to the post-burn increase of serotonin, $PGF_{2\alpha}$, aggregation of trombocytes, leucocytes, other types of injuries occuring at burn (inhalation damages, lung contusion), or to treatment (PEEP, CPAP) of respiratory complications.

I should like to emphasise that Dopamine has a PVR-elevating effect, thus besides its tachycardia-induction, other side effects should be considered

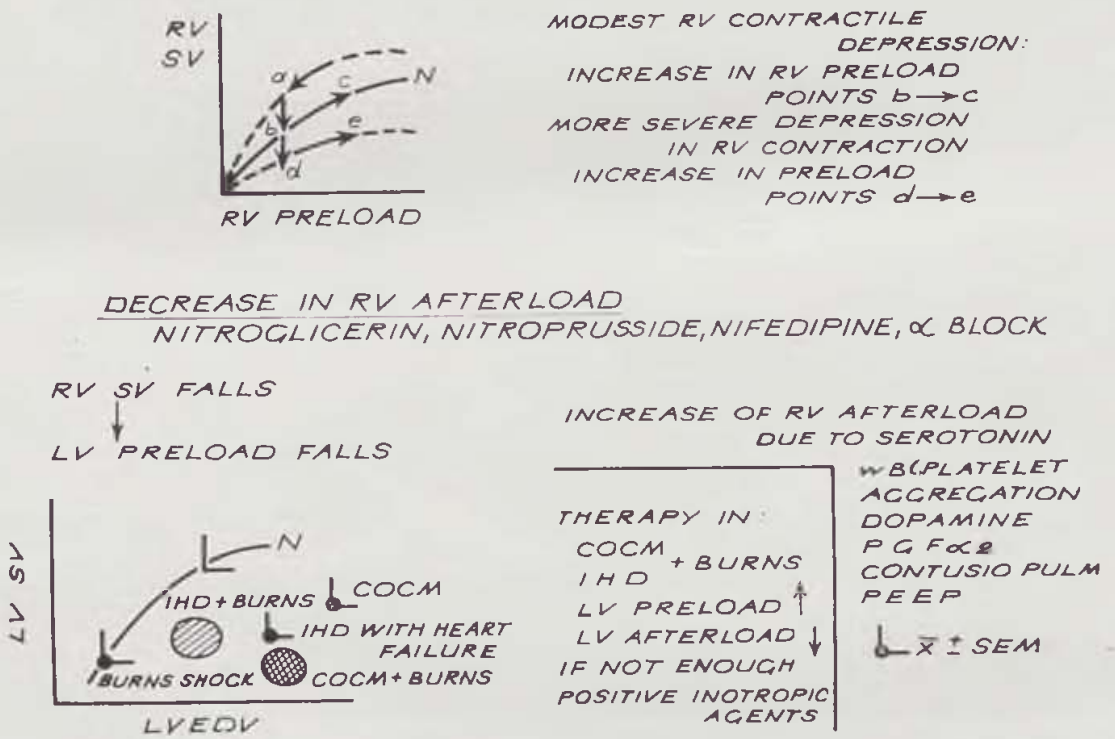

Fig. 8. Maintenance of the right ventricular stroke volume (RVSV) is possible only at appropriate fluid replacement. In case of failure due to the increased pulmonal resistance, the latter should be reduced by adequate treatment. If the right ventricular stroke volume fails to maintain a sufficient left ventricular stroke volume (LVSV), systemic vasodilators should be used. If in spite of all the above-mentioned therapeutic steps insufficient circulation develops, application of positive inotropic drugs is necessary

when choosing this drug because of its well-known positive effects. In burned patients with shock the beneficial effect of dopamine on cardiac index was not supported by others (7). In the "ebb" phase of burn shock the stroke volume is low due to the insufficient preload. In patients with COCM, in ischemic heart disease, the preload values of the small heart are low. Thus the left ventricle fails to perform even the diminished stroke work observed at normovolemia. The afterload elevation (high TPR) deteriorates the left ventricular performance (8), further aggravating the O_2 deficit of the otherwise ischemic myocardium (7) due to tachycardia and short diastolic time (10). Considering these factors in the "ebb" phase of shock, preload increase accompanied with adequate fluid replacement as well as the decrease of pulmonal resistance and TCR (7, 8) is absolutely necessary. Application of coronary dilators (first of all NG) and improvement of compliance (Ca-entry blockers) are by all means reasonable steps in therapy. Ca-entry blockers decrease TPR (cit in 10), moderate the tachycardia, protect against the myocardial damage (10). Positive inotropic agent should be given only in cases of really decreased contractility, proved by objective measurements. Dobutrex or if there is none available, digitalis can be applied.

The use of diuretic agents is indicated only at hyperdynamic, hypervolemic circulation, usually during edema resorption during the 3—7 post-burn days.

Considering the above-mentioned facts, establishment of terms for objective hemodynamic studies at burn units should be solved. Till now besides the invasive methods (pulmonal artery pressure, thermodilution) only electroimpedance, ECHO and enlarged STI studies are the non-invasive methods applied.

In the "flow" phase of burn disease the patients are normo- or hypervolemic as a rule (2, 4, 10).

Extreme elevation of hypermetabolism in burns leads to the high cardiac output. If it lasts for weeks it becomes disadvantageous for the organism, for hypermetabolism and shunt circulation in the injured zones mean extra work for the damaged myocardium. The result is an inadequacy between O_2-demand and supply in the heart muscle (10).

Beneficial effect of beta-blockers in this situation is due to their metabolic and cardioprotective effect. Longlasting treatment with beta-blockers is desirable in the "flow" phase and burn disease, for these drugs prolong the diastolic time and normalize the relationship between the electric and electromechanic systole (10).

NG treatment normalizes the "compliance" improving the ischemic post-burn damages (9). Simultaneous treatment of patients with hypocontractive heart with vasodilator agents maintains the optimal, that is a slightly increased performance of the heart in the hypermetabolic post-burn state. Naturally if the measured ventricular contractibility is diminished in flow phase or sepsis digitalis or dobutamine should be administered too.

SUMMARY

The author describes the hemodynamic changes typical of burn shock and burn disease and emphasises the typical features of the phases of burn shock ("ebb", "flow"). The author also stresses that the myocardial insufficiency of the burned patients is due to the changes of preload—afterload, disturbances of the myocardial compliance and desynchronisation of the left-right ventricular function.

If the injured were pretraumatically heart patients (COCM, ischemic heart disease) fluid replacement in these cases is an appropriate heart therapy. The choice of further treatment is based upon normalization of PVR, TPR "compliance" and oxygenization of myocardium. In the "ebb" phase of shock vasodilators and Ca-entry blockers, in the "flow" phase beta-adrenergic blockers are suggested. In every severe case due to ischemia induced by metabolic and hemodynamic changes, NG (and derivatives) treatment is justified. The author considers the application of positive inotropic agents in all the cases as unreasonable and proves their necessity (Dobutrex, Digoxin) only after objective determination of decreased contractility.

RÉSUMÉ

Traitement cardiologique chez les brûlés atteints de cardiopathie

Szabó, K.

L'auteur décrit les changements hémodynamiques qui prédominent dans l'état de choc de brûlure et dans la maladie du à la brûlure. Il souligne les signes typiques des phases du choc de brûlure („ebb" et „flow"). Egalement, l'auteur met l'accent sur le fait que l'insuffisance de myocarde des brûlés est due aux changements „preload — afterload", aux troubles de la compliance de myocarde et à la désynchronisation de fonction ventriculaire gauche-droite. Si les sujets atteints souffraient d'une maladie du coeur même avant le traumatisme (cardiomyopathie congestive, ischémie chronique du coeur), une thérapie par les solutions de substitution est compétente. Le choix d'une thérapie ultérieure s'oriente vers la normalisation de résistence vasculaire périphérique, résistence périphérique globale, compliance et oxygénation du myocarde. Pour la phase „ebb" du choc, on peut recommander les vaso-dilatateurs et les calcium-bloquants, pour la phase „flow", on recommande les bêta-bloquants adrénérgiques. Dans les cas extrêmement graves, causés par l'ischémie due aux troubles métaboliques ou aux variations hémodynamiques, la nitroglycérine et ses dérivés sont pleinement à leur place. L'application des substances inotropes positives est considérée par l'auteur comme déplacée dans tous les cas. Il donne la preuve que ces substances (Dobutrex, Digoxin) sont appropriées uniquement dans les cas ou la baisse de contractibilité était objectivement prouvée.

ZUSAMMENFASSUNG

Kardiale Behandlung bei Verbrennungen von herzkranken Patienten

Szabó, K.

Der Autor beschreibt hämodynamische Veränderungen, die für einen Schock durch Verbrennungen sowie für eine Erkrankung infolge von Verbrennungen typisch sind,

und betont dabei die typischen Kennzeichen der Phasen des Schocks durch Verbrennungen („ebb" und „flow" — Ebbe und Flut). Der Autor betont zugleich, dass die Insuffizienz des Herzmuskels bei verbrannten Patienten durch Veränderungen des „preload — afterload" — Vorbelastung — Nachbelastung, durch Störungen der myokardialen „compliance" (Willfährigkeit) sowie durch Desynchronisierung der linken und rechten Kammerfunktion verursacht wird. Soweit die Betroffenen bereits vor dem Unfall (kongestive Kardiomyopathie, ischämische Herzkrankheit) an Herzkrankheit litten, ist eine Therapie mit Arsatzlösungen am Platz. Die Wahl einer weiteren Therapie beruht auf der Normalisierung der peripheren vaskulären Resistenz, der allgemeinen peripheren Reistenz, der „compliance" (Willfährigkeit) und der Oxygenisierung des Myokardiums. In der „Ebb"-Phase des Schocks kann man gefässerweiternde Mittel und Kalziumblockierende Mittel empfehlen, in der „Flow"-Phase beta-adrenergische blockierende Mittel. In äusserst schweren Fällen, hervorgerufen durch Ischämie, die durch metabolische oder hämodynamische Veränderungen verursacht wurden, sind NG und dessen Derivate am Platze. Der Autor erachtet die Anwendung positiv-iontotropischer Mittel in jedem Fall als ungeeignet und beweist, dass sie (Dobutrex, Digoxin) nur bei einem objektiven Befund verringerter Kontraktivität am Platze sind.

RESUMEN

El tratamiento cardíaco en los quemados con la enfermedad del corazón

Szabó, K.

El autor describe los cambios hemodinámicos característicos del "shock" en quemados y de la enfermedad quemadura y pone en enfásis sobre los razgos típicos de las fases del "shock" de quemados ("ebb" y "flow"). El autor también acentúa que la insuficiencia del músculo cardíaco de los enfermos quemados está debida a los cambios de "preload — afterload", a los defectos de "compliance" miocardíaca y la desincronización del ventrículo izquierdo-derecho. Si los enfermos quemados ya tenían la enfermedad del corazón antes del accidente (cardiomiopatía congestiva, enfermedad isquémica del corazón), se recomienda la terapéutica por medio de las soluciones de sustición. Después, el tratamiento depende de la normalización de la resistencia vascular, la resistencia periférica general, "compliance" y de la oxigenación del miocardio. En la fase de "ebb" del shock se recomiendan los remedios vaso-dilativos y los bloqueadores de calcio. En la fase de "flow" se recomiendan emplear los bloqueadores beta-adrenérgicos. En los casos bastante serios causados por isquemia provocada por los cambios metabólicos o hemodinámicos, se recomienda aplicar NG y sus derivados. El autor considera la aplicación de los agentes positivamente ionotrópicos en todos los casos como un procedimiento inadecuado y da prueba que éstos (Dobutrex, Digoxin) pueden ser aplicado solamente en caso de un hallazgo objectivo de la contractilidad reducida.

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EFFECTS OF CERTAIN THERAPEUTIC FACTORS ON FACIAL DEVELOPMENT IN ISOLATED CLEFT PALATE

Z. Smahel

In a previous study were investigated the effects of certain therapeutic factors, especially of the age at the time of palate surgery and of orthodontic treatment, on the development of the face in unilateral cleft lip and palate (Šmahel, in press). The aim of the present study was to determine how far the changes in the treatment of clefts effected during the first and second postwar decade in Prague acted on the development of the facial bony framework in patients with an isolated cleft palate. The changes consisted mainly in the postponement of surgery into the period of later childhood. This postponement was made in the attempt to protect the upper jaw against untoward postoperative sequelae limiting the growth of the jaw and was based on the observation of a satisfactory prominence of the maxilla in idividuals with delayed surgical repair or without any surgical treatment.

In spite of numerous studies devoted to the mentioned question, so far the effect of the age at the time of palate suture was not yet clearly defined. Our previous study was suggestive of a favourable effect of delayed palatoplasty in a complete unilateral cleft lip and palate (Šmahel, in press). The present communication deals with the effects of the age at the time of the surgical repair and of some other factors on the growth and development of the jaws in an isolated cleft palate. The purpose of this study is to compare the ascertained data with the assumed mechanisms of action of the treatment which were described in the above quoted study.

The analysis was carried out in an earlier reported series of adult males with isolated cleft palate (Šmahel, 1984). This study provided evidence of

certain differences in the expression of craniofacial deviations related to the extent of the cleft which should be respected during the subsequent analyses. Therefore we have assigned into the analysis only individuals with complete, or more extensive incomplete cleft palate and during the subdivision of the material the groups included into the comparison contained equal proportions of these cases.

MATERIAL AND METHOD

Into the present study were assigned 32 adult males with incomplete cleft palate extending up to the foramen incisivum, and 32 males with clefts involving at least one third of the hard palate, all of them were free of any associated malformations. At the time of examination the mean age amounted to 29.7 years in complete clefts and to 27.8 years in incomplete

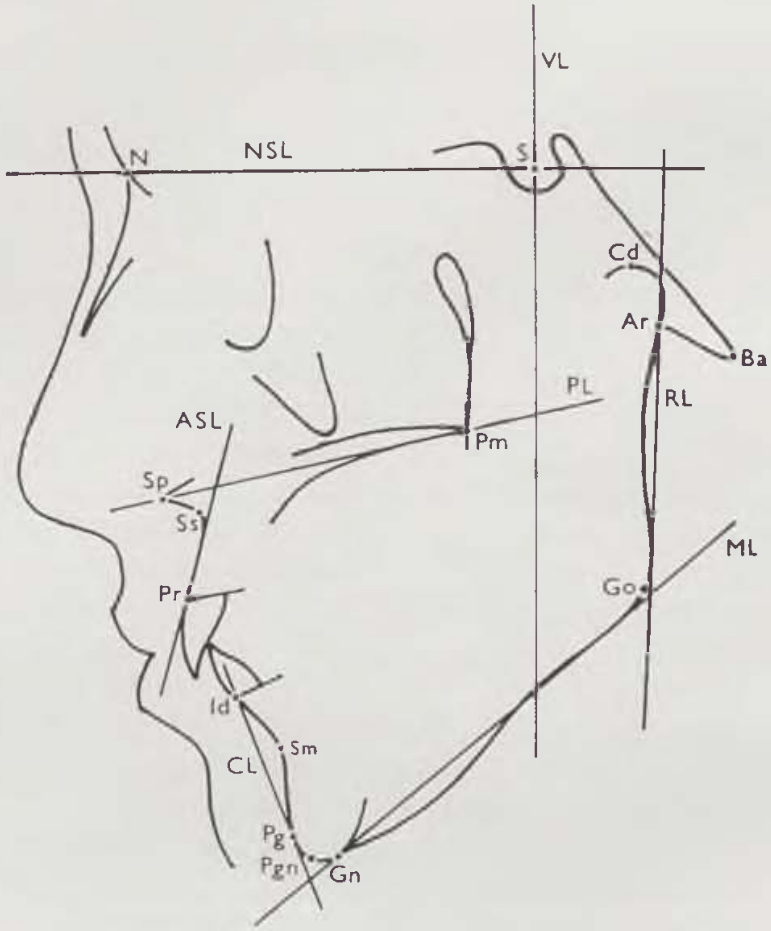

Fig. 1. Craniometric points and reference lines used in our study: NSL = line through N and S, VL = perpendicular to NSL through S, PL = line through Sp and most posterior point of the palatal processes, ML = tangent to the mandibular body through Gn, RL = tangent to the mandibular ramus through Ar, CL = line through Id and Pg, ASL = tangent to the upper alveolar process through Pr.

clefts, with their age ranging from 20 to 40 years. Primary palatoplasty was carried out between two and seven years of life and consisted of pushback mostly with pharyngeal fixation. More details were provided in our earlier study (Šmahel, 1984). A separate assessment was carried out in a group of five males ranging in age from 33 to 41 years operated upon very late, at the age between thirteen and twenty one years (mean age 15.6 years). All of them had an incomplete cleft palate which was repaired by pushback and pharyngeal fixation.

The craniometric points and reference lines are marked on figure 1 and were defined in one of our earlier studies (Šmahel, 1984). The depth of the maxilla was measured to the Pm point defined as the intersection of the palate plane with fissura pterygomaxillaris. The total number of 35 characteristics which were studied were indispensable for the construction of craniograms. According to need they were supplemented by additional characteristics (Pr-Id, RL/NSL, ASL/PL). The tables present data of all significant differences, as well as some important insignificant parameters. The perpendicular distance of a given point from the reference line is marked e.g. Pm-VL, an angle Ss-N-Sm (ANB), or as a fraction of the pertinent reference lines ML/RL. The patients were operated upon between 1944 and 1964. During this period of time the age at the time of palate surgery gradually increased from two years after the Second World War up to 6 years in the late fifties and early sixties.

The gradual subdivision of the series of individuals examined was based on three main criteria: the year of palate repair, the age at the time of surgery and the type of the occlusion of incisors. During the initial analysis the patients were subdivided into two groups, the first included individuals operated upon during the first postwar decade and the second consisted of those operated during the second postwar decade; each of these two groups included the same proportion of complete and incomplete clefts. As the dividing criterion served 1955 in complete clefts and 1956 in incomplete clefts. Since this analysis provided evidence that the growth and development of the jaws was not affected by the date of palatoplasty this parameter was not taken into account during the subsequent subdivision of our series. For the analysis of the effect of the age at the time of surgical repair were selected twenty youngest and twenty oldest patients at the time of surgery, each group included always ten individuals with a complete cleft and ten individuals with an incomplete cleft. In these groups the mean age at the time of palate surgery was 2.8 and 6.5 years resp.

During the last analysis the patients were subdivided according to the type of the occlusion of incisors. An overbite was present in a group of twenty individuals with complete clefts and eighteen individuals with incomplete clefts, the group of individuals with an anterior crossbite, or an edge to edge bite included twelve and fourteen individuals resp. The aim of this analysis was to identify those craniofacial parameters which contributed to the development of malocclusion of incisors. All differences were tested with the t-test.

RESULTS

We failed to disclose any significant differences (Tab. 1, Fig. 2) in the configuration of the face which could be related to the period during which

Tab. 1. Mean X-ray cephalometric values in adult males with isolated cleft palate operated upon during the first and second postwar decade or at an early and late childhood

Variable	I decade	II decade	Early	Late
Ss-Pm	49,10	47,94	47,45	47,30
S-N-Ss	77,70	76,29	78,10	76,55
S-N-Pr	78,77	77,82	79,35	77,85
S-N-Id	78,67	77,18	79,55	77,35
S-N-Sm	77,40	75,62	78,50*	75,60
S-N-Pg	79,47	77,71	80,75*	77,65
Ss-N-Sm	0,30	0,69	–0,40	0,95
ML/NSL	36,10	36,24	34,35	37,35
RL/NSL	86,13	88,53	84,40*	88,85
Cd-NSL	23,03	19,00	20,60	19,05
n	30	34	20	20

* = significant differences between individuals with early and late operations at $p<0,05$

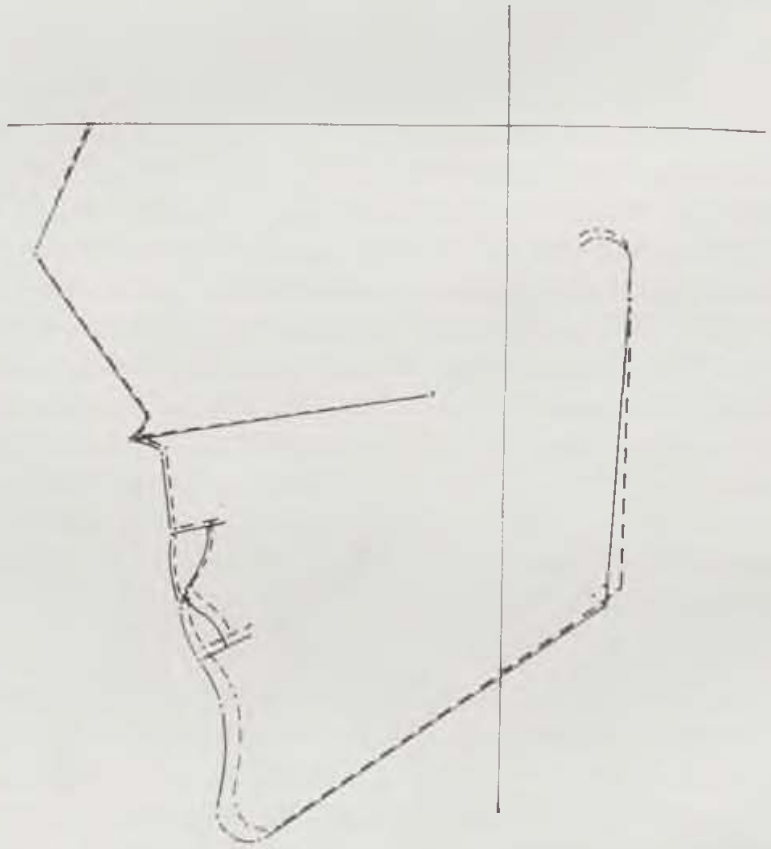

Fig. 2. Faciograms in adult males with isolated cleft palate operated upon during the first (full line) or second (dashed line) postwar decade.

the patients were operated. The deviation in the position of the lower jaw did not attain the 10 % significance level (S-N-Pg) and it was very small with regard to the position of the upper jaw (Ss-N-Sm). The results showed equally only a very slight effect of the age at the time of surgery, since individuals operated upon during the 2nd postwar decade were older (5.8 years), than those treated by surgery in the 1st decade (3.8 years).

Even in a difference of four years the effects of the age at the time of surgery resulted only in small differences (Tab.1, Fig. 3). Individuals operated upon at the mean age of six and half year had a more marked retroposition of the mandible (S-N-Sm, S-N-Pg), with a steeper slope of the ramus (RL/NSL), as compared to the patients operated upon at a younger age (2.8 years). We failed to disclose any other significant differences. The maxillary depth was identical (Ss-Pm) in both groups, the protrusion (S-N-Ss) was slightly superior in individuals with earlier surgical repair, while on the contrary due to the more marked retroposition of the mandible the sagittal jaw relations (Ss-N-Sm) were more favourable in children with delayed operations.

Five patients operated upon during or after puberty had a normal protrusion of both jaws (S-N-Ss, S-N-Pg) and the sagittal jaw relations were equally consistent with those in controls (Tab. 2, Fig. 4). However the depth of the

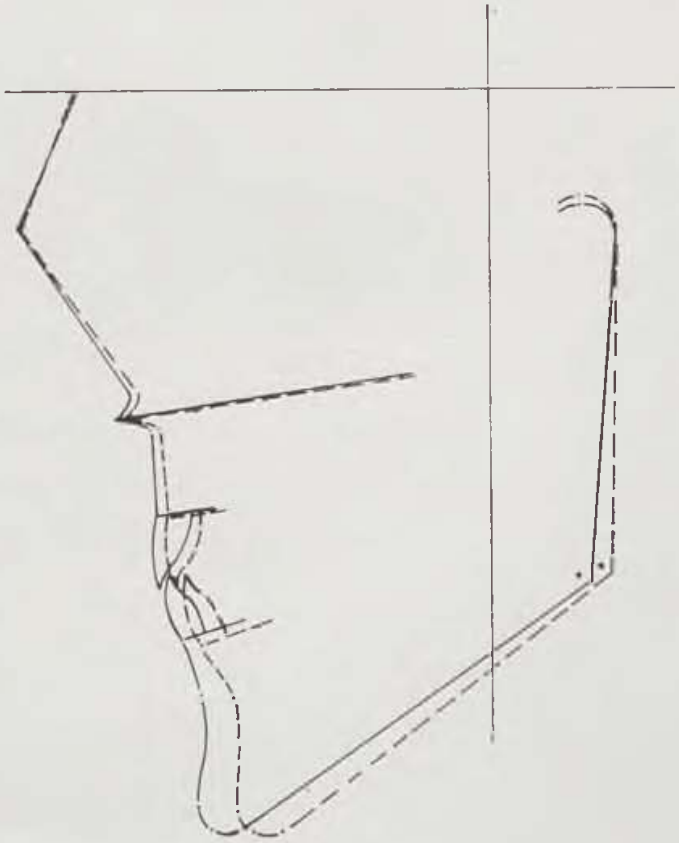

Fig. 3. Faciograms in adult males with isolated cleft palate operated upon during childhood at earlier (full line) or later (dashed line) age.

Tab. 2. Mean values in adult males with incomplete isolated cleft palate operated upon during early childhood (CP_i) and during adolescence (CP_{i15}) as compared to controls

Linear	CP_{i15}	CP_i	Control	Angle	CP_{i15}	CP_i	Control
N-S	73,00	73,91	75,04	N-S-Ba	129,60	131,22	132,16
N-Sp	60,80!!	57,81	57,14	S-N-Ss	80,40?	76,72***	80,68
N-Gn	136,60!	134,28*	130,16	S-N-Sm	78,40?	75,91*	78,20
Pm-NSL	50,80!!	48,28	48,86	S-N-Pg	80,60?	77,84*	79,84
Sp-Pg	70,40!	71,59**	67,66	Ss-N-Sm	2,00?	0,81**	2,48
Ss-Pm	49,20!	48,88***	53,08	ML/NSL	35,80!	37,13***	30,06
Pm-VL	13,40	12,31	13,46	RL/NSL	86,00	87,44	88,16
Pgn-Go	79,40?	76,41**	78,96	ML/PL	26,80!	27,63***	22,04
Cd-Go	64,40!	65,03*	67,42	ML/RL	129,80!	129,59***	121,96
Id-Gn	36,20	35,09	34,50	CL/ML	62,60!	63,63***	70,76
Cd-NSL	23,20!!	19,28	19,16	n	5	32	50

! different from controls, similar to CP_i
!! different from both controls and CP_i
? different from CP_i. similar to controls
* significant difference from controls at $p<0,05$ (**$p<0.01$. ***$p<0,001$)

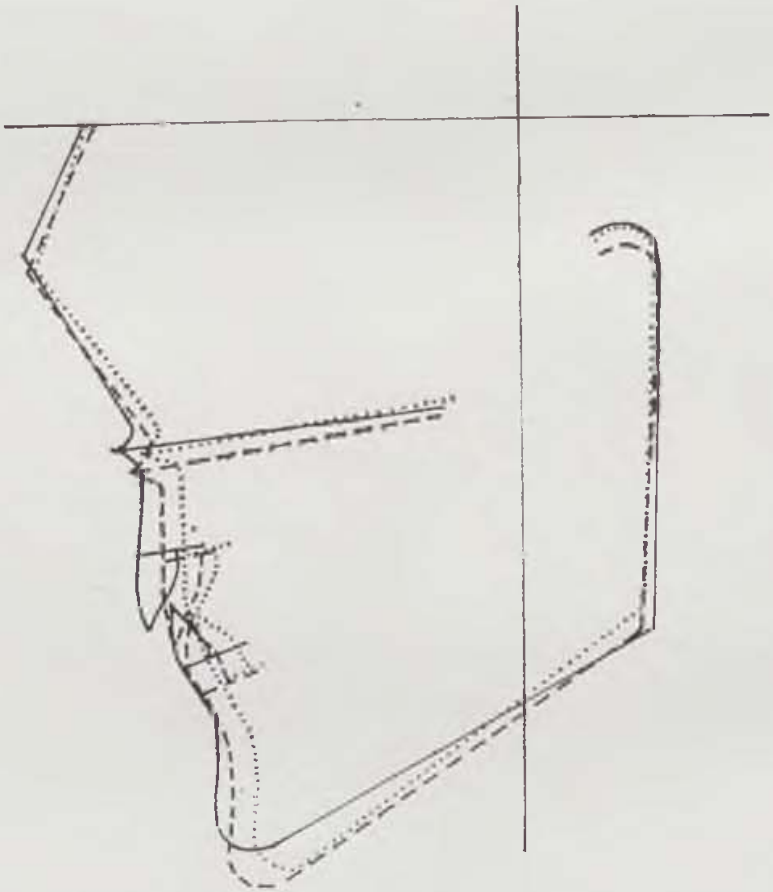

Fig. 4. Faciograms in adult males with incomplete isolated cleft palate operated upon during early childhood (dotted line) and during adolescence (dashed line) as compared to controls (full line).

maxilla (Ss-Pm) was shorter similarly as in patients operated upon during childhood. Since the position of the maxilla in relation to the cranial base (Pm-VL) was not changed an adequate protrusion of the jaw was due to the shortening of the anterior part of the cranial base (N-S). Vertical dimensions of the upper face (N-Sp, Pm-NSL) were increased both with regard to controls and to clefts, similarly as the dimension Cd-NSL. However with the exception of the longer mandibular body (Pgn-Go) the characteristics of the lower jaw reflected exactly the situation which is typical for cleft palate (Cd-Go, ML/NSL, ML/RL, CL/ML, ML/PL).

Patients with an anterior crossbite or an edge to edge bite (Tab. 3, Fig. 5) had a reduced inclination of the upper alveolar process (ASL/PL) as compared to individuals with an overbite. This malocclusion resulted in an increase of the anterior dental height (Pr-Id) and thus in a slight prolongation of the face (N-Gn, $p<0.1$), a steeper slope of the mandibular body (ML/NSL $p<0.1$) and a more obtuse gonial angle (ML/RL). There were no differences between the protrusion and length of both jaws or any other facial parameters in individuals with and without an overbite.

Tab. 3. Mean values in adult males with isolated cleft palate subdivided according to the occlusion of incisors

Variable	Overbite	Crossbite	Variable	Overbite	Crossbite
ASL/PL	107,29*	102,15	Pr-Id	22,08**	24,00
ASL/PL_c	106,85	101,50	N-Gn	131,66	134,85
ASL/PL_i	107,78	102,71	Ss-Pm	48,95	47,81
ML/RL	126,50**	131,88	S-N-Ss	77,18	76,62
ML/NSL	34,63	38,42	S-N-Pg	78,45	78,65
n	38	26	Ss-N-Sm	0,94	–0,15

* = significant differences between individuals with overbite and anterior crossbite at $p<0,05$ (**$p<0,01$)
c = complete clefts i = incomplete clefts

DISCUSSION

In contrast to unilateral cleft lip and palate (Šmahel, in press) in the isolated cleft palate no improvement of the sagittal jaw relations and of the facial convexity was recorded in the second postwar decade as compared to the first postwar period. However the improvement attained in individuals with cleft lip and palate was due exclusively to the retroposition of the mandible produced by a more intense orthodontic therapy leading to the restoration of overbite (Šmahel, in press). This treatment was provided at a specialized orthodontic centre attached to the Department for Plastic Surgery in Prague which was founded in 1957. Since overbite is recorded usually in isolated cleft palate, the mechanism by which restored overbite attains a retroposition of the mandible does not operate in this type of cleft. An improvement of the

anterior growth of the upper jaw, however, was not observed both in CP and UCLP. Removable orthodontic appliances, which were used exclusively during the above mentioned period did not change the anteroposterior position of the maxilla. The comparison of both series showed that the effects of orthodontic therapy on facial development were related to a large degree to the initial and final occlusion of incisors.

In a previous study we have recorded in individuals with unilateral cleft lip and palate operated upon at a later age an improvement of the anterior growth of the upper jaw, as compared to individuals operated at an younger age, though this hold true only in patients with complete clefts (Šmahel, in press). We failed to disclose any similar differences in isolated cleft palate. There was again evidence of a retroposition of the lower jaw in individuals operated upon in later childhood and simultaneously during a more recent period of time. The difference was already above the significance level, which was due also to the small difference in the retrusion of the maxilla (Fig. 3). In the following it will be shown that in a maintained overbite the retroposition of the mandible is related to the retrusion of the upper jaw.

The global results showed that in an isolated cleft palate during the investigated period of time the age at the time of surgical repair exerted no

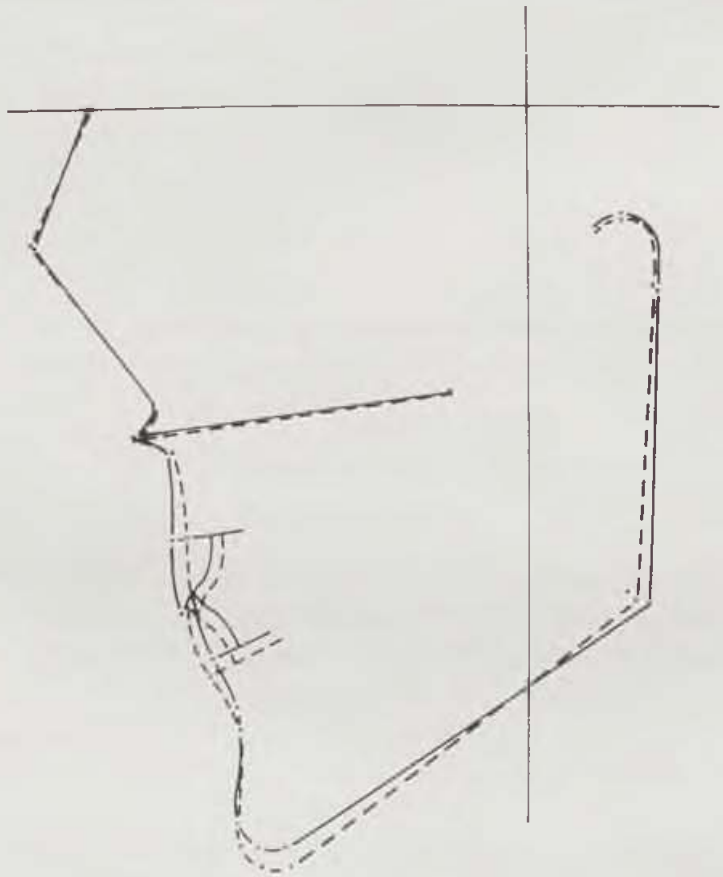

Fig. 5. Faciograms in adult males with isolated cleft palate with (full line) or without (dashed line) overbite.

marked effects on the subsequent growth of the jaws. Because of the observed effects of the age at the time of surgery on the growth in cleft lip and palate (Ortiz-Monasterio, 1974; Gnoinski, 1982; Šmahel, in press) it would appear worth-while to determine the age of choice for the surgical repair of the palate according to the type of cleft. In an isolated cleft palate the suture would be indicated at an earlier age. Further, it is justified to assume that the smaller the extent of the cleft, the slighter are the effects of secondary postoperative factors on the subsequent growth of the jaws (Šmahel, in press), and the smaller is the effect of age at the time of surgery. This holds true for palatal surgical repairs carried out in one or in two stages.

Yet, an improvement of the depth of the maxilla was not observed in patients operated upon as late as during adolescence. We consider this parameter more important for the assessment of the results than the degree of maxillary protrusion, which could be influenced by some other characteristics (by the length of the anterior cranial base N-S, or by the position of the maxilla as a whole Pm-VL). However, during the assessment is of least value the angle of the sagittal jaw relations, as documents the following analysis. The patients with isolated cleft palate were subdivided in three and into five groups according to the degree of maxillary retrusion (S-N-Ss). The graphical illustrations of the classification into three categories (Fig. 6) shows that during a persisting overbite the increasing retrusion of the maxilla leads to a retrusion of the mandible and the sagittal jaw relations remain unchanged. This observation is confirmed by the classification into five categories, in spite of the smaller numbers of cases in each category (Tab. 4). The angle

Tab. 4. Mean values of Ss-N-Sm (ANB) angle in categories subdivided according to the degree of maxillary retrusion (S-N-Ss; on the left subdivision into three grades, on the right into five grades)

S-N-Ss	ANB	n	S-N-Ss	ANB	n
82,38	1,52	21	84,09	1,73	11
77,05	–0,05	21	80,00	1,27	15
71,64	0,00	22	76,85	–0,08	13
			73,67	0,08	12
			70,46	–0,54	13

of the sagittal jaw relations was larger only in a more marked protrusion of the maxilla (Ss-N-Sm), in all other situations it varied around zero values. These results confirm that overbite represents a highly effective mechanism exerting favourable effects on the position of the lower jaw and on the configuration of the profile in individuals with clefts (Šmahel, in press).

A group of five available patients with an isolated cleft palate operated upon as late as in their teens is too small and the findings could be biased by the accidental composition of the series examined. This is illustrated by

some dimensions (Tab. 2). However the results obtained confirmed the deficient growth of the maxillary depth, even in the presence of a satisfactory prominence of the upper jaw and of normal values of the sagittal jaw relations, which could lead to an erroneous conclusion that the growth of the jaw was unchanged. Our findings are suggestive of the role played by the primary impairment of maxillary growth potential. Dahl (1970) also failed to disclose any difference of the depth and retrusion of the upper jaw in adult males affected by cleft palate with and without palatoplasty. In agreement with the assumption of a primary impairment of growth we have observed a shorter maxilla prior to palate surgery, though the difference was much smaller than in adults (Šmahel et al., 1987). Growth deficiency during the postoperative period could also represent late sequellae of the primary damage, and thus was not necessarily due to secondary untoward postoperative factors alone. However, at the present time it is not possible to provide a clear definition on the relative part played by these two factors.

The last analysis showed that anterior crossbite develops predominantly in individuals with a slighter proclination of the alveolar process of the maxilla (Fig. 5). The effect of this characteristic is confirmed by the regularity of this finding both in complete and incomplete clefts (Tab. 4). Other possible causes

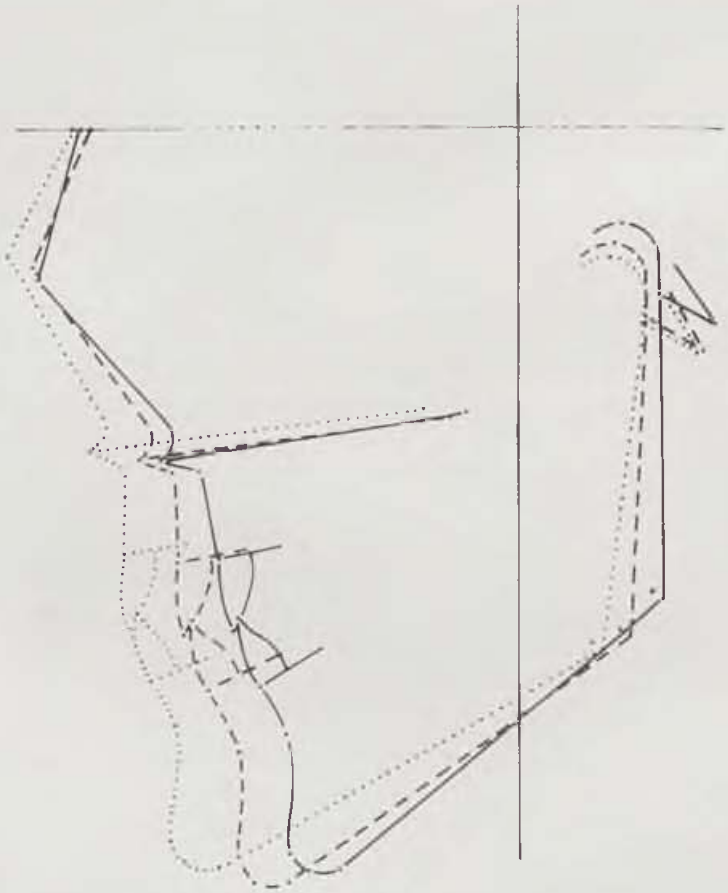

Fig. 6. Faciograms in adult males with isolated cleft palate subdivided into three categories according to the degree of maxillary retrusion.

are less common and thus cannot be reflected by the mean values of investigated characteristics, inclusive of the shortening of the upper jaw. Figure 6 confirms that the retrusion of the maxilla is not an essential prerequisite for the development of an anterior crossbite. Thus the high risk of the development of this malocclusion is present, predominantly, in individuals with a reduced inclination of the upper alveolar process. Therefore it appears mandatory to include the degree of alveolar inclination among the parameters used for the prediction of the development of this malocclusion. Since neither the mean values nor the variance of this characteristic in individuals with isolated cleft palate differed from those in controls, they represented values which were reduced within the range of normal variability. There were no differences in the inclination of the upper incisors (ISL/PL) between the two groups, which was due obviously to the effect of orthodontic treatment.

We failed to disclose in the literature available a report dealing with the same problem in individuals with isolated cleft palate. Some similar studies in patients with cleft lip and palate were discussed in a previous paper (Smahel, in press).

SUMMARY

Roentgencephalometry was used during the investigation of the effects of some therapeutic factors on the growth and development of the jaws in 64 adult males with an isolated cleft palate repaired by pushback. The anterior growth of the maxilla was not related to the age at the time of surgery or to orthodontic therapy with removable appliances. A small number of individuals operated during adolescence had also a shorter depth of the maxilla similarly as patients operated upon during early childhood. Anterior crossbite developed mostly in patients with reduced proclination of the upper alveolar process, while, on the contrary, a retrusion of the maxilla played no essential part. This observation proves useful for the prediction of the development of this malocclusion. The angle of sagittal jaw relations does not represent necessarily a valid criterion of the development of the jaws. In the presence of an overbite retrusion of the maxilla is associated with a retroposition of the mandible and thus the angle of sagittal jaw relations remains unchanged. Thus overbite represents an effective mechanism acting on the position of the mandible. A differentiated approach for the determination of the age of choice at the time of palate surgery according to the type and extent of the cleft is proposed.

RÉSUMÉ

L'influence de quelques facteurs thérapeutiques sur l'évolution de splanchnocranium chez la fente palatine isolée

Šmahel, Z.

Par les examens radiocéphalométriques on a suivi l'influence de quelques facteurs thérapeutiques sur la croissance et l'évolution des maxillaires chez 64 hommes adultes

avec une fente palatine isolée qui ont été opérés par suture et rétroposition. La croissance antérieure du maxillaire supérieur ne présentait pas de dépendance de l'âge opératoire et de thérapie orthodontique, effectuée par les appareils amovibles. Aussi dans un groupe peu nombreux de sujets opérés à l'âge adulte, on a constaté la profondeur du maxillaire supérieure raccourcie de la même façon que chez les patients opérés en basse enfance. L'occlusion inverse s'est dáveloppé nottament chez les patients avec l'inclinaison amoindrie de l'arcade alvéolaire supérieure, alors que la rétroussion du maxillaire supérieur ne représentait pes un facteur déterminant. Ces observations peuvent être utilisées dans les pronostics des malocclusions. L'angle des relations sagittales des deux maxillaires n'est pas toujours un critère valide pour l'évolution des maxillaires. La supraclusion étant conervée,le maxillaire inférieur occupe une position postérieure, même si le maxillaire supérieur est en retroussion, et l'angle des relations sagittales des maxillaires n'est pas changé. De cette manière, la supraclusion sert comme mécanisme d'influence sur la position du maxillaire inférieur. Les auteurs font remarquer que l'indication de l'âge opératoire favorable à l'intervention du palais nécessite un accès individualisé, selon le type et l'étendue de la fente.

ZUSAMMENFASSUNG

Der Einfluss einiger Therapiefaktoren auf die Entwicklung von Splanchnokrania bei einer isolierten Gaumenspaltung

Šmahel, Z.

Roentgenkephalometrisch wurde der Einfluss einiger Therapiefaktoren auf das Wachstum und die Entwicklung der Kiefer bei 64 erwachsenen Männern mit isolierter Gaumenspaltung beobachtet, die mit Sutura und Retroposition operiert worden waren. Das anteriore Wachstum der Maxilla zeigte keine Abhängigkeit vom Alter des operierten Patienten und der orthodontischen Therapie mittels Abnahmeapparturen. Auch eine kleinere Gruppe von Patienten, die erst im Alter des Heranreifens operiert wurden, wies eine verkürzte Tiefe der Maxilla auf, ebenso wie die in ihrer frühen Kindheit operierten Patienten. Ein umgekehrter Biss entwickelte sich vor allem bei Patienten mit verringerter Inklination des oberen Alveolarauslaufers, während die Retrusion der Maxilla keinen entscheidenden Faktor darstellte. Dieser Befund kann bei der Voraussage einer Entstehung einer Störung des Bisses ausgenutzt werden. Der Winkel der segitalen Beziehungen zwischen den Kiefern ist nicht immer ein gültiges Kriterium der Kieferentwicklung. Bei aufrechterhaltenem Biss ist der Unterkiefer auch bei einer ausgesprägten Retrusion der Maxilla posterior verschoben, und der Winkel der sagitalen Beziehungen zwischen den Kiefern ändert sich damit nicht. Der Biss ist so ein wirksamer Mechanismus zur Beeinflussung der Position der Mandibula. Es wird ein differenzierter Zutritt zur Bestimmung des geeignetesten Alters einer Gaumenoperation je nach dem Typ und dem Umfang der Spaltung vorgeschlagen.

RESUMEN

Influencia de algunos factores de la terapéutica sobre el desarrollo del esplacnocráneo en la hendidura aislada del paladar

Šmahel, Z.

De los aspectos radiográficos y cefalométricos fué observado el efecto de algunos factores terapéuticos sobre el crecimiento y desarrollo de la mandíbula en 64 hombres

con la hendidura aislada del paladar quienes fueron operados por medio de la sutura y retroposición. El crecimiento anterior de la maxila ni indicó dependencia sobre la edad, en la cual la operación se realizó, ni sobre la terapéutica ortondótica efectuada por medio de los aparatos amovibles. También un grupo menor de los enfermos operados hasta la adolescencia tuvieron la hondura maxilar reducida tanto como los pacientes operados muy temprano en la infancia. La oclusión invertida se desarrolló, en primer lugar, en los pacientes con la inclinación reducidada la protuberancia alveolar superior, mientras que la retrusión maxilar no fué un factor decisivo. Este hallazgo puede ser utilizado como pronóstico de maloclusión. El ángulo de las relaciones intermaxilares sagitales no es siempre un criterio válido del desarrollo de la mandíbula. En la protrusión maxilar preservada, la mandíbula, aun cuando con una retrusión significante de la maxila, está situada posteriomente y así el ángulo de las relaciones intermaxilares sagitales no indica cambios. De esta manera la protrusión de la maxila está un mecanismo eficaz ue influye la posición de la mandíbula. Se propone que la operación del paladar sea ejecutada con respecto a la edad más conveniente según el tipo y extensión de la fisura.

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CEPHALOMETRIC ANALYSIS OF REVERSE OVERJET IN PATIENTS WITH TOTAL UNILATERAL CLEFT LIP AND PALATE

I. Procházková, Ž. Müllerová

One of the most significant changes in facial skeleton in patients with cleft lip and palate is reverse overjet. It is due to an insufficient sagittal growth of the maxilla following surgery of the palate. The defect is often accompanied by dentoalveolar compression in the upper jaw and a cross bite in the lateral segments. Unlike the true prognathia, the lower jaw is not enlarged.

In a preliminary analysis of 718 patients with cleft lip and palate, no differences were found in the incidence of reverse overjet between patients born in 1950 — 1960, when a consistent follow-up of these affected persons was initiated, and those born in 1960—1970 who were given a proper orthodontical care. In the first decade, reverse overjet, registered prior to orthodontical treatment by fixed appliances, occurred in 32 % (out of 361 patients), during the second decade in 32.5 % (out of 357 cases). The occurrence of reverse overjet seems to be primarily due to more severe morphological anomalies of the maxilla, whose orthodontical treatment can be hardly influenced with removable appliances. The aim of our study was to test this hypothesis and to find out which structures of the splanchnocranium are responsible for the incidence of reverse overjet.

MATERIALS AND METHODS

The group under study included a random selection of 30 boys, aged 12 to 15, with complete unilateral cleft lip and palate with reverse overjet, i.e. by the time reverse overjet had been well developed. The control group comprised 30 age-matched persons with the same cleft type without reverse overjet. In all cases, each patient with reverse overjet was matched against the same person of identical age without reverse overjet.

All patients underwent the same type of surgery without primary osteoplasty or periosteoplasty, the lip being operated on according to Tennison at approximately eight months of age, the palate by means of retroposition with pharyngofixation at the age of 4—5 years. The X-ray pictures were taken in central occlusion, under standard conditions, with the patient's head fixed in the cephalostat.

The measurements made in the pictures involved 65 characteristics of the splanchnocranium and of the soft facial profile. The cephalometric points are shown in Fig. 1, reference lines in Fig. 2.

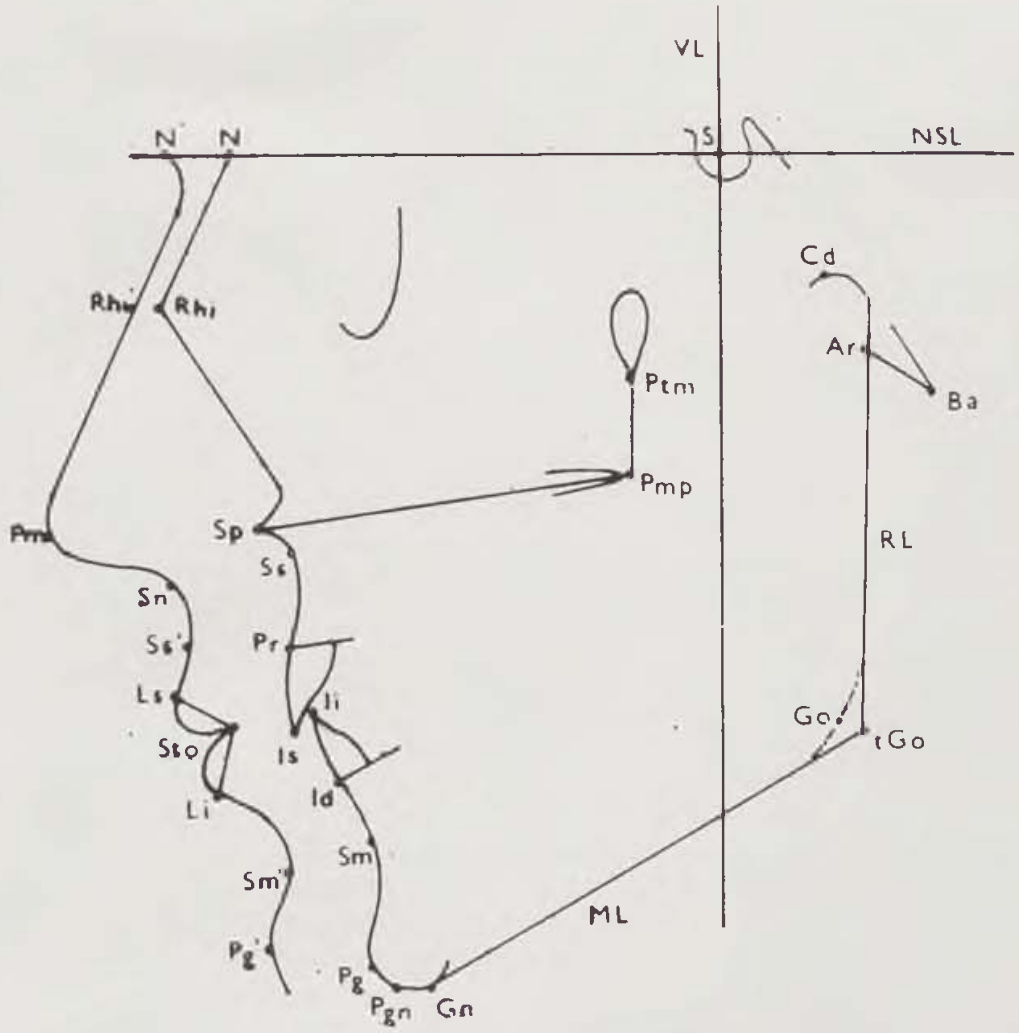

Fig. 1. Cephalometric points used for assessing lateral pictures

The linear dimensions were marked in the usual manner (Ss — Pmp), the perpendicular distance from the reference line with Pmp — NSL, and the angle with a three-element symbol (S-N-Sm) or as a fraction of the corresponding reference lines, for example, with CL/ML. The overbite was measured as a projection distance between the edges of the upper and lower

incisors vertical to the occlusion plane. The overjet was measured between the above mentioned points parallel with the occlusion plane. To indicate the inclination of the upper incisors to the cranial base, the abbreviation I_u/NSL is used in the Table, while the lower incisor in-

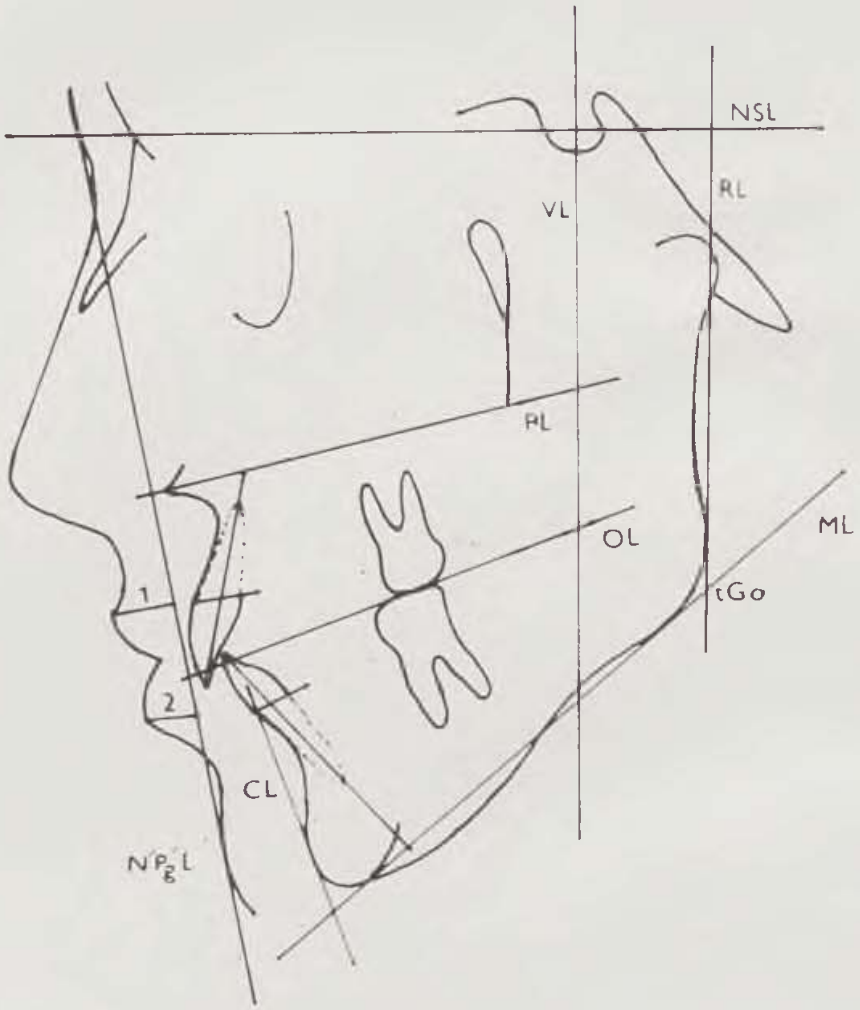

Fig. 2. Reference lines constructed on lateral pictures
NSL = line interesecting points N and S, VL = line normal to NSL running through point S, PL = line running through the frontal and posteior nasal spine, CL = line intersecting points Pg and Id, ML = tangent to the mandibular body intersecting point Gn, RL = tangent to the mandibular ramus intersecting point Ar, OL = line running in the midle of the distance between Is and Ii and the apex of the interbuccal cusp of the first upper molar, N'Pg'L = line intersecting points N' and Pg', 1 = Ls — N'Pg'L, 2 = Li — N'Pg'L, tGo = gonial anóle tangent

clination to the mandibular corpus is given as I^1/ML. The upper lip prominence was determined by the differences between Ls — N'Pg'L and Li — N'Pg'L characteristics (in Fig. 2 designated as LS ⊥ Li). The facial rotation was evaluated according to the proportion of the anterior and posterior facial height (S — Go X 100 : N — Gn).

The measured data served for the calculation of the basic statistical characteristics, and the differences between the mean values were tested with the t-test in each group.

Tab. 1. Basic statistical data and significance levels

Characteristics	Reverse overjet		Control		Dif.	t	p
	x	sx̄	x̄	sx̄			
Ss-Pmp	43,53	0,56	46,90	0,80	–3,37	3,45	0,001
Ii-Gn	45,30	0,61	43,46	0,60	1,84	2,15	0,05
S-Ar	35,53	0,51	33,63	0,67	1,90	2,23	0,05
S-N-Sm	76,66	0,73	73,10	0,60	3,56	3,75	0,001
S-N-Id	77,96	0,71	74,46	0,62	3,50	3,69	0,001
S-N-Pg	77,40	0,74	74,90	0,62	2,50	2,58	0,02
N-tGo-Gn	79,00	0,84	75,03	1,65	3,97	2,13	0,05
N-Ss-Pg	186,76	1,71	181,76	1,05	5,00	2,50	0,02
Ss-N-Sm	–2,90	0,56	–1,63	0,52	–4,53	5,86	0,001
Overbite	–3,66	0,62	–1,90	0,29	–1,76	2.54	0,02
Overjet	–4,83	0,44	1,66	1,80	–6,49	8,75	0,001
I_u/NSL	96,16	1,06	92,93	0,93	3,23	2,28	0,05
S-N′-Sm′	78,26	0,67	75,36	0,59	2,90	3,22	0,005
S-N′-Pg′	80,03	0,71	77,01	0,56	3,02	3,33	0,002
Ss′-N′-Sm′	2,10	0,43	5,53	0,51	–3,43	4,83	0,001
Ls ⊥ Li	–2,40	0,58	1,53	0,39	–3,93	5,57	0,001

Appendix: other measured non-significant characteristics:
S-N. S-Ba. N-Rhi. N-Sp. N-Ss. N-Pr. N-Gn. Sp-IS. Id-Gn. Sm-Gn. Sp-Pg. Sp-Pmp. S-Go. S-Pgn. Cd-Go. Pgn-Go. Pmp-NSL. N-S-Ba. N-S-Cd. N-S-Ar. N-S-Pgn. S-N-Rhi. S-N-Sp. S-N-Ss. S-N-Pr. S-N-Gn. Ar-tGo-N. VL/ML. OL/ML. RL/NSL. CL/ML. I_l/ML. PL/ML. S-N′-Ss′. N′-Prn. N′Sn. N′Ss′. N′-sto. N′-Pg′. Prn—Sp. Prn-Sn. Sn-Ls. Li-Sm′. N-N′. Rhi-Rhi′ Ls-N′Pg′l. Li-N′Pg′L. Sto-N′Pg′L,

RESULTS

The results are summarized in Table 1. We indicated only those variables which showed a significant difference between the two groups. Other measured characteristics are indicated in the appendix. Some parametres are shown mainly with regard to their constructional siginificance (Fig. 3).

The maxillary depth (Ss-PmP) in patients with reverse overjet compared to that found in persons without it is reduced, though non-significantly, during measurement with regard to the anterior nasal spine (Sp-PmP). Equally, the same maxillary retrusion (S-N-Ss) is not significantly greater than in patients without reverse overjet. On the other hand, a great deviation is seen in the position of the mandible which, in reverse overjet, is extended anteriorly (S-N-Sm, S-N-Id, S-N-Pg). Thus the lower part of the gonial angle (N-tGo-Gn) becomes slightly flattened. The mandible size is unchanged, the length of the corpus (Pgn-Co) and of the ramus (Cd-Go) are identical in both groups.

Due to the mandibular overjet, the patients with reverse overjet suffer from extensive disorder of the sagittal intermaxillary relations (Ss-N-Sm) and of a flattened skeletal facial profile (N-Ss-Pg). Significant differences were seen in the overbite, especially in the overjet, a reverse occlusion being typical of persons with reverse overjet. A greater inclination of the upper incisors (I_u/NSL) found in these patients may be the outcome of too intensive orthodontic therapy used for attaining overbite. The changes in the soft facial profile correspond to the skeletal deviations (S-N'-Ss', S-N'-Pg') associated with the disorder of the sagittal relationship between the upper and lower parts of the face (Ss'-N'-Sm').

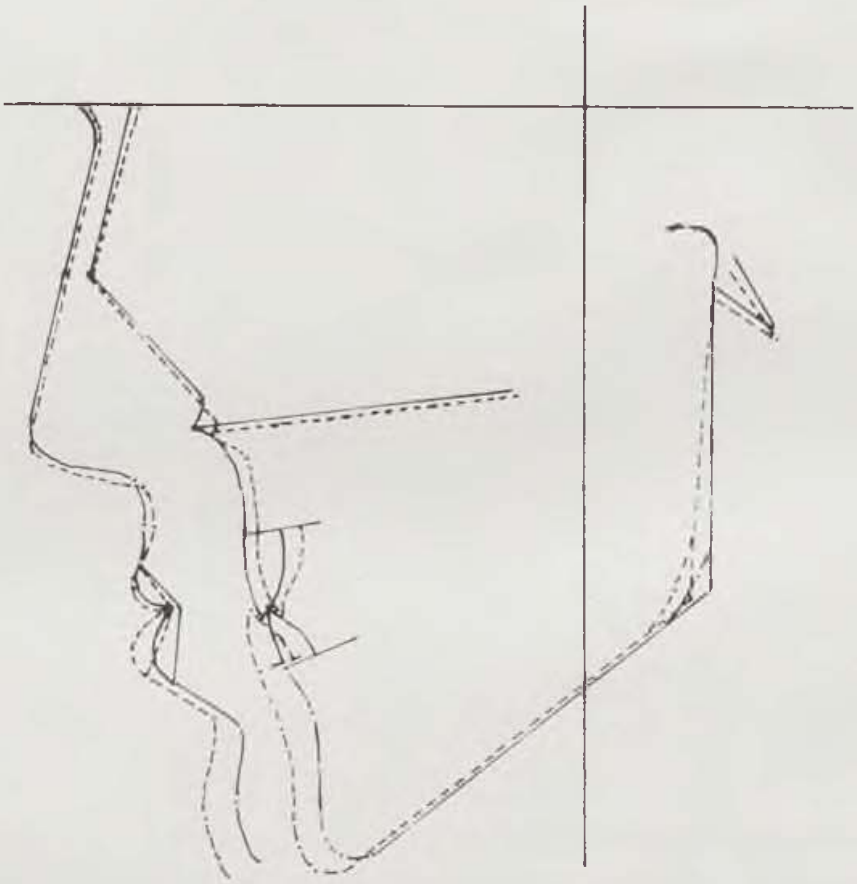

Fig. 3. Final cephalogram of patients with reverse overjet (dashed line) and without reverse overjet (solid line)

Patients with reverse overjet have a significantly less prominent upper lip which is in the retrocheilial position (Ls ⊥ Li). A slight enlargement of the anterior mandibular height (Ii-Gn) and an extension of the distance S-Ar are of no significance with regard to this study. These deviations do not correspond to the difference in the height of the mandibular symphysis (Id-Gn) or to the position of the mandibular joint (N-S-Cd, N-S-Ar).

DISCUSSION

Our investigations showed that maxillary retrusion in patients with reverse overjet is not significantly greater than that found in persons without reverse overjet. The deviation is more frequently caused by a mandibular overjet. The findings indicate that this occurs in situations when overbite was not achieved, which prevents the jaw to move anteriorly. This is confirmed by the size of the lower jaw identical in both groups and by the morphological mandibular changes in cases of reverse overjet, such as the flattening of the lower part of the gonial angle (N-tGo-Gn) and the deviation in the inclination of the ramus (RL/NSL $p<0.1$). This view wash commonly held by some specialists before World War II (Korkhaus, 1939) but was abandoned later on.

The position of the mandibular joint and facial rotation remained unchanged. The mean values of the posterior and anterior facial heights ratio was in accordance with the neutral growth type.

With the exception of the characteristics associated with mandibular overjet, the patients with reverse overjet did not show any significant difference in splanchnocranial morphology in comparison with those without reverse overjet. The same conclusions were reached by Guyer (1986) whose investigation centered on healthy population.

Our conclusions show that due to failure to reach overbite, the anterior teeth region results in an overjet and subsequent morphological changes in the mandible (Šmahel, in press). Similar changes were found in our group of patients with reverse overjet. These changes are closely associated with other deviations of the skeletal and soft facial profile. Therefore, it is necessary to begin with consistent orhtodontic therapy as soon as possible to reach overbite in the anterior teeth region and to decrease the possibility of the defect. Delayed treatment of patients with reverse overjet brings about problems, and the later it is commenced and the more reverse overjet is developed, the less the chance of success it has (Müllerová et al., 1974).

SUMMARY

The study presents a craniometric analysis of facial morphology in patients with complete unilateral cleft lip and palate with reverse overjet well developed. The aim was to find out which structures are responsible for the incidence of reverse overjet. Examined were: 30 patients, aged 12—15, with this affection and 30 age-matched persons with the same type of cleft defect but without reverse overjet. The findings showed that in most cases reverse overjet in clefts is not caused by any greater maxillary retrusion than that found in patients without reverse overjet but by mandibular overjet. An analysis of data confirmed that the overjet is due to the loss of overbite and its non-restoration.

With regard to medical practice, immediately after the permanent teeth eruption, it is advisable to restore the overbite in the anterior teeth in order to prevent the development of reverse overjet.

RÉSUMÉ

Analyse céphalométrique de la pseudoprogénie chez les patients présentant la fente labio-palatine totale

Procházková, I., Müllerová, Ž.

L'étude est fondée sur l'analyse craniométrique de la formation du visage des patients présentant la fente labiopalatine unilatérale totale, chez lesquels la pseudoprogénie s'est développée.

Le but était de vérifier quelles structures ont été responsables de la création de pseudoprogénie. On a examiné 30 patients ainsi atteints, âgés de 12 à 15 ans, et 30 sujets de même âge et du même type de la fente sans pseudoprogénie. Les observations ont mis en évidence que la pseudoprogénie chez les fentes n'était pas due, en majorité des cas, au retroussement du maxillaire supérieur plus exprimé que chez les sujets sans pseudoprogénie, mais qu'elle résultait d'une propulsion du maxillaire inférieur. L'analyse a fait preuve que la protrusion était due à la perte et au non-renouvellement de la supraclusion.

Du tout ce qui a été introduit résulte une prétention pratique de renouveler la supraclusion dans la partie frontale de la denture le plus tôt possible après l'éruption des incisives définitives, ce qui pourrait empêcher l'évolution de la pseudoprogénie.

ZUSAMMENFASSUNG

Kephaloelektrische Analyse einer Pseudoprogenie bei Patienten mit vollkommener einseitiger Spaltung der Lippe und des Gaumens

Procházková, I., Müllerová, Ž.

Die Studie befasst sich mit der kraniometrischen Analyse der Ausbildung des Gesichts bei Patienten mit vollkommener einseitiger Spaltung der Lippe und des Gaumens, bei denen sich Pseudoprogenie entsickelt hat. Das Ziel war es festzustellen, welche Strukturen für die Entstehung der Pseudoprogenie verantwortlich sind. Untersucht wurden 30 derart betroffene Patienten im Alter von 12 bis 15 Jahren sowie 30 ebenso alte Personen mit dem gleichen Typ einer Spaltung, jedoch ohne Pseudoprogenie. Die Befunde zeigten, dass die Pseudoprogenie bei Spaltungsdefekten in den meisten Fällen nicht von einer ausgerpägteren Retrussion des Oberkiefers verursacht wird, als man bei den Patienten ohne Pseudoprogenie findet, sondern von einem Vorschieben des Unterkiefers. Die Datenanalyse hat gezeigt, dass das Vorschieben durch einen Verlust und Nichtwiedererneuerung des Bisses verursacht wird.

Aus den angeführten Befunden ergibt sich die praktische Forderung, so bald wie möglich nach dem Durchkommen der ständigen Schneidezähne den Biss im frontalen Abschnitt des Gebisses zu erneuern, was der Entwicklung einer Pseudoprogenie vorbeugen kann.

RESUMEN

Análisis cefalométrico de pseudoprognatismo en pacientes con la fisura unilateral total del labio y paladar

Procházková, I., Müllerová, Ž.

En este estudio se trata del análisis craniométrico de la morfología facial en los enfermos con la fisura unilateral total del labio y paladar con pseudoprognatismo bien

desarrollado. El óbjeto del estudio fué averiguar que estructuras causan la ocurrencía de pseudoprognatismo. 30 pacientes, en la edad de 12—15 años, con esta afección, fueron examinados en conjunto con 30 personas de misma edad con la fisura idéntica, pero sin pseudoprogantismo. En la mayoría de los casos los hallazgos mostraron que pseudoprognatismo en fisuras no está causado por una retrusión maxilar más grande que está ocurriendo en los enfermos sin pseudoprognatismo, pero por la protrusión de la mandíbula. El análisis confirmó que la protrusión está causada por le hecho que la oclusión oral fué pérdida y no restituída. Por lo que se refiere a la práctica médica, inmediatamente después de la erupción de los dientes permanentes, se aconseja restaurar la protrusión en la sección de los dientes anteriores y de esta manera prevenir el desarrollo del pseudoprognatismo.

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A WRAP-AROUND PROCEDURE USING THE GLUTEUS MAXIMUS MUSCLE FOR THE FUNCTIONAL RECONSTRUCTION OF THE SPHINCTER IN A CASE OF ANAL INCONTINENCE

K. Onishi, Y. Maruyama, T. Shiba

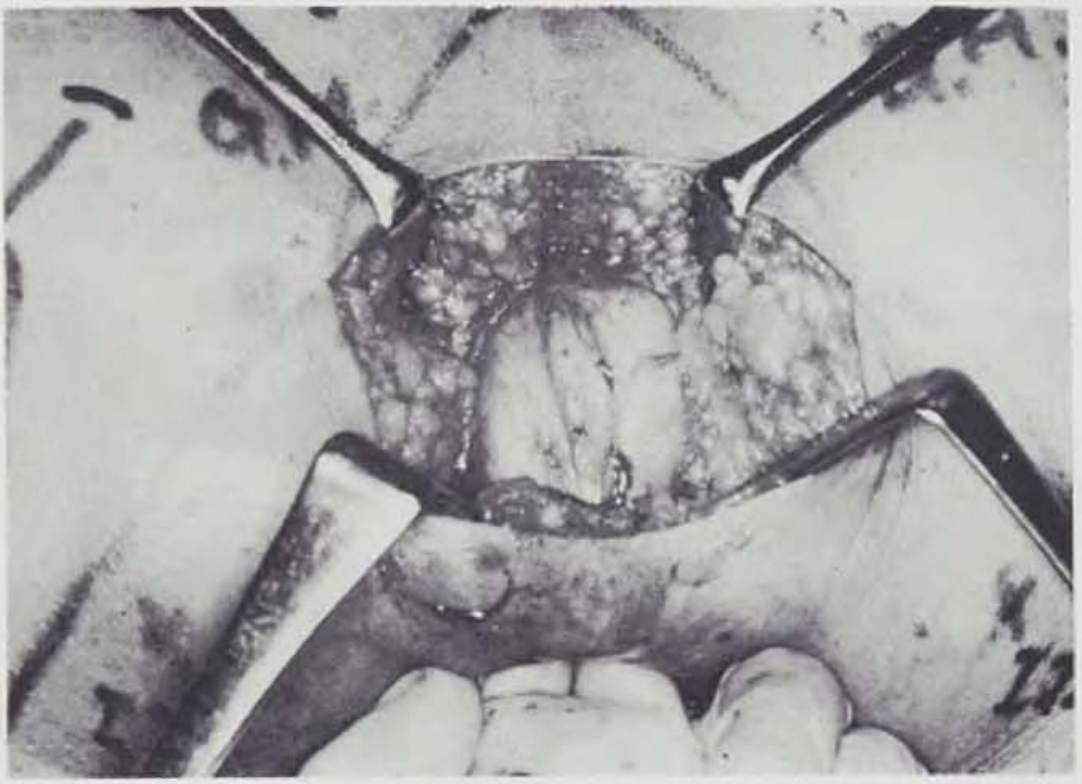
INTRODUCTION

Anal incontinence is a distressing disorder and one that is difficult to repair. We performed a wrap-around procedure using the gluteus maximus muscle, which created a new anal sphincter mechanism, combined it with muscle-tightening of the levator ani and sphincter ani muscles, and we found this procedure to be quite useful for the functional repair of anal incontinence.

CASE REPORT

A 38-year-old woman came to our hospital with anal incontinence. After the second delivery, she noticed the dysfunction of her anal contracting ability and always wore a sanitary napkin because of constant soiling. On first examination her anal contracting function was very poor and the sphincter ani muscle at the anterior one-third region could not be detected by digital examination.

After induction of general anesthesia, the patient was placed in the jack-knife position. A transverse incision between the medial border of both sides of the gluteus maximus muscle was made. The anococcygeal ligament was cut off and loose fatty tissue was dissected laterally. An approximately 4 to 5 cm vertical incision of the levator ani and sphincter ani muscles was made and the muscle was peeled off from the anal canal just above the rectum on each side of the canal. The peeled-off muscle flap was then pulled to the opposite side, more strongly so at the anal side in order to make the lower part narrower, and sutured to the outer surface of the rectum using an absorbable



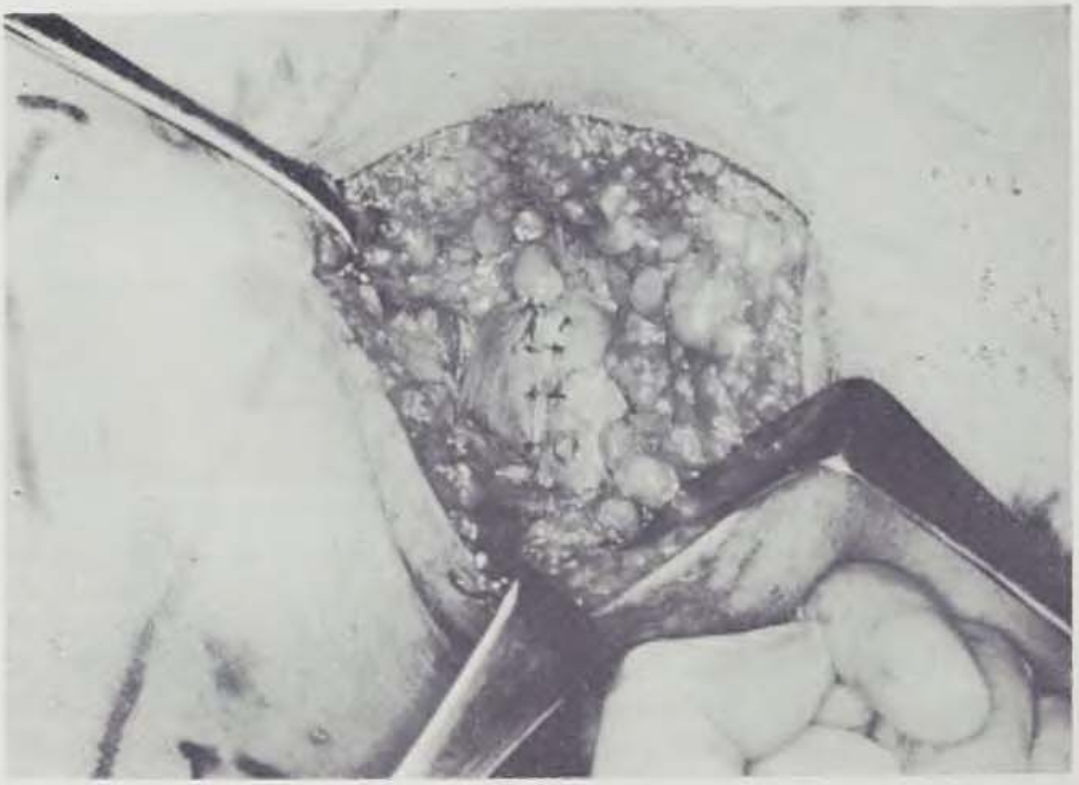


Fig. 1. above: Muscle-tightening procedure: 4 to 5 vertical incision was made.
below: View just after the procedure

suture material. The same procedure was followed on the opposite side.. Then the muscle flap was overlapped and sutured (Fig. 1).

The gluteus maximus muscle was exposed and followed medially to its proximal origin. At the attachment of the muscle, including all available fascia and periosteum at the origin, an incision of approximatelly 10 cm in length was made along the muscle's fiber direction at a width of 5 cm. The muscle

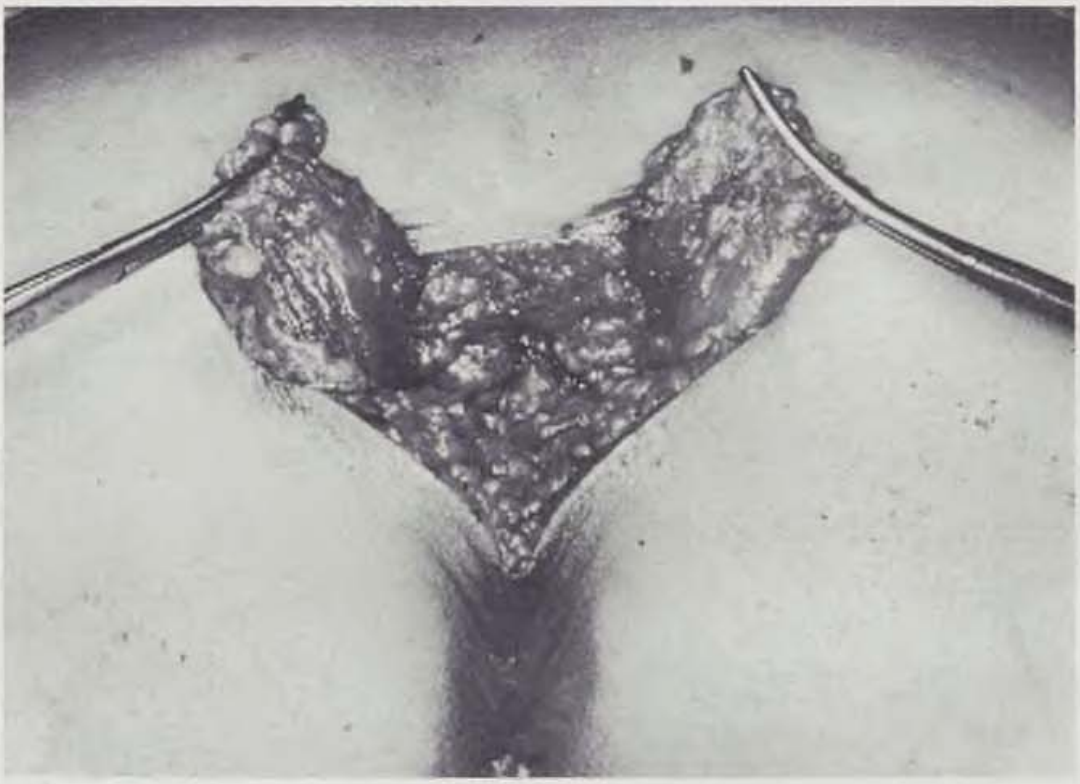
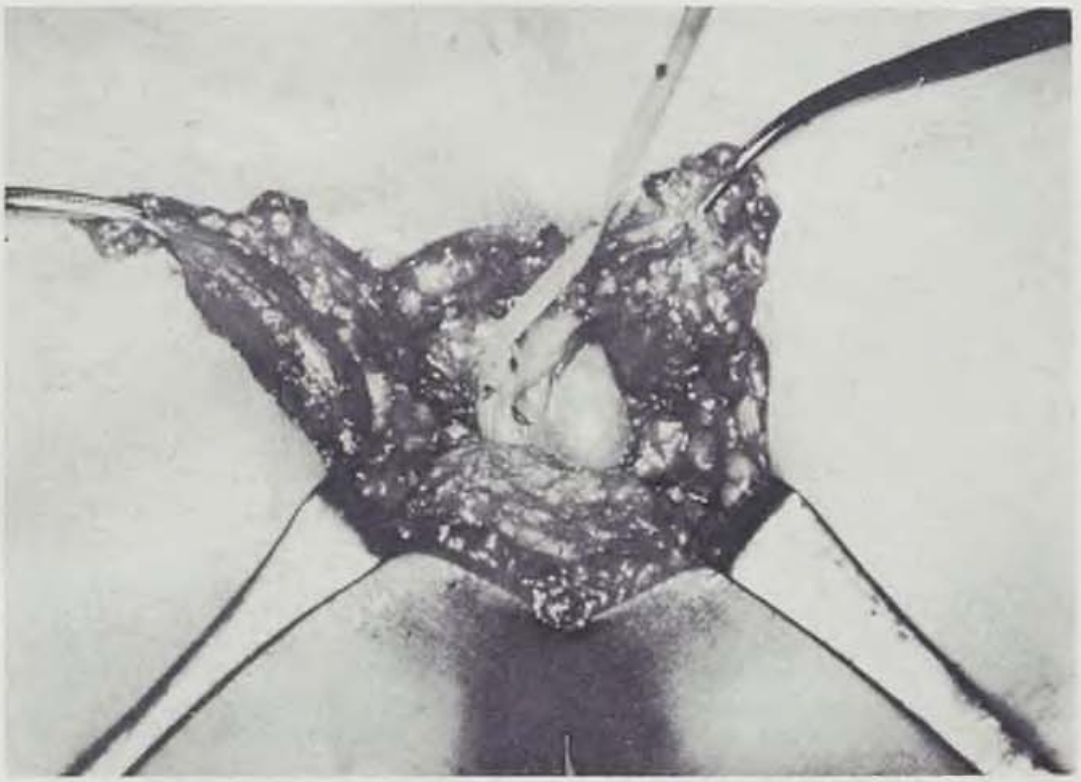


Fig. 2. Distally based bilateral gluteus maximus muscle flap was elevated.

was then detached from its coccygeal origin with care taken not to injure the inferior gluteal neurovascular bundle (Fig. 2). The muscle flap was divided into two parts; the anterior part was 3 cm wide and the posterior was 2 cm, in order to increase the tension from the posterior side. At the lower area of the levator ani muscle, the anal canal was divided carefully so as not to injure the inferior rectal neurovascular bundle, the perineal nerve or the muscles on the outer surface of the rectum, but with enough space to allow the bilateral muscle flaps to pass. The divided muscle flap was then passed and each fascial end was sutured to itself with an absorbable suture material. The muscle flap from the opposite side was also passed around the rectum, overlapping the first muscle flap, and sutured to itself (Fig. 3). Additional

suture were made connecting the two muscle flaps at the distal ends (Fig. 4). A suction drain was put in place and the anococcygeal ligament was sutured, after which the wound was closely primarily layer by layer.

Postoperatively, the patient was prohibited from taking solid foods for one week and from walking for two weeks. In the early stages of recovery



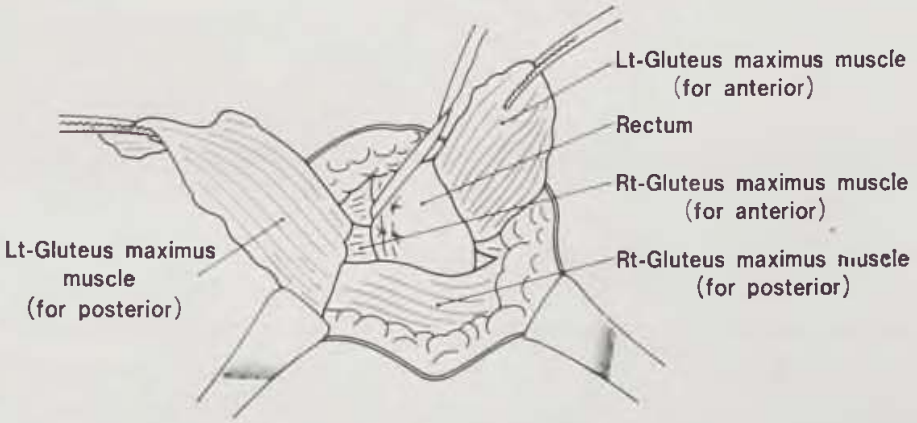
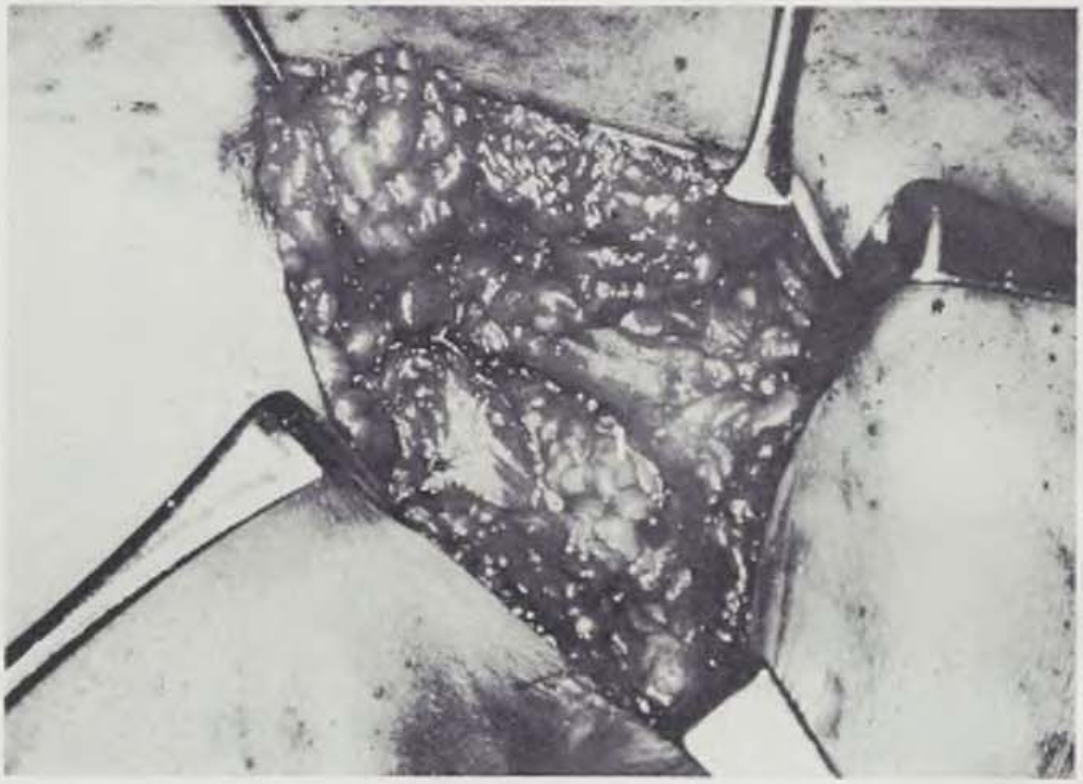


Fig. 3. above: Bilaterally split gluteus maximus muscle flaps were passed, one anteriorly and another posteriorly, around the rectum.
below: Schema

soiling continued to occur, but from 4 to 5 weeks following the operation the patient reported an improvement in her rectal continence. During digital examination the muscle sling was palpable around the rectum and its contracting function was forceful. She reported no problems in walking, sitting.



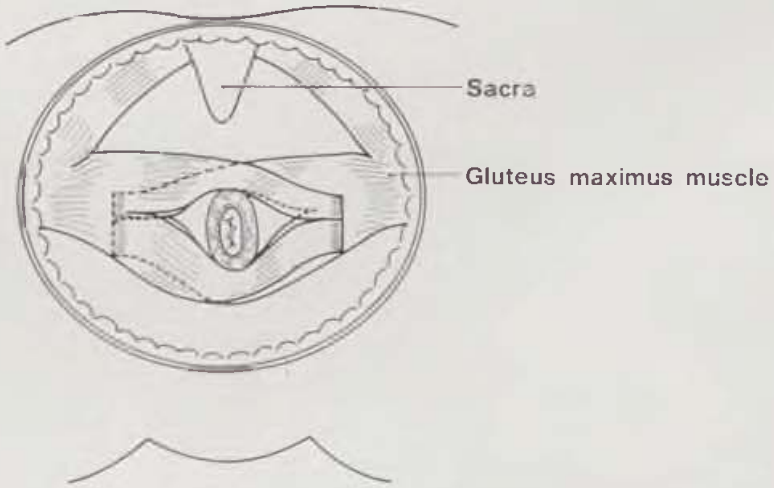


Fig. 4. above: The gluteus maximus muscle created a muscle sling around the rectum. below: Schema of the operative procedures.

or going up and down stairs. Seven months after the operation, she was continent and was able to perceive and control stool boluses in her rectum.

DISCUSSION

The gluteus maximus muscle or musculocutaneous flap and its clinical applications for soft tissue defects are well known (6, 7). Functional reconstruction to repair anal incontinence using the gluteus maximus muscle was also reported by Chetwood (1902) and Bistrom (1944). But there have not been any reports concerning repairs using this muscle since World War II (2). Several recent papers have recommended the use of this muscle for the functional repair of anal incontinence (2, 4, 8).

We approached the improvement of anal incontinence from the point of view of pathophysiology, and as such planned the operation by taking into consideration the following points (5, 9, 10):

1. Make the anal canal narrow.
2. Increase the contracting function of the levator ani and of the sphincter ani muscles.
3. Increase the anorectal angle.

That is. first, in order to make the anal canal narrow and to increase the contracting function, a muscle-tightening procedure was performed. Second, surrounding the rectum with the gluteus maximus muscle flap, which remains vascularized and innervated, produces the piling up and reinforcement of the defective sphincter ani muscle, and increases its contracting ability. And last, changing the width of split muscle and looping the thicker bundle anteriorly makes it possible to produce the increased anorectal angle by strengthening the pull force of the anal canal from the posterior.

Objective evaluation of the postoperative course of cases of anal incontinence is relatively difficult. In our case, the patient was continent seven months after the operation and sphincter tone was found to be forceful by digital examination. We think that our present procedure need not be a complicated technique and that it has a wide applicability in the functional repair of anal incontinence.

SUMMARY

A successful case in which a wrop-around procedure using the gluteus maximus muscle for the functional reconstruction of anal incontinence has been described. The case was a 38-year-old woman whose sphincter ani muscle was severed by the perineal incision at the time of delivery. Muscle-tightening of the levator ani and sphincter ani muscles was performed, and the distally based bilaterally split gluteus maximus muscle flap produced a forceful rectal contracting function.

RÉSUMÉ

Procédure d'encerclement du grand fessier lors de la reconstruction fonctionnelle du sphincter de l'anus dans le cas de l'incontinence de l'anus

Onishi, K., Maruyama, Y., Shiba, T.

Décrite la méthode d'une utilisation réussie du grand fessier comme matériel d'encerclement, dans le cas de la reconstruction fonctionnelle de l'incontinence anale. Chez une femme agée de 38 ans, le sphincter anal a été interrompu par l'incision périnéale pendant l'accouchement. La tension musculaire de l'élevateur anal et du sphincter anal a été obtenue. Un lobe fendu de grand fessier, distalement mis en place, assure bilatéralement unepuissante contraction rectale.

ZUSAMMENFASSUNG

Die Prozedur einer Umwicklung des m. gluteus maximus bei der Funktionsrekonstruierung des m. sphincter ani im Fall einer analen Inkontinenz

Onishi, K., Maruyama, Y., Shiba, T.

Es wird die Methode einer erfolgreichen Anwendung der Umwicklung des m. gluteus maximus im Fall einer Funktionsrekonstruierung einer analen Inkontinenz beschrieben. Bei einer 38-jährigen Frau war der m. Sphincter ani infolge einer perinealen Inzision bei der Geburt unterbrochen. Es wurde eine Muskelspannung des m. levator ani und des m. sphincter ani erzielt. Ein distal eingelegter gespalteter Lappen des m. gluteus maximus gewährleistet bilateral eine mächtige rektale Kontraktion.

RESUMEN

El método del envolvimiento de m. gluteus maximus en la reconstrucción funcional de m. sphincter ani encaso de la incontinencia anal

Onishi, K., Maruyama, Y., Shiba, T.

El papel describe un método exitoso que usa el envolvimiento de m. gluteus maximus en el caso de la reconstrucción funcional en incontinencia anal. Una mujer de 38 años tuvo el m. sphincter ani desconectado por la incisión perineal en el parto. En tal manera se obtuvo la tensión muscular de m. levator ani y de m. sphincter ani. La posición distal del colgajo hendido de m. gluteus maximus asegura bilateralmente una contracción rectal intensa.

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