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CONTENTS

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ACTA CHIRURGIAE PLASTICAE 37, 1, 1995, pp. 3 - 6

LATE RESULTS OF SURGICAL TREATMENT OF OPPOSITION OF THE THUMB IN PERIPHERAL PALSY OF N. MEDIANUS TRUNK

K. Dlabal

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SUMMARY

The author presents his long term experience with his own modification of opposition operation of the thumb in peripheral paresis of the trunk of n. medianus. He describes in short the operation procedure, which is very simple both for the surgeon and the physiotherapist. In a group of 110 operated patients he showed that the results of surgery are very good, but the cooperation of the surgeon and of the physiotherapist in the early rehabilitation of the operated hand is most important.

ZUSAMMENFASSUNG

Spätergebnisse nach der Oppositions-Operation bei einer peripheren Parese des Truncus N. medianus

K. Dlabal

Der Verfasser berichtet über langjährige Erfahrungen mit ihrer eingenen Modifikation der Oppositions-Operation des Daumens bei einer peripheren Parese des Truncus des N. medianus. Er beschreibt kurz die Operationstechnik, die sowohl für den Chirurgen, wie auch für das Rehabilitationspersonal einfach ist. An einem Krankengut von 110 operierten Patienten werden die günstihgen Operationserfolge demonstriert. Während der frühen Rehabilitation der operierten Hand ist jedoch von besonderer Wichtigkeit eine enge Zusammenarbeit zwischen den Chirurgen und dem Rehabilitationspersonal.

Key words: peripheral paralysis of the n. medianus trunk, opposition surgery of the thumb

Atrophy of the thenar muscles occurs in peripheral palsy of the n. medianus trunk. It results in the loss of opposition of the thumb which can be only partly substituted by a similar learned movement or by a static surgery on the skeletal part or by dynamic surgical repair on the tendons.

The latter method requires a thorough knowledge of functional anatomy, which is a prerequisite for proper substitution of the lost thenar function by means of another muscle suitable for thumb opposition. The large number of possible modifications led into two basic works by Bunnell and by Thompson. Both authors use as motor of this movement mostly the functional superficial flexor of finger IV.

Among numerous modifications are well known substitutions by thumb extensors and transposition of hypothenar muscles to thenar, but because of complicated method of surgery or of rehabilitation they do not attain the high standard of methods of both authors. The more simpler the method the more advantageous it is for the surgeon and the patient.

METHOD

Studies of the function of the long thumb flexor led to the conclusion that its motor could be used for opposition surgery by means of a tendon graft sutured from the side of the wrist to its tendon and conducted over the thenar muscles to the attachment of the short thumb abductor. The prerequisite for proper thumb opposition is its application along the axis of os pisiforme to the attachment of m. abductor brevis. Our modification deflects from this axis only by about 15 degrees. In order to fix this opposition axis we slip the tendon graft through a slot formed on the radial side of the carpal ligament, whether in an open channel in surgery of isthmus syndrom or in a closed channel in other diagnoses.

It is necessary to proceede according to the situation within the operated area. The findings are stable during the exposure of the long flexor tendon on the wrist, while the procedure of the cutting of the tendon graft of about 10 to 11 cm

long may vary. If the palmar longus muscle tendon is missing (in about 16 percent), we used one of the superficial flexors from the operation field, most frequently the finger IV possibly III or II. In severe damage of the wrist where superficial flexor tendons may be missing, it is sometimes necessary to use the extensor tendons from the dorsum leg.

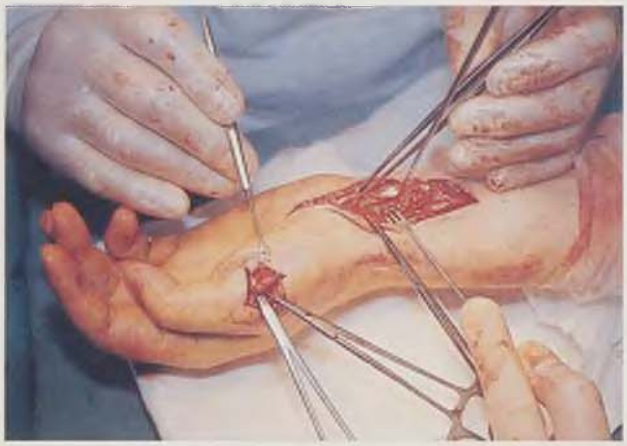

Fig. 1: Suture of the tendon graft to long thumb flexor and to insertion of short abductor.

Fig. 2: Postoperative early thumb rehabilitation.

Fig. 3: Thumb opposition and the formation of a circle after the operation.

The most important condition is joining the tendon graft to the abductor pollicis brevis muscle attachment in the moment when the patient starts to activate the tendon of the long thumb flexor on the order of the surgeon. This moment provides the possibility to determine the correct length of the tendon graft allowing thumb opposition together with the flexion of the distal phalanx of the thumb. A further important condition of a good result of surgery is an early beginning of rehabilitation under guidance of a physiotherapist who re-educates opposition from the third to fifth postoperative day, in course of the whole post-operative stay of about 16 to 28 days

of duration. By a gradual increase of the rehabilitation load the patient learns to perform the movement on discharge.

In acute cases with evidence of a disconnection of the median nerve, or in subsequent operations, besides the nerve suture, it is convenient to use opposition surgery for the enhancement of the grip function of the thumb.

Of the variations of the hitherto carried out opposition surgery, we have only once used own method in combination with the method by Ney, where the tendon of extensor pollicis muscle, interrupted on the wrist, serves for the tendon graft. Its peripheral stump is pulled through on the volar side of the wrist and sutured to the long flexor of the thumb as is typical for our method.

MATERIAL

Since the beginning of 1984, in our department were performed 128 opposition operations in 125 patients i.e. in 3 patients bilaterally. In addition were performed 18 static operations with a fixed opposition. Apart from two surgeries according to Thompson and our method combined with Ney, all surgeries were performed with our method.

The ratio of males to females was almost equal: 56 percent to 46. According to the medical history predominates conditions after transcisions of the n. medianus or in combination with n. ulnaris, followed by a paresis of the thenar muscle in severe syndromes of the carpal tunnel, rarely incomplete pareses and twice an interruption of a branch of the thenar muscle during surgery (Dupuytren's contracture).

Average age of the patients was 33 years in males, but 47 in females, which may be due to a trauma in males and to the carpal tunnel syndrome in females. The youngest male patient was six, the oldest 76, in females 8 years and 71 resp. According to the age, two patients were operated before the age of ten, eight between 70 - 80, the distribution between 20 and 70 was about equal

(Tab. 1). The types of tendon grafts are presented in Table 2.

Tab. 1. Distribution of patients according to the age at the time of surgery.

years	n
0-10	2
10-20	17
20-30	21
30-40	22
40-50	22
50-60	17
60-70	19
70-80	8
Total	128

Tab. 2. Type of tendon graft sutured to the tendon of m. flexor pollicis longus.

Type of tendon graft	n
Flexor digit. superfic. IV	45
M. palmaris longus	52
Ext. digit. pedis	1
Flexor digit. superfic. II, III	11
M. extensor pollicis brevis	1
Total	110

RESULTS

In order to avoid a bias of the results of the opposition surgery, operations in 1994 (18x) were not included, thus 110 operations were evaluated after one, three and six months. Similarly as in the previous study some of them were check-up after years.

1) Very good results: 57 patients (52 percent).

According to the rehabilitation chart, in thumb opposition the patient is able to align the metacarpus I axis with that of axis II, the tip being five to six cm distant from the other fingers and the opposition of the slightly flected distal phalanx will reach the IV and V fingers.

2) Good results: 38 patients (33.5 percent).

The patients manage to pull the thumb axis to the axis of finger II, pull the thumb four or five cm away from the palmar level and attain easily the opposition to finger II or III. They manage "the ring sign" typical for opposition with a lightly flected distal phalanx.

3) Satisfactory results: 10 patients (9 percent).

In the opposition, the patients reach the II and III fingers with an extended thumb, they do not manage the simultaneous light flexion of the distal phalanx against it, i.e. they do not attain the typical ring-sign.

4) Unsatisfactory results: 5 patients (4.5 percent).

In these patients, the proper rehabilitation training after discharge from the hospital was not performed. Incorrect selection of patients may have been involved. They neglected the use of thumb opposition and were satisfied with palmar grip function. Some of them could attain thumb opposition under proper training. Thus it would be worth to consider whether to carry out a fixed, static type of opposition. Thus in this group a wrong operation technique was not responsible. The comparison of the results in this series with the results obtained five years ago is presented in Table 3.

Tab. 3. The comparison of the results in this series with the results attained five years ago.

group	5 yeas ago	present series
1	52% (21)	52% (57)
2	35% (14)	34% (38)
3	8% (3)	9% (10)
4	5% (2)	4.5% (5)

in brackets the numbers of patients

DISCUSSION

The long term results of opposition surgery confirm our opinion that a functionally competent long thumb flexor can perform the opposition function with the use of simple technique consisting of a graft applied through the region of the deficient thenar towards to the insertion of the m. abductor pollicis brevis. Correct operation method is always most important, together with a properly carried out early postoperative rehabilitation treatment. If rehabilitation is not a part of the postoperative treatment, adhesions will occur in the graft as it was reported from another clinic. Our conclusions were substantiated by longterm results: age limit of 50 years is not important. The thumb flexor should be strong enough not to be hampered by the double function. Other contraindication to the operation (poor trophic state, scar alterations in the operation field, arthrogenic contractures) are in agreement with reports of other authors.

CONCLUSION

According to the long-term results and the large number of operated patients it was demonstrated that our technique of dynamic opposition operation proved fully satisfactory, it was attractive and which is most important it restored a full function of opposition of the injured hand. Interest for the method has been shown abroad and it is being introduced in some departments in our country.

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ACTA CHIRURGIAE PLASTICAE 37, 1, 1995, pp. 7 - 11

IMMEDIATE FREE FLAP RECONSTRUCTION OF TRAUMATIC DEFECTS

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SUMMARY

In a series of 180 transfers of free flaps were in 11 cases on upper extremities applied emergency flaps, both for immediate reconstruction of function and for the replacement and covering of tissue defects. In one case a scapular flap was used simultaneously with the replantation of the forearm. In three cases was applied a forearm flap for the reconstruction of the thumb and of the scalped index finger, and in three cases a central venous flap for traumatic defects of tissues on fingers. These flaps yielded surprisingly good functional results after an injury associated with a loss of dorsal aponeurosis of fingers and with an exposure of IP joints. A toe-to-hand transfer was used in one case for the reconstruction of the thumb. A groin flap and a lateral arm flap were applied for the covering of tissue defects.

ZUSAMMENFASSUNG

Anwendung von freien Lappen in der primären Rekonstruktion der traumatischen Gewebsdefekte

J. Veselý, J. Kučera

Von den insgesamt 180 Übertragungen von freien Lappen an die obere Extremität wurde in elf Fällen sog. "emergency" Lappen angewandt, und zwar sowohl zu der Deckung von Gewebsverlusten, als auch zu der unverzüglichen Rekonstruktion der Funktion. In einem Fall gelangte ein skapularer Lappen zur Anwendung gleichzeitig mit der Replantation des Unterarmes. In drei Fällen wurde ein Unterarm-Lappen zur Rekonstruktion des Daumens und des skalpierten Zeigefingers angewandt, und in weiteren drei Fällen diente ein zentraler venöser Lappen als Ersatz der Gewebsverluste an verletzten Fingern. Diese Lappen lieferten überraschend günstige funktionelle Ergebnisse nach Verletzungen mit einem Verlust der dorsalen Aponeurose der Finger und bei offenen Verletzungen der TP Gelenke. In einem Fall erfolgte die Übertragung der grossen Zehe an die Hand zur Rekonstruktion des Daumens, ferner wurden ein inguinaler Lappen und ein Lappen aus dem lateralen Arm zur Deckung der Gewebsverluste appliziert.

Key words: microsurgery, immediate flaps reconstruction, emergency flaps

At the congress of IPRS in Madrid, 1992, Sirpa Asko-Seljavaara reported on the classification of flap reconstructions of traumatic defects according to time elapsed since the injury. The flap used in the first 24 hours after injury is called emergency flap, during the interval of the second till seventh day it is the acute flap, after the seventh day within the following healing period is called delayed flap. Secondary flap reconstructions are those that treat the accident sequalae after the wound is healed.

In our group of more than 180 free flap transfers represented the flaps used for treatment of primary defects only a few percent. It is interesting that these so called emergency flaps were used only in upper extremities and not on the lower extremity, although the absolute number of flaps on the lower extremity is about double. This is first of all because in an extensive devastating injury particularly of the crural region the traumatologist aimes primarily at conservation both of as much of functional musculature as possible and of muscles covering the skelet and postpones the necessary flap reconstruction into the acute or delayed stage when the debridement can be performed very exactly and the defect not yet been infected particularly by the nasocomial infection.

In the group of eleven patients, were used a sensitive forearm flap in four cases. Three times in combination with a bone graft for reconstruction of an amputated thumb where the replantati-

on was technically not possible. In two cases the crista illiaca was used for the bone graft, in the third case the skelet of the amputated thumb was used. In one case this flap was used for covering a glove-type of scalped index finger in a young woman. Technically, these operations were quite simple. Vascular anastomoses were performed between the a. radialis, v. cephalica, concomittant veins and the veins of the first interdigital region. Both nerves of the flap in all three cases were sutured to stumps of digital nerves and provided a satisfactory sensitive innervation.

In three cases the central venous flap was used for narrow finger defects. In one of them for a distal thumb phalanx which was not successful, and in two for defects of the dorsal side of middle fingers with loss of dorsal aponeurosis, skeletal erosion and exposure of PIP joints (Fig. 1) , in the second case of the DIP joint as well after a planing machine injury. The flaps were harvested from the volar side of the forearm (Figs. 2, 3) . A thin cutaneous vein was selected corresponding by its diameter with the digital vessels and the flap was isolated so as to achieve central placement of the vein and the width of the flap did not exceed 12 - 13 mm. The fascial flaps were obtained and fascia of forearm muscles was dissected too so as to compensate for the loss of dorsal aponeurosis. The healing of the flap passed through the bullous stage (Fig.4) and from the seventh postoperative day developed gradually a satisfactory blood supply. The blood suply of the flap is provided by the vasa vasorum of the respective vein. This course was the same in both successful flaps, even though one of the cases with the distal vessel anastomoses was A-V and in the other V-V. A proximal vascular anastomosis was of course always V-V. This means that in one of the cases the flap was supplied by arterial and in the other case by venous blood. The functional outcome of both injured fingers was about 90 percent of movement range and surprising considering the loss of a part of aponeurosis and exposure and erosion of PIP joints and DIP one as well (Figs. 5, 6).

In one case, a lateral arm flap was used for covering the defect of a part of hand dorsum and forearm after a devastating injury by circular saw of the right hand in an 18 year old girl. This flap with a thin vascular pedicle is not always convenient for free flap transfers. We used the flap from the homolateral arm, the defect was sewn by a linear suture, because the low morbidity of the donor site of flap seemed to be the most suitable in this young patient.

In one case an extensive defect of the left hand and forearm after a train accident was treated with an inguinal flap, size 33x16 cm (Fig. 7). Two vascular pedicles were isolated in this flap, both in a. circumflexa ilium superficialis and a. epigastrica inferior superficialis. Only one artery was sutured - epigastrica inf. superf. and the tip of this vast flap belonging rather into the vessel region of the second nourishing pedicle, desquamated superficially. The secondary defect after harvesting the flap had to be treated partially by cutaneous transplantation (Figs. 8,9) .

In one case, the loss of the dorsal side of thumb on the upper extremity where replantation was impossible, was treated by a transfer of a part of big toe from the foot, the size of which corresponded with the size of the thumb on the hand (Figs. 10, 11). The skelet contained a part of the proximal phalanx, IP joint and the distal phalanx. Both flexor and extensor tendons were sutured and both digital nerves as well. Vascular anastomoses were made between a. dorsalis pedis and a. radialis and influx of v. saphena magna and the vein of the first interdigital region (Figs.12, 13). The postoperative healing was complicated by a necrosis of the tip of the volar skin flap of the stump of the thumb and the defect was complemented by a secondary pedicled axilar flap. Sensitivity, appearance and function of the reconstructed thumb are very good (Figs.14,15).

In our last case, a scapular flap was used together with the replantation of the distal part of the forearm. After the replantation of the forearm with a rather extensive loss of skin of the dorsum of forearm, the exposed extensor tendons as well as the sutured a. radialis and venous anastomoses were covered with a parascapular flap. It was selected because of its sufficiently long and large pedicle and a quick transfer. The donor site is closed with a linear suture. The usual time required for this procedure of parascapular flap is two to three hours. During the post operation course the healing was complicated not as regards nutrition of the hand but by venostasis of the flap requiring several revisions. Further healing, both of the flap and of the hand was uneventful.

RESULTS

The results show that emergency flaps on the upper extremity are most useful for immediate functional reconstruction and for covering the tissue defects. But for one venous flap, the healing was not complicated by a fatal necrosis not even there where the flaps were used for covering tissue losses in devastating forearm injuries with no complications of the healing even in contused tissues undergoing a gradual disintegration. In the lower extremities no emergency flaps were indicated until now and the flaps were sutured rather during the acute phase, i.e. up to the seventh day after injury with primary defect covered with synthetic material.

At the present time when the hand reconstruction is aimed not only at the function but at the appearance of the hand or fingers as well, we would probably not use a skin flap and a bone graft for the loss of thumb, because this new thumb has no nail and the achieved sensitivity is much lower than the sensitivity of transferred to-

Fig. 1: Traumatic loss of dorsal aponeurosis and of skin cover of the 3rd finger and a devastating injury of the 2nd finger.

Fig. 2: Harvesting of a venous flap on the forearm.

Fig. 3: Harvesting of a venous flap on the forearm.

Fig. 4: The 7th postoperative day characterized by a bullous stage.

Fig. 5: Functional result 4 months after surgery. Secondary reconstruction of the 2nd finger by a transplantation of a toe was performed later.

Fig. 6: Functional result 4 months after surgery. Secondary reconstruction of the 2nd finger by a transplantation of a toe was performed later.

Fig. 10: A traumatic loss of tissues on the thumb of the right hand. From the skelet remained only the basis of the proximal phalanx.

Fig. 7: Devastation of the left hand by a train. Condition after the excision of contused tissues.

Fig. 11: The area of the flap from the great toe.

Fig. 8: The hand is covered with a flap from the groin measuring 33x16 cm and with a small skin graft on the wrist.

Fig. 12: Harvesting of the flap containing the skelet of the thumb, dorsal skin, the nail, digital nerves, vessels and tendons.

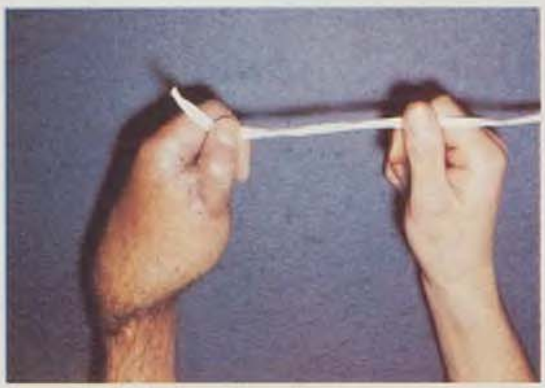

Fig. 9: The function was satisfactory.

Fig. 13: Immediately after reconstruction.

Fig. 14 Result after 8 months.

Fig. 15: Functional result after 8 months. Necrosis of the dermal stumb of the thumb, and thus outside of the transplanted flap, was covered with an unipedunculated and tubuliyed axilar flap.

es. We would also like to point out the possible complications in the healing of a thumb skeleton placed into a skin flap, when the thumb could not be replanted, as it happened in one case.

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continued on p. 28

ACTA CHIRURGIAE PLASTICAE 37, , 1995, pp. 12 - 16

FREE CROSS LEG FLAP AS A METHOD OF RECONSTRUCTION OF SOFT TISSUES DEFECTS

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SUMMARY

Authors demonstrate on clinical cases the possibility of reconstruction of soft leg tissues by the use of the so called free cross flap. This method appears to be convenient in cases where there are no suitable recipient vessels within reach on the injured extremity and where the defect is of such an extent that the conventional cross flap does not provide sufficient amount of tissue.

ZUSAMMENFASSUNG

Gekreuzte Freilappen Übertragung als ein Verfahren zur Rekonstruktion von Weichteilen der Unterschenkels

M. Tvrdek, Z. Pros, A. Nejedlý, J. Kletenský, J. Stehlík

An klinischen Fällen demonstrieren die Autoren die Möglichkeiten einer Rekonstruktion von Weichteilen des Unterschenkels mit Hilfe eines sog. freien gekreuzten Lappens. Dieses Verfahren eignet sich besonders gut für Fälle bei den an der verletzten Extremität keine erreichbare Empfänger-Gefässe vorbilden und wo der Ausmass des Defektes so gross ist dass der klassische gekreuzte Lappen nicht die benötigte Gewebsmenge liefern kann.

Key words: microsurgery, free cross flap

Reconstruction of soft leg tissues with free flaps, most frequently muscular or musculo-cutaneous flaps, is quite a common procedure. There are cases where no suitable recipient vessels exist in neighbouring or more distant regions of the defect. A prerequisite for the use of venous grafts for prolongation of the vascular pedicle of the flap is a good quality of soft tissues through which these vessel grafts would pass. If this requirement is not fulfilled a free cross flap can be used with a vascular pedicle of the transferred flap anastomosed to recipient vessels on the other leg. During the last two years we have encountered three times this type of involvement. All three were girls, aged 10 - 16 with an injury of the leg in a traffic accident.

Case No. 1 (Figs. 1 - 5)

An eleven-year-old girl, hit by truck suffered a severe crush injury to the left leg with an open tibial-fibular fracture. On the day of the accident, adaptation osteosynthesis of the fracture was carried out and the necrotic soft tissues were debrided. On the second day after the injury thrombosis of the proximal part of the popliteal artery developed. Revision of the artery and thromectomy were carried out and the fracture was stabilized by an external fixation. Because of the severe contusion of the leg, including the main vascular trunks the skin cover necrotized together with a part of the muscles and the bone. From the level of the distal thigh the extremity was supplied only by colateral circulation. After multiple debridement the skin defects were repeatedly covered with skin grafts. On the site of the fracture an infected defect with exposed tibia occurred. This was the condition in which the patient was recommended for admission to our department. Arteriography confirmed the above described status and because of the quality of soft tissues proximally from the defect it was decided to use a free cross flap. Posterior tibial vessels of the right leg were chosen as the recipient vessels. The vascular pedicle of the left latissimus was anastomosed to recipient vessels - arteries by means of end to side, the vein end to end. The muscle surrounding

Fig. 1: A 11-year old girl with fractured tibia prior to surgery.

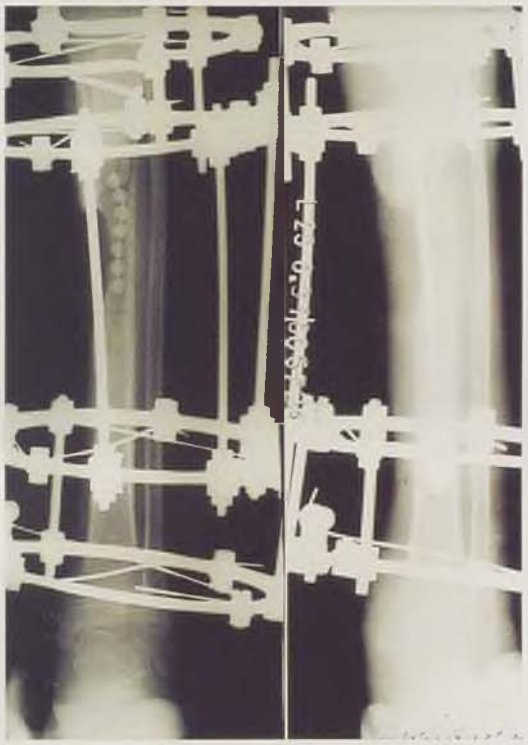

Fig. 2: Radiographs at the time of surgery.

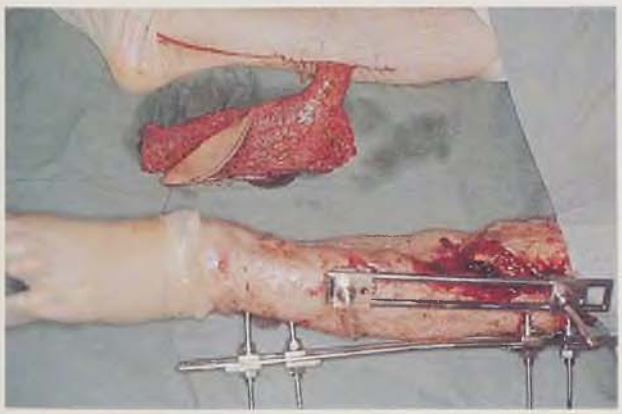

Fig. 3: Free latissimus dorsi flap with vascular pedicle anastomozed to recipient vessels.

Fig. 4: Two weeks after surgery, the method of immobilisation.

Fig. 5: One year follow-up after reconstuction.

the vascular pedicle was stitched to the calf muscles to avoid tension on vascular anastomoses. The unstable scar around the defect was excised and the latissimus muscle was spread into this place. The bridging over a part of the muscle connecting both extremities was formed into a tube around the vascular pedicle and covered by a xeno graft. The part of the muscle filling up the defect was covered by a meshed skin graft. After four weeks, the vascular pedicle of the flap was ligated and the bridging part of the muscle was excised. The remaining surface areas were skin grafted, too. Six weeks later when the healing of soft tissues was completed, the patient underwent a spongioplasty.

Case No. 2 (Figs. 6 - 8)

A thirteen-year-old girl suffered a cominutive fracture of the left tibia with an extensive defect of soft tissues. The patient was treated at the department of orthopedics of another hospital. The bone healed, shortened by seven cm. At three quarters of the crural length the soft tissues were healed by means of skin grafts. In the anterior half of the crural circumference the grafts healed directly to the tibia periost, in the posterior part to the remnants of calf muscles. The loss of soft tissue continued in the proximal direction mediodorsaly over the popliteal fossa to the thigh. The patient was referred to our department in order to replace the unstable scar on the anterior side before the planned prolongation of the tibia. Arteriography showed the blood flow only through posterior tibial artery, the course of which was deformed by scarring. In the anterior tibial artery only the short stump closely below the branching fills up, fibular artery was not visualised. Because of the necessity of an extensive tissue reconstruction we used the free latissimus dorsi flap transfer, the vascular pedicle of which was anastomosed to the popliteal vessels. The postoperation course was complicated by vein thrombosis. Venous anastomosis was resected and a substition by a venous graft was performed. In spite of it the flap failed. After the necesary local and general preparation we decided to use the same flap from opposite side as a free cross leg flap. Similarly as in case No. 1 we used posterior tibial vessels from the other leg as recipient vessels with the same type of vascular anastomosis. Stabilization of the extremities in the required position was provided by external fixation. The transferred muscle was covered by a meshed skin graft. Further course was without complications and after 4 weeks the vascular pedicle and the flap were disconnected. External fixation was removed and the skin grafting of the remaining skin defects was completed. After healing the patient was referred back to the department of orthopedics for planned tibial prolongation.

Fig. 6: Appearence of the extremity prior to surgery.

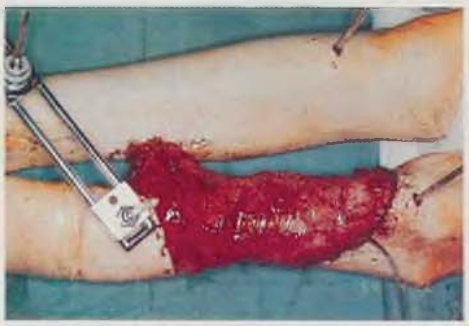

Fig. 7: Free flap wrapped arround the proximal tibia.

Fig. 8: Eight months follow-up after reconstruction.

Case No. 3 (Figs. 9 - 15)

A sixteen-year-old girl suffered a quadruple fracture of the pelvis, a severe crush injury of the right leg with amputation of the fibular part of talus, calcaneus and supramaleolar fracture of the fibula. Similarly like in the previous cases, the injury was suffered in a traffic accident. Immediately after the accident, debridement of clearly devitalized tissues was performed together with an arthrodesis of the talocrural joint. On the second day, after stabilization of her general condition, a radical debridement was performed when non-viable parts of soleus gastrocnemius peroneal muscles and two thirds of tibialis anterior muscle were excised. Anterior tibial vessels were crushed along their whole length, fibular vessels in the lower two thirds of the leg. The vessel supply of the foot was provided only by the posterior tibial vascular pedicle. Damage to the nervous trunks corresponded to the vascular damage. After necrectomy the a. fibularis stump was isolated with its concomitant veins in the proximal part of the leg. The crushed part of the vessels was resected. The vascular pedicle of the combined latissimus-serratus flap was anastomosed to these recipient vessels. These transferred muscles were used for covering the defect on the anterior surface of the leg, where the bone was exposed. After the anastomoses were terminated, the blood supply to the free flap was quickly reestablished and the flap was covered by xenografts. In spite of the good blood flow through the vascular pedicle controled regularly by Doppler the transferred muscles gradually necrotized from periphery and within two weeks occurred a necrosis of their whole extent. Subsequently to the debridement and preparation of the defect a free cross flap transfer was performed after four weeks. A combined latissimus-serratus flap from the opposite side was transferred to the site of the defect. The latissimus was circularly wrapper around the exposed tibia and fibula, serratus covered the opened talocrural joint. Common vascular pedicle of both muscles was anastomosed to the same recipient vessels of the other leg as in previous cases. Fixation of extremities was again provided by external fixation. After ten days the muscles were covered by meshed skin grafts. With regard to the character of the injury and the quality of the remaining tissues, the bridging of both extremities continued for six weeks. After disconnecting of the flap and ligation of the vascular pedicle, considerable bleeding from the muscle edge occurred at the site of disconnection. Remaining surfaces were covered by skin grafts.

Fig. 9: Avulsion injury in a 16-year old girl.

Fig. 10: Two weeks later after multiple debridements.

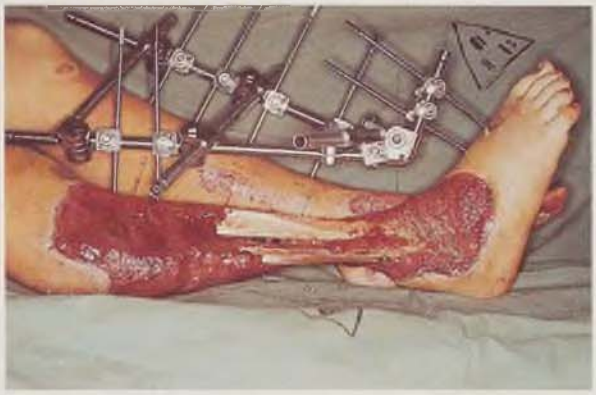

Fig. 11: Four weeks after injury at the time of reconstruction.

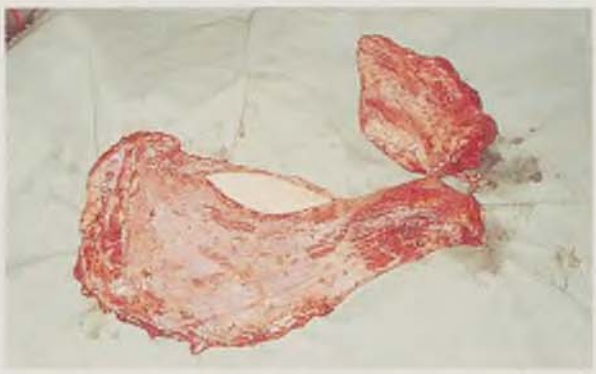

Fig. 12: Free latissimus dorsi and serratus anterior muscle flap harvested.

Fig. 13: The muscles survived and a mesh split-thickness skin graft was applied.

Fig. 14: Six weeks after operation the vascular pedicle was ligated and bridging segment of the muscle resected.

Fig. 15: Three months follow-up after reconstuction.

CONCLUSION

Free flap transfer by means of the cross flap allows to transfer sufficient amount of tissue to the site where it is required in cases where there are no suitable recipient vessels in the vicinity of the defect and the use of vascular graft is not possible because of the poor quality of soft tissues surrounding the defect.

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INTERNAL MAMMARY VESSELS AS RECIPIENT VESSELS TO THE FREE TRAM FLAP

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SUMMARY

For the reconstruction of the breast after mastectomy, it is possible to use the internal mammary artery and vein as recipient vessels. The authors consider their experience and some new knowledge gained on the basis of 53 cases. They try to promote the indisputable advantages of the use of the mentioned recipient vessels.

ZUSAMMENFASSUNG

Thoracica interna Gefässe als Annahmegefässe für den freien TRAM Lappen

A. Nejedlý, M. Tvrdek, J. Kletenský, Z. Pros

Es ist möglich, die Thoracica interna Gefässe als Annahmegefässe bei der Brustrekonstuktion nach der Mastektomie zu verwenden. Die Autoren teilen ihre Erkentnisse mit, die sie nach der Durchführung von 53 solchen Eingriffen gewannen. Einige unbestreitbare Vorteile werden erläutert, die sich aus der Wahl dieser Annahmegeffässe ergeben.

Key words: breast reconstruction, free TRAM flap, recipient internal mammary vessels

In the plastic and reconstructive surgery, among a variety of operation modes, the reconstruction of breast in the form of a TRAM flap already occupies its firm place. In comparison to the reconstruction of the breast by means of a pedicled TRAM flap, the free transfer represents several advantages. The operation is less extensive, is accompanied by a lesser blood loss, and proves itself better to save the abdominal wall tissue. Harvested flap is well perfused. Departments in which free tissue transfers are being performed, usually prefer the reconstruction of the breast by means of the free TRAM flap as compared to the pedicled one.

A consistent anatomical course, good size match, and high blood flow rate insuring reliable inflow and outflow are decisive in the selection of recipient vessels. Thoracodorsal artery and vein, together with the internal mammary vessels fulfil these objectives and, usually, are being used.

For the first time, the dissection of the internal mammary for its use in the free TRAM flap transfer, was described by Shaw. At our department, after several successfully performed breast reconstuctions, the use of those vessels has been adopted as the method of choice. With respect to the fact that our department appears to be one among those rare departments that have adopted the use of the internal mammary as the recipient vessels, we take the liberty to present this experience to our readers, and to suggest to them several further ideas.

By means of a suitable selected excision of the mastectomy scar and after the mobilisation of the skin and the subskin tissue, we form the room for the transfer of the TRAM flap. After having performed a blunt dissection of the pectoral muscle, a third or fourth of the costal cartilage is resected from its perichondrial bed. The diameter of the internal mammary artery is stable and very appropriate in the intercostal space II and III. In most cases, in the intercostal part II it is possible to find a vein of suitable size, in the intercostal part III even two accompanying veins of unequal diameter. Recipient vessels are to be dissected from the surrounding tissue and small vascular branches are to be ligated. Exposure of recipient vessels is conveniently feasible, however, the anastomosis end to end impedes the breathing excursion of the chest wall. The arterial anastomosis is uneventful. In most cases, the commitant veins usually have very thin walls, nevertheless, at least one of them can figure as the recipient vein. In the presence of two commitant veins, we do our best to complete the anastomosis of both of

them with the accompanying deep epigastric inferior artery veins.

As of this writing 53 free TRAM flaps for breast reconstruction have been performed at our department. The thoracodorsal artery and vein have been used only in one instance. It was in the case of an immediate breast reconstruction. Internal mammary as the recipient vessels were adopted in all other instances. As to the quality of the recipient vessels: several times, we came across a striking fragility of the intima of the internal mammary artery, that required maximal caution. The venous wall used to be very thin, but in all cases, it was possible to use at least one of the veins as the recipient vein. Within the group of 53 flaps performed, one failed. It happened due to the vein thrombosis. Not even the transposition of the vein drainage of the flap to the external jugular vein by means of vein graft did succeed to restore the perfusion of the flap. We have observed five perfusion complications requiring reexploration. In most cases, they manifested themselves within three hours postoperatively. They have arisen due to the kinking or due the compression of the pedicle. After its replacement, the perfusion of the flap re-established itself and the flap survived in its entirety. At the dissection of recipient vessels, we caused no pneumothorax. After healing, the resected costal cartilage caused no difficulties to the patients. Our present experience with the use of the internal mammary artery and veins as the recipient vessels are very good and bring about several fundamental advantages. Their anatomic course is consistent. It cannot be damaged during the mastectomy. The inflow to the flap through the internal mammary artery is excellent, and the outflow through either one or two accompanying veins is reliable. The anastomosis between those vessels and the vessels of the pedicle may be considered as technically demanding. However a satisfactorily long and suitably positioned pedicle assures fully free placement and shaping of the flap. A maximum esthetic and functional result of the entire breast reconstruction is then the best reward to us for our endeavour.

Fig. 1: Modeling the breast pocket with the resected costal cartilage and the exposed recipient vessels.

Fig. 2: The anastomoses between the recipient vessels and the vessels of the pedicle.

Fig. 3: The advantages of the placement of the pedicle and its length.

Fig. 4: A further case showing the length and the position of the pedicle within the breast pocket.

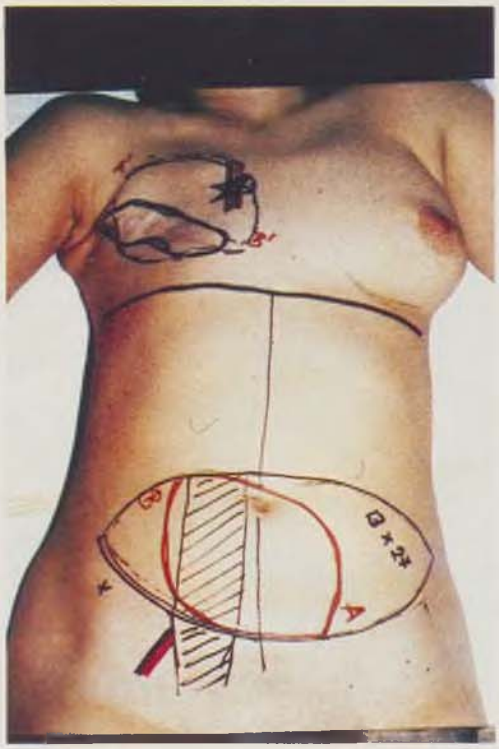

Fig. 5: Status before the reconstruction of the breast.

Fig. 6: Status after the reconstruction of the breast by means of the free TRAM flap, frontal view.

Fig. 7: Status after the reconstruction of the breast by means of the free TRAM flap, side view.

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ACTA CHIRURGIAE PLASTICAE 37, 1, 1995, pp. 20 - 24

CULTURED EPIDERMAL ALLOGRAFTS FOR THE TREATMENT OF DEEP DERMAL BURNS

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SUMMARY

The paper summarizes the experience with the application of cultured epidermal allografts in the treatment of deep dermal burns. In a series of patients, including 10 adults and 32 children this method allowed to attain an epithelialization in 90% of deep dermal burns.

The advantages of this therapeutic method consist particulary in the early epithelialization of the burnt area and the maintenance of all vital layers of the corium. The risk of a transmission of infection by the transplantation of allografts of live human cells can be minimalized by keeping all directions prescribed for the examination of donors.

The possibility of cryopreservation and the easy transport of cultured epidermal allografts renders them available for the use as a new therapeutic method in the treatment of deep dermal burns.

ZUSAMMENFASSUNG

Behandlung von tiefdermalen Brandwunden mit den kultivierten epidermalen Allotransplantaten

P. Brychta, I. Suchánek, H. Říhová, J. Adler, J. Komárková

Ein Bericht über die Erfahrungen mit der Behandlung von tiefdermalen Brandwunden durch die Applikation von kultivierten epidermalen Allotransplantaten. Bei einem Krankengut von 10 Erwachsenen und 32 Kindern konnte in 90% eine Epithelisation von tiefdermalen Brandwunden erreicht werden.

Zu den Vorteilen dieser Behandlungsmethode gehört insbesondere eine frühe Epithelisation der Wundoberfläche, bei gleichzeitiger Erhaltung sämtlicher vitalen Komponenten der tiefen Schichten des Koriums. Die Gefahr einer Infektionsübertragung bei der Allotransplantation von lebenden menschlichen Zellen dann durch die strikte Einhaltung der vorgeschriebenen Richtlinien für die Untersuchungen der Spender minimalisiert werden.

Die Möglichkeit einer Kryokonservierung und der einfache Transport der kultivierten epidermalen Allotransplantate beitragen dazu, dass diese Methode ein wirksames Verfahren zur Epithelisierung von tiefdermalen Brandwunden darstellt.

Key words: burns, cultured epidermal allografts, epithelization

A predominant part of all burns consists of deep dermal burns. The series of 303 in-patients treated at the Burn Centre of the University Hospital in Brno - Bohunice in 1993 included 253 individuals (i.e. 81.8%) who had, at least partly deep dermal burns.

Out of this series 42% were children who had deep dermal burns caused by scalding in as many as 94% (1).

The treatment of deep dermal burns can be as follows

a) Conservative therapy - consisting of a local application of antiseptic ointments (Dermazin, Flamazine) and subsequently with compounds promoting epithelialization, mostly for several weeks.

b) Radical surgery - consisting of an early radical necrectomy (most tangential) with a subsequent autotransplantation of a dermoepidermal graft.

Either of these methods is associated with advantages and disadvantages.

Conservative therapy is rather prolonged and relatively painful. It is associated with the risk of wound sepsis and the several weeks healing can lead to the development of hyperthrophic scar. In children (especially in toddlers) the daily use of general anaesthesia for several weeks during change of dressing of the wound is also mostly necessary.

Radical surgery is quicker, cheaper and is associated with a lesser stress for the patient, with

more rapid restoration of skin cover. However, in view of long term results dermoepidermal grafts do not provide an adequate substitution of normal skin since they do not include a complete dermal component inclusive of the adnexa and they are not greased, they shrink and can develop contractures.

Recently literature contains reports on the use of cultured allo- and autogenous epidermal grafts in the treatment of deep dermal burns (2, 3, 4).

Our department has also some clinical experience with the use of this method.

MATERIAL AND METHOD

In the period from April 2, 1993 to September 15, 1994 were applied on deep dermal burns in 10 adults and in 32 children 185 cultured epidermal allografts within 3 to 42 days after injury. The total area of the grafts amounted to 11 100 cm^2.

Vital keratocytes were harvested as followes:

a) In patient with extensive burns a skin specimen was harvested on the day of admission from some part of their body which was not affected by burns, either in the form of a dermoepidermal graft of about 4x4 cm, or by an excision of the full- thickness skin of about 6x1 cm in size. Their cultured epidermal grafts were used as donor grafts when either a healing of burns or a death of the patient occured during the process of tissue culturing.

b) Patients subjected to elective plastic surgery with a normal medical history and examined according to a uniform scheme (Table 1). The cultured grafts can be used as donors only after repeated negative results of examination after 6 months (since September).

The most commonly used and most convenient area for the harvesting of vital keratinocytes represented the skin of the posterior sides of auricles obtained during the surgical procedure of aposthasis. In this case it was performed in children aged from 6 to 12 years. On the second place of a convenient harvesting of keratinocytes there was the skin of the upper eye lids of middle aged females treated surgically for ptosis. The skin from the abdomen and from chest obtained during surgery for venter pendulus or for gigantomastia or for mammary ptosis is most inconvenient for the harvesting of keratinocytes. These patients were mostly middle aged females. The number and types of biopsies are presented in Table 2.

The donor site is disinfected with 0.1% Persteril, 3% Jodonal B or with 76% alcohol. The harvested specimen is washed in saline or in Ringer's solution and placed into a transport medium represented by MEM (minimum essential medium).

Tab. 1. Scheme of the testing of donors of dermal grafts.

Screening	Examination
AIDS	HIV 1/2
Syphilis	BWR
Hepatitis B	HBsAg
Hepatitis C	HCV
Other hepathopathies	ALT

Tab. 2. Donor sites.

Sampling sites	number
trunk of a burnt patient (groin)	13
posterior side of the auricle	9
skin of eye-lids	5
skin of abdomen or breasts	8
others	6
Total	41

The harvested specimen is immediately treated with trypsin to obtain individual keratinocytes which are subsequently used for the primary culture. This culture is deeply frozen after 6 - 8 days and stored at a temperature of -150C for 6 months and after a repeated examination of the donor it is further subcultivated, the cells are grown in passagers and subcultures are started in plastic bottles with a bottom area of 75 cm^2. The time required for the growth of a confluent multilayer amounts to 12 - 14 days. Thus the total duration of the growth of a culture is most frequently about 20 days (18 - 22 days). The culture is grown with a slightly modified Rheinwald - Green's technique.

The grafts are detached with Dispase and subsequently fixed with metallic clips to a vazeline gauze and then saturated with a medium (MEM) of 7.5% (for 30 minutes) and subsequently for 30 minutes with 15% glycerol. After saturation they are placed into the two layers special refrigeration sacs and frozen at a rate of 1C per minute up to -150C. At this temperature they can be stored for several months. Before the application the frozen sac is placed for 1 - 2 minutes into a water bath of 37C. Subsequently it is removed from the sac and washed in MEM without glycerol, placed into a transport medium and taken to the operating theater.

The recipient area of the wound should be, as far as possible, free of bacterial contamination. This is readily attained by a daily application of Dermazin for several days. Immediately prior to the transplantation of the cultured epidermal graft it is no more possible to apply the commonly used antiseptics but they can be replaced by solutions of antibiotics according to the given sensitivy. The graft is placed very carefully on the recipient site (Fig. 1) and over the carrier another layer of fat gauze is placed. Further layers consist of a compress with the solution of antibiotics according to the given sensitivy, as well as several layers of dry cotton gauze. To attain the perfect con-

tact between the graft and the wound it is necessary to pass slightly a roller pin over the site of the graft, and to fix it with an elastic bandage. To attain a better fixation it is mostly required to use staplers and metallic clips.

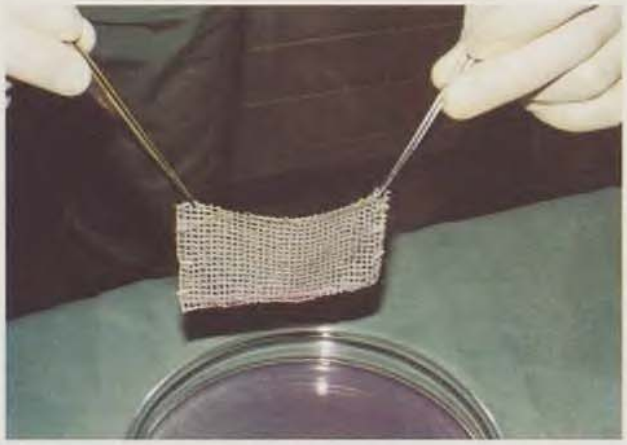

Fig. 1: A cultured epidermal graft fixed with metallic clips to a carrier after removal from the transport medium prior to the application on the burn area .

The dressing is changed for the first time 48 hours after the graft application when it already adheres to the surface of the wound and when the carrier can be easily removed. The wound is usually dry, epithelized and painless. The subsequent management is identical with that applied in conventional conservative treatment of burns (vazeline gauze or Peruvian balsam). After further three days the above mentioned gauze is removed and the wound area remains free for the routine application of oinments.

It is very difficult to determine exactly the " take rate " of temporary healed cultured epidermal allografts. In cases of a massive bacterial contamination of the wound or of a missing corium occur a dissolution and disappearance of the graft as early as within 48 hours. In cases of only slight contamination of a deep dermal burn almost 100% " take rate " follows within 48 hours. In a correct indication this method yields satisfactory epithelialization in about 90% of treated areas.

CASE REPORTS

Patient No. 1 (Figs. 2 - 4)

L. K., a female born on March 19, 1992, aged two years at the time of the injury.

She scalded herself with a hot soup on the chin, anterior part of the neck, chest and of the right arm. The superficial and deep dermal burns amounted to 10% of her total body surface.

Within the first 6 days of in-patient treatment burn shock was treated. The burns were at first treated with compresses of a boric acid solution and subsequently with Dermazine. The superficial burns healed spontaneously. In the centre of the wound persisted deep dermal burn with the exposed corium. On the 12th day after injury cultured epidermal allografts were applied. After 48 hours was recorded an epithelialization of the whole burn area.

Fig. 2: Patient No. 1 - prior to the application of the cultured epidermal allograft.

Fig. 3: Patient No. 1 - cultured epidermal allograft in situ.

Fig. 4: Patient No. 1 - 48 hours later, immediately after the removal of the carrier.

Patient No. 2 (Figs. 5 - 7)

M. M., a male born on October 20, 1992, aged 18 months at the time of the injury.

He was burned with hot coffee on the chin and on the anterior part of the neck and chest. The superficial and deep dermal burns affected 20% of the total body area .

Fig. 5: Patient No. 2 - prior to the application of cultured epidermal allografts.

Fig. 6: Patient No. 2 - the cultured epidermal allograft in situ.

Fig. 7: Patient No. 2 - 48 hours later, immediately after the removal of the carrier.

The burned areas were treated at first with compresses of a solution of boric acid and from the 5th day with Dermazin - once daily. On the 10th day of in-patient treatment he had on the anterior part of his trunk rather well delimited area of a deep dermal burn with a denuded corium. The other superficial burns were healed. On the exposed corium were applied cultured epidermal allografts which were covered with vazeline gauze and with dry gauze. At the time of the rebandage after 48 hours the wound was healed.

DISCUSSION

During the initial period cultured epidermal allografts play the same role as classic grafts by replacement the missing keratinocytes on the surface of deep dermal burns. However, after 9 - 14 days they are rejected as a foreign body and they are gradually replaced by the keratinocytes of the recipient (5).

The secretion of various cytokines which activate the mitotic activity, migration and proliferation of keratocytes of the recipient during the period of temporal "take" is produced by the cultured epidermal allografts affecting a maximum mobilization of the healing potential of the wound. In deep dermal burns this mobilization is so marked that during the above mentioned period occurs epithelialization even in these wounds which would normally undergo a change to full-thickness burns.

A certain number of the above mentioned cytokines has already been defined. Well-known are: the Epidermal Growth Factor (EGF), the basic Fibroblast Growth Factor (bFGF), Platelet Derived Growth Factor (PDGF), Transforming Growth Factor (TGF-beta and TGF-alpha), Nerve Growth Factor (NGF), Insulin Like Growth Factor (IGF), Interleukin-1 (IL-1) and Interleukin-6 (IL-6) etc. It is quite certain that some further factors and their interactions have not been recognized yet.

The application of cultured epidermal allografts is obviously associated with numerous so far unknown questions, both in theoretical and in practical views.

1. Would it be possible to attain the same effects by the application of cells treated in some other way (e.g. in the form of suspension) or in a subconfluent form on a collagenous or some other carrier?

2. Would it be possible to attain the same effect by the application of so far defined cytokines alone (EGF, IGF, TGF, PDGF) into the wound without the participation of a cellular component (6)?

3. What are the risks of transmitting of an infectious disease to the recipient, even the donors are examined with all currently requested tests?

4. What is the proportion of this risk to the positive effect of the application of cultured epidermal allografts?

5. What procedures would be most convenient for the storage and transport of these grafts for a more wide-spread use?

At present it can be stated that the effect of cultured keratinocytes applied in the form of a suspension or in subconfluent form is less marked than the effect of cultured epidermal multilayer (7). Similarly the composition of all effective cytokines and their interrelations remain so far unknown and therefore their direct application does not yield results which could be compared with the action of the secretion of live donor skin cells.

The risk of a damage to the recipient by transmitting an infectious diseases is negligible assuming that the donor is subjected to all the requested studies, inclusive of the interval of 6 months prior to repeated examinations since a conversion of the serum would occur during this period. According to Buck (8) the probability of AIDS transmission by allografting of human tissue (bone) amounted in the conditions of the USA to 1 : 1 500 000. The production of cultured grafts from one donor which would be carried out on a larger scale could give positive economic results in spite of the high costs of these procedures.

For the storage of cultured epidermal grafts cryopreservation with an ad hoc defrosting at the time of application seems to be most convenient.

CONCLUSION

According to our experience the treatment of deep dermal burns with cultured epidermal allografts provides quick and effective procedure enhancing their epithelialization which combines the rapid healing attained otherwise by a surgical excision and by autografting with maintaining all the vital elements in the deeper layers of the dermis, as it can be seen during the conservative therapy.

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PORT-WINE STAINS: LONG TERM HISTOLOGIC CHANGES INDUCED BY ARGON AND CO_2 LASER TREATMENT

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SUMMARY

A good success rate has been achieved using argon and CO_2 laser in the treatment of port-wine stains. So far however only a few studies have been published concerning the long term histologic changes in the irradiated skin. In the present study we report our findings from skin biopsies in patients treated for port-wine stains with argon and CO_2 lasers. The results show that in spite of the high level of selectivity of optical absorption of argon emission by hemoglobin, after 3 - 9 months there is histologic evidence of connective proliferation and reactive fibrosis of the necrotic dermis comparable with that resulting from CO_2 emission.

ZUSAMMENFASSUNG

Port-Wine Flecke: langzeitige histologische Veränderungen nach der Behandlung mit Argon und CO_2 Laser

G. L. Campiglio, P. Candiani, L. Maturri

Hohe Raten von Erfolgen wurden nach der Behandlung von Port-Wein Flecken mit Argon und CO_2 Laser, verzeichnet. Vorläufig gibt es jedoch nur wenige Berichte über die langzeitigen histologischen Veränderungen der bestrahlten Haut. Die vorliegende Mitteilung berichtet über die anhand der Haut-Biopsien erhobenen Befunden bei Patienten die wegen Port-Wein Flecken mit Argon und CO_2 Laser behandelt wurden. Die Ergebnisse zeigten dass trotz der hohen Selektivität der optischen Absorption durch Hämoglobin, nach 3 - 9 Monaten histologische Zeichen einer Proliferation der Bindegewebes und eine reaktive Fibrose der nekrotischen Dermis bestehen, die mit den nach der Emission von CO_2 übereinstimmen.

Key words: port wine stain, laser theraphy, histopathology

Port-wine stain is a venous malformation within the dermis. Clinically it appears as a flat stain, varying in colour from pink to dark red and normally present from birth or in a few cases shortly after. It is often situated in the cephalic region, affecting in particular the skin area corresponding to the trigeminal distribution. Sometimes it occurs in the trunk or limbs, with the characteristic resemblance to a geographic map (4).

Like all vascular malformations the lesion is permanent. It follows the somatic growth of the patient, in time developing small sessile pedunculated tumors. In 2 - 5% of cases the port-wine stain is part of a more complex pathology such as the Sturge-Weber syndrome (trigeminal distribution of the stain associated with vascular malformation of the homolateral leptomeninges with or without cortical calcification and oligophrenia), the Beckwith-Weidemann syndrome (facial port-wine stain, hyperplasia of the Langerhans cells and hepatic hypertrophy) or the Klippel-Tranaunay-Weber syndrome (port-wine stain, venous malformations with or without artero-venous fistulas and hyperthrophy of the soft tissues and bones of the lower limbs ; 8, 17).

Among the wide range of treatments available for vascular malformations, laser theraphy is effective above all in treating port-wine stains because the vascular structures of the lesion are situated in the upper dermis and therefore easily reached by laser emission (1, 2, 6, 7, 8, 10, 11, 14, 18).

In spite of the widespread use of laser theraphy, however, only a few histomorphologic studies have appeared in the literature, mostly dealing with the short term effects of the treatment (2, 9, 12, 15, 16). Here we report the results of a study on the long term effects on skin tissues following treatment of port-wine stains with argon and CO_2 lasers.

MATERIAL AND METHOD

Following infiltration of the lesion with 1% lidocaine skin biopsies from port-wine stain were taken in 11 patients of both sexes, aged between 7

and 24 years prior to laser treatment and at 3 - 9 months after treatment.

The tissue fragments were fixed in 4% calcic formalin buffered (pH 7.2) at 4C. After 24 hours the specimens were rinsed and subsequently dehydrated using alcohol baths at increasing concentrations. After dehydration the fragments were embedded in paraffin, cut into 5 micron sections and stained using various techniques (hematoxylin-eosin, Azan-Mallory, Weigert-Van Gieson).

CO^2 laser: It was used a 1.5 - 3.5 Watts laser in a continuous wave mode (spot size 2 mm). The radiation emitted (far infrared) is readily absorbed by water, thus the optical and thermal penetration of the laser is minimal and the effects are evident only between 30 and 50 microns below the surface. This type of laser produces obliteration of the vascular network present in the upper dermis only after coagulation or evaporation of all the epidermis.

Argon laser: The apparatus used emits a blue-green light (wave length 488 - 514 nm) with a power of 1 - 2 Watts and an exposure of 0.2 sec (spot size 2 mm). About 80% of the light energy is absorbed by hemoglobin molecules, red being the colour complementary to argon laser light. The light beam penetrates the skin surface to reach the lesion where the energy absorption causes photocoagulation of vessels with a diameter of 0.5 mm max. situated at a depth of 1 - 1.5 mm.

RESULTS

The light microscopy examination of the biopsy specimens taken prior to laser treatment revealed the typical histologic appearance of the lesion (Fig. 1).

At 3 months from CO^2 laser treatment it was found that the epidermal component had regenerated and scar tissue had formed in the upper dermis, indicating widesperead connective proliferation. In the deeper dermis there was extensive nonspecific chronic phlogosis of varying intensity. On the other hand in the argon laser treated patients we found complete reepithelization of the lesion, flattening of the papillary ridges and transformation of the granulation tissue into compact scar tissue rich in collagenous fibres (Fig. 2).

After 9 months histologic findings in the CO^2 laser treated patients showed clear evidence of dermal fibrosis and persisting lymphocytic infalammatory perivascular infiltrates (Fig. 3). Argon laser treatment did not appear to modify the epidermal structure and at the same time the melanocyte population was preserved. Furthermore intense fibrosis was found in the papillary dermis with partial preservation of skin appendages. Inflammatory infiltrate were absent and clinically successful cases there was a clear evident transformation of vascular structures into narrow cavities of small diameter within the newly formed connective tissue (Figs. 4, 5). There were no apparent alteration of nerve structures.

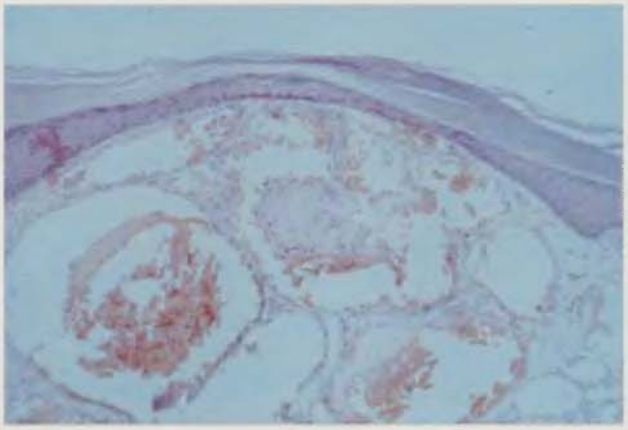

Fig. 1: Untreated port-wine stain. Thin walled dilatated blood vessels containing agglutinated erythrocytes are present within the dermis (Hematoxylin-eosin X 75).

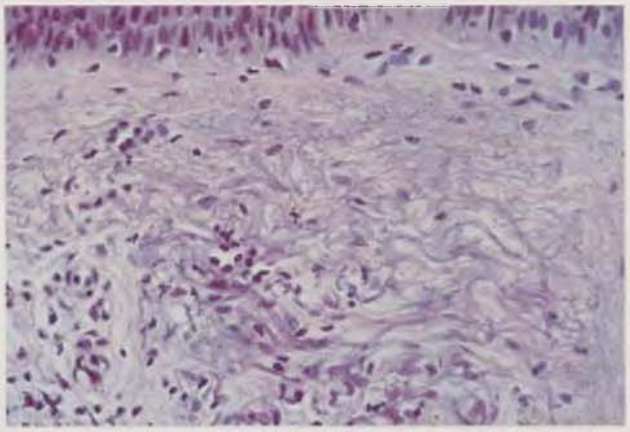

Fig. 2: Port-wine stain 3 months after argon laser treatment. Note the normal epidermis, the flattening of the papillary ridges and the fibrosis of the dermis (Hematoxylin-eosin X 200).

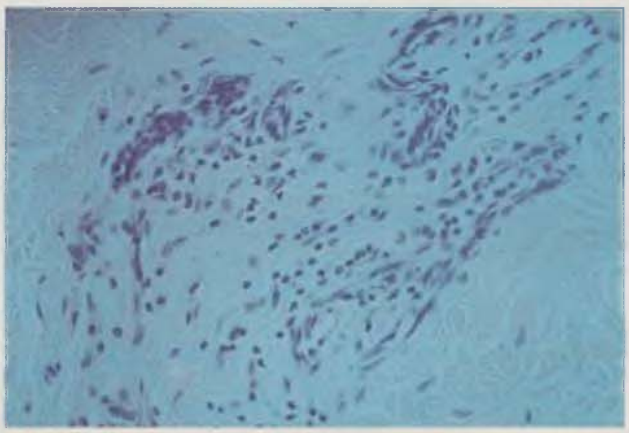

Fig. 3: Port-wine stain 9 months after CO^2 treatment: widespread reactive fibrosis of the dermis (Hematoxylin-eosin X 400).

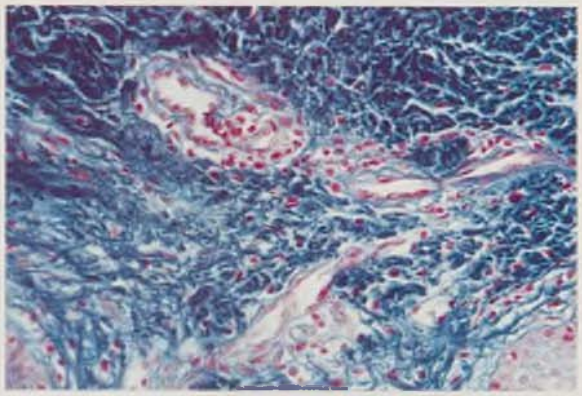

Fig. 4: Nine months after the argon laser treatment the dermal vessels are transformed into narrow cavities of small diameter (Azan-Mallory X 200).

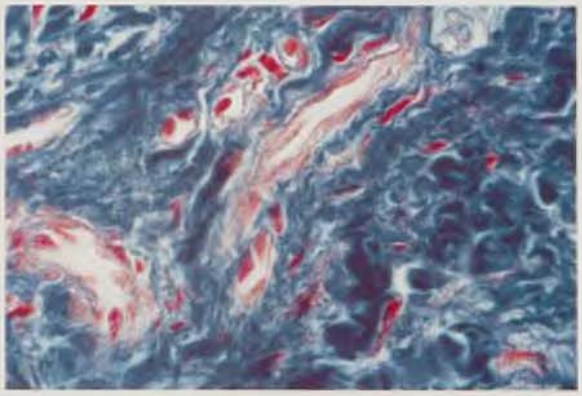

Fig. 5: Few residual vessels surrounded by diffuse dermal fibrosis (Azan-Mallory X 400).

Fig. 6: Dilatated and thickened wall dermal vessels in one case of poor clinical result (Azan-Mallory X 100).

In cases where the clinical situation remained unchanged even after treatment it was often found that in addition to papillary dermal sclerosis and elastosis the vascular structures were often numerous and dilatated (Fig. 6). This finding was observed in 2 cases where the vascular structure was characterized by a considerable thickening of the vessel wall due to the presence of fibromuscular tissue.

CONCLUSIONS

It can be concluded that argon and CO^2 laser treatment of port-wine stains results in the reduction and/or the disappearance of the vascular structures replaced by sclerosis. With the argon laser a good to excellent result is generally achieved in over 70% of cases (18). Moreover it appears that the more superficial the lesion the better the outcome. The degree of damage of the tissues surrounding the lesion depends on the type of laser used and on the biological characteristics of the treated tissue. With CO^2 laser treatment the thermal effect on the tissues is completely nonspecific because the radiation is absorbed by water. However, even with the argon laser, in spite of high selectivity of the optical absorption of hemoglobin, the therapeutic effect is achieved through thermal damage initially to the vascular lesions but subsequently to the other skin structures with histologic evidence of connective proliferation and reactive fibrosis of the necrotic dermis. In the long term the residual skin appendages, like the epidermis, do not appear to undergo any changes, apart from melanocyte activation. The precise pathogenetic mechanism of this phenomenon has not yet been clarified but it is probably related to the thermal stimulation of melanogenesis as in the case of superficial burns (5). Finally, it is likely that the large amount of collagen deposited in the papillary dermis also contributes indirectly to the favourable clinical outcome by obscuring the deeper vascular lesions not reached by the laser beam.

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CRANIOFACIAL GROWTH AND DEVELOPMENT IN UNILATERAL CLEFT LIP AND PALATE: CLINICAL IMPLICATIONS (A REVIEW)

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SUMMARY

The main problem of facial development in cleft palate consists of deficient anterior growth of the upper jaw. Roentgencephalometric data showed that the sagittal jaw relations deteriorated gradually from palate surgery up to adulthood. In spite of this adverse trend of growth, orthodontic therapy succeeded in improving the occlusion of incisors during prepubertal period. However during the pubertal growth spurt occurred an impairment of occlusion which was caused by the depletion of compensatory dentoalveolar mechanisms of the jaws due to the previous orhodontic treatment. An effective compensation of the gradual impairment of sagittal jaw relations can be attained with fixed appliances. These observations showed that the main problems of facial growth in clefts developed only after palate surgery and in particular during puberty.

For favourable sagittal jaw relations and the configuration of the facial profile is of paramount importance the restoration of a positive overjet which exerts marked effects on the position of the mandible. On the other hand the configuration of the facial profile and the results of orthodontic therapy are affected by the rotation of the lower jaw and the amount of posterior displacement of the TM joint, which represent inborn growth patterns of the skull. The most favourable developmental situation represents the posterior displacement of the TM joint associated with neutral type of rotation. Therefore, it is of importance to predict the development of these characteristics.

ZUSAMMENFASSUNG

Kraniofaziales Wachstum und Entwicklung bei einseitigen Lippen- und Gaumenspalten: klinische Bedeutung. Ein Übersichtsreferat

Z. Šmahel, Ž. Müllerová

Das Hauptproblem der Gesichtsentwicklung bei Gaumenspalten besteht in der Wachstumsinsuffizienz des vorderen Oberkiefers. Roentgenzephalometrische Befunde zeigen, dass eine allmähliche Verschlechterung der sagittalen Verhältnisse zwischen den beiden Kiefern im Zeitraum von der Gaumenoperation bis in das erwachsene Alter vorhanden sind. Trotz dieser ungünstigen Wachstumstenden bewirkte die orthodontische Behandlung eine Besserung der Okklusion der Schneidezähne im Verlauf der prepubertalen Period. Während des pubertalen Wachstumsspurts kam es jedoch zu einer Störung der Okklusion, die die durch die Depletion des dentoalveolaren Kompensationsmechanismus, bzw. durch die früher stattgefundene orthodontische Behandlung bedingt war. Eine wirksame Kompensation der allmählichen Verschlechterung der sagittalen Verhältnisse zwischen beiden Kiefern konnte durch die Anwendung von fixierten Apparaturen erzielt werden. Diese Beobachtungen zeigten, dass die grössten Probleme des Gesichtswachstums bei Spaltmissbildungen erst nach der chirurgischen Operation des Gaumens und insbesonders im Laufe der Pubertät auftraten.

Für eine günstige sagittale Beziehung zwischen beiden Kiefern und für die Konfiguration des Gesichtsprofiles ist von grosser Bedeutung die Wiederherstellung eines positiven Überbisses der einen starken Einfluss auf die Position des Unterkiefers ausübt. Dem gegenüber sind sowohl die Konfiguration des Gesichtsprofiles und die Erfolge der orthodontischen Therapie beeinflusst durch die Rotation der Unterkiefers und den Grad der rückwertigen Lage des TM Gelenkes, die durch angeborne Wachstumstypen des Schädels bedingt sind. Die günstigste Situation für die Entwicklung war die rückwertige Verlagerung des ZM Gelenkes, die mit einem neutralen Typ der Rotation verbunden war. Deswegen ist von besonderer Bedeutung die Prädiktion der Entwicklung dieser Charakteristiken.

Key words: cleft lip and palate, craniofacial growth, overjet, compensatory mechanisms, mandibular growth patterns

The main problem of facial development in cleft lip and palate consists of the deficient anterior growth of the upper jaw. While in controls the upper face growth in forward and downward direction, in clefts predominates its growth in downward direction. The development of the lower jaw is characterized by the predominant growth in vertical direction as well, with an elongation of the lower face, but the deficiency of anterior growth is much less marked than in the upper jaw. This results in a retrusion of the maxilla, flattening of the face, impairment of sagittal jaw relations and in the development of anterior crossbite. In clefts the steep slope of the mandibular body remains unchanged from infancy up to adulthood (the mandible moves vertically) while in controls the face undergoes anterior growth rotation.

The development of three clinically important characteristics from palate surgery at 5 years till adulthood based on mixed longitudinal roentgencephalometric data is presented on Figure 1. The sagittal jaw relations deteriorated gradually throughout the whole period and thus the difference from controls which was absent prior to palate surgery, gradually increased. In spite of this adverse trend of growth, orthodontic therapy succeeded in improving the occlusion of incisors from an anterior crossbite after the eruption of permanent incisors to the restoration of a positive overjet at the age of 12 years. However during the pubertal growth spurt occurred an impairment of occlusion and even an intense orthodontic therapy with removable appliances failed to maintain the previously attained good results. After the termination of puberty it was again possible to improve the occlusion of incisors. At the age of 5 years the prominence of the upper lip was still unchanged and then deteriorated simultaneously with sagittal jaw relations, contrary to controls, where it did not change (the slight improvement in patients at the age of 12 years was due to the attained positive overjet). These observations showed that the main problems of facial growth in clefts developed only after the palate surgery and in particular during puberty.

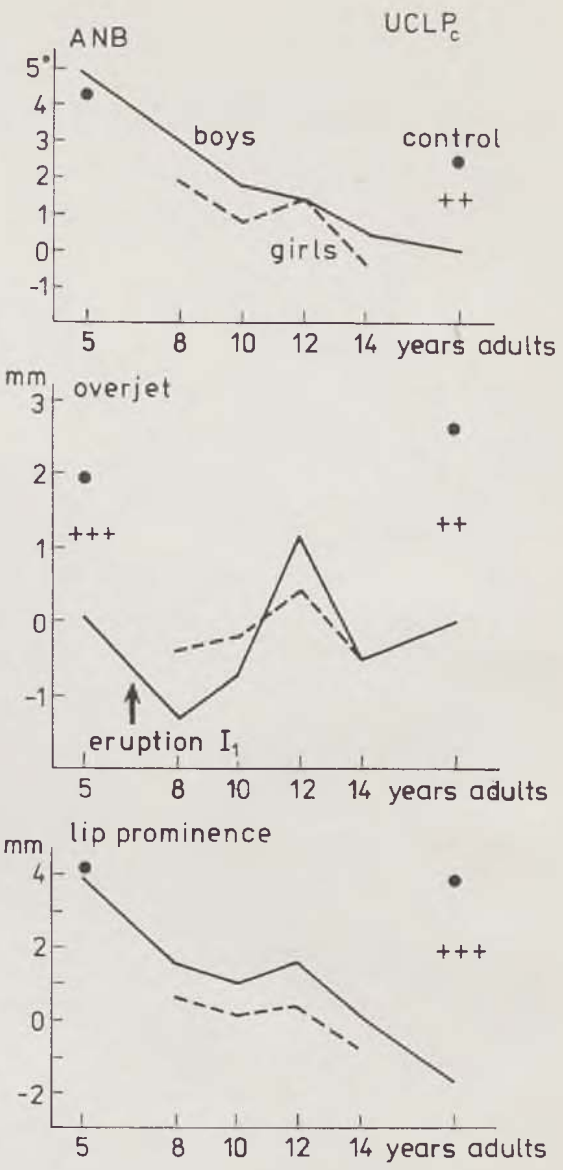

Fig. 1: Growth curves of sagittal jaw relations (ANB), overjet and upper lip prominence from the time of palate surgery up to adult age (patients without bony graft or periosteal flap; + = significant difference between clefts and controls at $p < 0.05$, ++ = $p < 0.01$, +++ = $p < 0.001$).

An impairment of overjet during the period of puberty was not caused by a higher growth rate but rather by the depletion of compensatory dentoalveolar mechanisms of the jaws due to the previous orthodontic treatment. The main compensatory mechanism represents the proclination of upper incisors and of the alveolar process which lead to the restoration of a positive overjet. During the prepubertal period it was possible to improve the proclination of upper incisors much more markedly then during puberty (Fig. 2). Therefore it was possible to improve the overjet in spite of the deterioration of sagittal jaw relations (see Fig. 1). However, during puberty a steadily increasing disproportion between the anteroposterior position of both jaws could not be adequately compensated after the depletion of the mentioned compensatory mechanism and the overjet deteriorated in direct proportion with impairment of sagittal jaw relations (correlation coefficient = 0.577, $p<0.001$ contrary to 0.121 in prepubertal period). These observations provide evidence why an impairment of occlusion was recorded only during a certain period of time, while sagittal jaw relations deteriorated steadily after palate surgery. This illustrates also why after early palate surgery the development of dental and skeletal parameters could appear as favourable throughout a prolonged period of time (Robertson and Jolleys, 1974). The differences could occur much later (Blocksma, 1975). It is not possible to exclude that the earlier the surgical and orthodontic treatment the sooner followes the exhaustion of

compensatory mechanisms of jaws. Therefore an assessment of the effect of age at the time of surgical repair on the development of the face and dentition is possible only after the termination of growth.

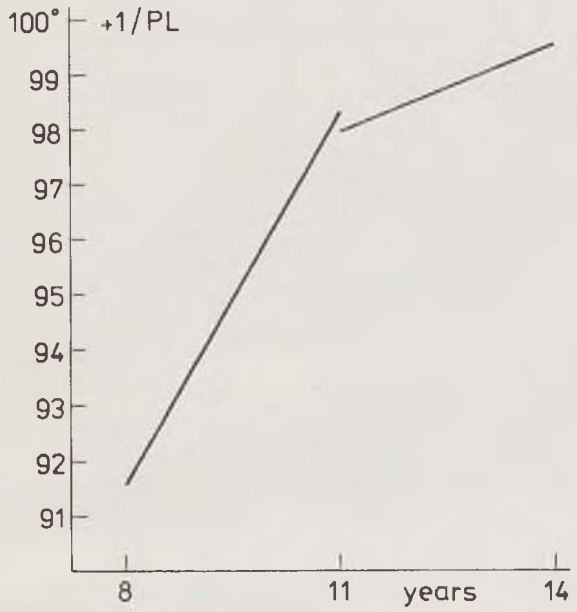

Fig. 2: Changes of inclination of upper incisors during prepubertal and pubertal periods.

However, the action of compensatory mechanisms can be promoted by the use of fixed appliances. Our results showed that an improvement of overjet could be attained with fixed appliances even in the presence of a more marked impairment of sagittal jaw relations (Šmahel and Müllerová, 1994 a). This was due to the greater efficiency of fixed appliances as compared to removable appliances in attaining a larger proclination of both the upper incisors and the alveolar process. The restoration of a positive overjet and overbite is of paramount importance for the development of favourable sagittal jaw relations and configuration of the facial profile since they exert a marked action on the position of the mandible. This fact was confirmed by the analysis of 64 adult males with isolated cleft palate and with almost regularly restored positive overjet. They were subdivided into three groups according to the degree af maxillary retrusion. The Table 1 illustrates that in a maintained positive overjet the increasing retrusion of the maxilla (SNA) displaces the mandible backwards (SNB) and the sagittal jaw relations (ANB) remain almost unchanged. The same results were obtained after the subdivision of patients into five groups. These observations indicate that the restoration of a positive overjet and overbite represents a highly effective mechanism exerting favourable effects on the position of the lower jaw and on the configuration of the facial profile in individuals with clefts. Therefore patients with unilateral cleft lip and palate who neglected orthodontic therapy differed in adult age from individuals who underwent systematic treatment by the anterior position of their lower jaw, while there was no difference in the retrusion of the upper jaw (Šmahel, 1994). The mandibular posterior displacement was attained in adequately treated patients by the restoration of an overbite resulting in a restriction of the forward development of the mandible. This was cofirmed by a subsequent analysis during which the patients were subdivided according to the final result of orthodontic treatment. Patients with a restored overbite had marked displacement of the mandible backwards with a retroinclination of its branch. In these cases where a positive overjet was not restored the mandible was displaced forwards. There were, again, no differences in the retrusion of the maxilla. Thus impaired sagittal jaw relations should be compensated in the first place by the change of the position of the lower jaw which can be attained by the restoration of a positive overjet. It is mandatory to restore a positive overjet as soon as possible after the eruption of permanent incisors. This can be effective in the prevention of a mandibular protrusion and negative sagittal jaw relations.

Tab. 1. Sagittal jaw relations (ANB) and position of the mandible (SNB) in adult males with isolated cleft palate subdivided into three (up) or five (down) groups according to the degree of maxillary retrusion (SNA).

SNA group range	SNA mean	SNB mean	ANB mean	n
80 -	82.4	80.9	1.5	21
75 - 79	77.0	77.0	0.0	21
- 74	71.6	71.6	0.0	22
82 -	84.1	82.4	1.7	11
79 - 81	80.0	78.7	1.3	15
76 - 78	76.8	76.9	-0.1	13
73 - 75	73.7	73.6	0.1	12
-72	70.5	71.0	-0.5	13

The results of orthodontic therapy and the growth and development of the face are interrelated and mutually affected. Thus on the other hand the configuration of the facial profile and the results of orthodontic therapy are affected by the rotation and growth direction of the lower jaw, which represent inborn growth patterns of the skull. Clefts are associated with relatively small changes of mandibular rotation (Šmahel and Müllerová, 1994 a) and for therapeutic results are unfavourable anterior as well as posterior growth rotation. Between the age of 10 to 15 years it was not possible to improve anterior crossbite, even in the presence of posterior growth rotation (Šmahel and Müllerová, 1994 b). This is most probably due to the tendency to an open bite during posterior rotation with a simultaneous proclination of lower incisors and of the alveolar process or with an anterior displacement of the lower jaw. This was confirmed by calculation of

correlation coefficients. Posterior growth rotation underlines further the vertical disproportion of the face. Anterior growth rotation has an even more marked untoward effect on the development of the face and occlusion of incisors resulting in the development of mandibular prognathia. The most favourable was the neutral type of rotation.

The direction of the growth of the lower jaw was assessed according to the extent of posterior displacement of the mandibular joint towards the sella turcica. Though it does not represent an actual condylar growth of the jaw its assessment is useful for the practice. A posterior displacement by about 3 mm between 10 and 15 years of age, i.e. by more than 0.5 mm per year had a favourable effect on the configuration of the lower face and provided the possibility to attain an overbite (Šmahel and Müllerová, 1994 b). This shift resulted in a displacement of the lower jaw backwards and thus did not lead to a disproportion between the functional length of both jaws. It also had no effects on the vertical disproportion of the face. Therefore, it is useful to assess and predict the development of this characteristic as well as the rotation of the face. The most favourable developmental situation represents the posterior displacement of the mandibular joint associated with neutral type of rotation.

The therapeutic results depend equally on the extent of the growth of the maxilla in anterior direction which varies in individual patients, however on the average it attains about one third of the normal maxillary growth. Of a certain importance is also the angle of the cranial base. Our results showed that individuals with a flat base had a slightly better chance of the restoration of a positive overjet as compared to individuals with a more acute angle. Since only very little is known on mechanisms of action of individual growth patterns as well as on their heredity and the possible effects of orthodontics and jaw orthopedics it is necessary to continue with studies into these problems. These growth patterns could be of major importance for the development of the face in individuals with craniofacial malformations. However, clinical trials on patients with these malformations should be based on studies of normal population samples.

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