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EXTRA-ANATOMICAL RECONSTRUCTION OF THE OESOPHAGUS

Tvrdek M.¹, Pafko P.²

¹Department of Plastic Surgery, 3rd Medical Faculty

²3rd Department of General Surgery, 1st Medical Faculty,
Charles University, Prague, Czech Republic

SUMMARY

The authors present the case of a 53-year-old patient with spinocarcinoma of the thoracic part of the oesophagus. The thoracic part of the oesophagus was resected, and the resulting defect was dealt with in several stages with regard to complications. First, the stomach was interposed; subsequently, an attempt was made at reconstruction using the colon and a loop of the small intestine. All these attempts at reconstruction failed, and the resulting condition was oesophagostomy and nutritive jejunostomy. In light of the patient's general condition, past surgical operations and the size of the defect, a stage-wise extra-anatomical reconstruction using tubed flaps was made.

ZUSAMMENFASSUNG

Extraanatomische Rekonstruktion der Ösophagus

Tvrdek M., Pafko P.

Autoren beschreiben einen Fall des 53 jährigen Patienten mit einem Stachelzellenkarzinom im Brustteil des Ösophagus. Der Brustteil des Ösophagus wurde reseziert und der Defekt wurde angesichts der Komplikationen etappenweise behandelt. Zuerst wurde der Magen interponiert, dann wurde eine Rekonstruktion mittels des Grimmdarms und der Dünndarmschleife durchgeführt. Alle diese Rekonstruktionsversuche wurden erfolglos und die Oesophagostomie und Ernährungsjejunostomie mussten ausgeführt werden. Mit Rücksicht auf den Gesundheitszustand des Patienten, vorangehende Eingriffe und den Umfang des Defektes, eine extraanatomische Rekonstruktion durch tubuläre Lappen wurde etappenweise durchgeführt.

Key words: oesophageal carcinoma, oesophagectomy, reconstruction, skin flaps

CASE-REPORT

In a 53-year-old patient with a history of myocardial infarct, aortocoronary bypass, duodenal stenosis on account of an extramural lipoma and surgery of restenosis resolved by a gastroenteroanastomosis, a spinocellular carcinoma of the thoracic portion of the oesophagus was diagnosed in 1997. Resection was performed with interposition by the stomach and a cervical anastomosis. The course was complicated by necrosis of the interposed stomach, which called for its removal and the implementation of cervical oesophagostomy and nutritive jejunostomy (Fig. 1). The condition was further complicated by associated cardiac problems, sepsis and respiratory insufficiency, which called for long-term mechanical pulmonary ventilation. After stabilization of his condition, the patient was prepared for reconstruction of the oesophagus by the colon. He had

this operation in February 1998, but an inadequate blood supply made substitution by the colon or a loop of the small intestine impossible. The operation was finished only by dextrorotational hemicolectomy. In June 1998 followed a partial reconstruction of the oesophagus by a loop of the small intestine, which was interposed subcutaneously and ended blind 5 cm above the costal arch. Further reconstruction by a free transfer of part of the jejunum was abandoned.

At this stage the cooperation of a plastic surgeon was requested. The patient was troubled by salivary secretion from the oesophagostomy, the surroundings of which were permanently macerated. Nutrition was ensured by jejunostomy, but with regard to the marked reduction of the small and large intestine the condition was associated with imperative diarrhoea.

The length of the defect of the digestive tube was 31 cm. Because reconstruction by transposi-



Fig. 1. The patient before reconstruction, flap outline



Fig. 2. The tubed flap created



Fig. 3. The skin defect temporarily covered by a xenograft



Fig. 4. After second stage of reconstruction – anastomosis of the oesophagostomy with the upper part of the newly created tube



Fig. 5. Final result after last stage of reconstruction – connection of the distal end of the created tube with the blind intestinal stump

tion of a musculocutaneous flap from the m. rectus abdominis was not possible due to the use of the interna mammary arteries during cardiosurgery, the authors decided on a stage-wise extra-anatomical reconstruction with tubed skin flaps. The plan of reconstruction was also elaborated with regard to the patient's general condition, to make the operations untroublesome as possible.

In August 1999 the first stage of the reconstruction was implemented. From the jugulum to the level of the costal arch a skin flap 8 cm wide was circumcised. Its lateral thirds were mobilized and a tubed flap was created (Fig. 2). The skin defect which resulted was temporarily covered by a xenograft and after an interval of two days by a meshed dermoepidermal skin graft (Fig. 3). The postoperative course was without any complications. The subsequent stage of reconstruction, anastomosis of the oesophagostomy with the upper part of the newly created tube, had to be postponed

because the patient had to have a cholecystectomy and closure of an intestinal fistula on account of perforating gangrenous cholecystitis. This stage of reconstruction was started only after stabilization of the general condition and proper realimentation of the patient in October 2000. For connection, again tubulization of a skin flap was used as in stage one. The skin defect was covered in the same way, i.e. by a dermoepidermal graft. The postoperative course was complicated by the development of a salivary fistula which, however, closed spontaneously within one week (Fig. 4).

In December of the same year followed the last stage of reconstruction – connection of the distal end of the created tube with the blind intestinal stump. After a four-week interval the pa-

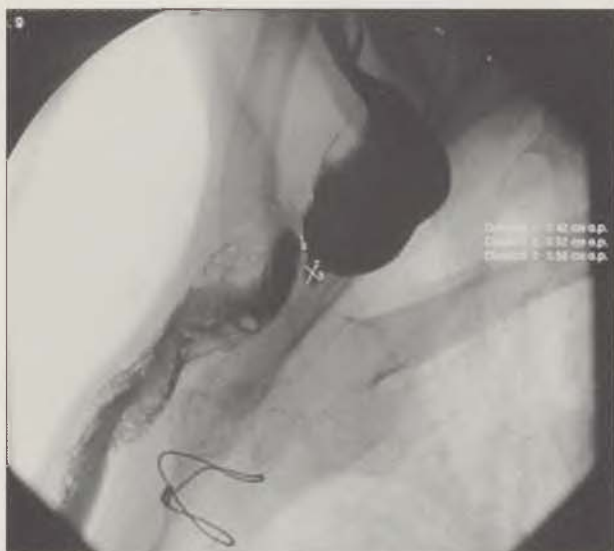


Fig. 6. Contrast X-ray examination demonstrating deteriorated patency at the site of upper anastomosis caused by bending



Fig. 7. Contrast X-ray examination demonstrating restored patency

tient was able to ingest liquids and partly also thin homogenized food (Fig. 5). After another two months the patency at the site of the upper anastomosis deteriorated at the transition of the cervical part of the oesophagus and the reconstructed tube. The deteriorated patency was also confirmed by contrast X-ray examination. On its basis a surgical revision was made, which did not

reveal stenosis at that site, only bending which caused deteriorated patency (Fig. 6). By shortening the tube at the site of the original proximal anastomosis, its course was straightened and satisfactory patency was restored (Fig. 7). The patency and possibility of intake of fluids and a thin homogenized diet persists.

CONCLUSION

Reconstruction of the thoracic portion of the oesophagus after its resection on account of carcinoma by interposition of the stomach, colon or loop of the small bowel are commonly used procedures. Another possibility, depending on the extent of the defect, is also reconstruction by a free transfer of part of the jejunum. A defect of the oesophagus of 31 cm would call for the transfer of a portion of the jejunum on two arcades of mesenteric vessels. The latter possible reconstruction, although it would be the most physiological, was out of question with regard to the patient's general condition and previous operations. Replacement by a transposed musculocutaneous flap from the m.rectus abdominis was not feasible due to the absence of the aa.mammariae internae, which were used for an aortocoronary bypass. Extra-anatomical reconstruction by tubular skin flaps made possible bridging of the defect, free salivary flow, and the intake of fluids and thin homogenized food. Nutritive jejunostomy was preserved. The implemented reconstruction certainly is not optimal replacement, but under the given conditions it was perhaps the only possibility that contributed markedly to an improvement of the patient's quality of life.

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Address for correspondence:

M. Tvrdék
Šrobárova 50
100 34 Prague 10
Czech Republic

REDUCTIVE MAMMAPLASTY WITH SUPERIOR-BASED PEDICLED DERMO-GLANDULAR FLAP: OUR EXPERIENCE

Valeriani M., Mezzana P., Madonna Terracina F. S.

Operative Unit of Plastic Surgery, S. Filippo Neri Hospital, Rome, Italy

SUMMARY

The authors used a reductive mammoplasty technique with superior pedicled dermoglandular flap described by Laldrie in 1972 and modified by Lauro. Twenty-eight patients who presented medium to heavy macromasty were treated. In all these cases the aesthetic result was very satisfactory and major complications, like extended tissue necrosis, were not encountered.

This method proves safe and effective in cases of significant gigantomasty for the following reason: for the efficient vascularization of the flap, it is possible to carry out significant transposition of the areola-nipple complex without risk of complications.

This technique can be used in less serious cases in conjunction with other equally easy techniques. Because of its simplicity, this technique also allows younger, less experienced, surgeons to approach this type of surgery with the necessary peace of mind.

ZUSAMMENFASSUNG

Brustreduktion mit proximal gestieltem dermo-glandularen Lappen

Valeriani M., Mezzana P., Madonna Terracina F. S.

Die im 1972 von Laldrie beschriebene und von Lauro modifizierte Methode der Brustreduktion mit dem proximal gestielten dermo-glandularen Lappen, wurde von Autoren dieses Beitrages angewandt. 28 Patienten mit der mittleren und schweren Makromastie wurden mithilfe dieser Methode behandelt. Hinsichtlich des ästhetischen Aussehens waren die Ergebnisse bei allen Patienten sehr gut. Komplikationen wie die Nekrose der Gewebe, wurden nicht bemerkt. Zur Behandlung von schweren Gigantomastien erwies sich diese Methode als sicher und effizient. Einerseits ist die Gefäßversorgung des Lappens sehr gut, andererseits besteht hier die Möglichkeit ausgedehnte Transpositionen des areolomamillären Komplexes ohne Risiko der Komplikationen ausführen. Diese Methode kann auch zur Behandlung von leichtereren Fällen benutzt werden. Dank ihrer Einfachheit können auch jüngere und weniger erfahrene Chirurgen zu dieser Art von Eingriffen schreiten.

Key words: reductive mammoplasty, breast surgery, gigantomasty

The serious aesthetic disadvantage and the manifold psychological and physical problems that characterize women with macromasty, led surgeons to search for more refined techniques with the smallest number and size of residual scars.

The first description of a reductive mammoplasty in the literature dates back to 1669 and it is ascribed to Durston (3).

We must wait until 1957 to have a description of a modern technique that revolutionized reductive breast surgery: Ariè proposed a total skin and gland resection on the inferior pole, a lifting of areola-nipple complex on a superior pedicled flap and a single vertical scar (1).

The limit of this technique is its indication only for the treatment of medium hypertrophies.

In 1970 Lassus described a superior-pedicle technique with a single vertical scar, referring to the technique described by Ariè but extending the indication also to pronounced macromasty, with an extension of the vertical scar beyond the sub-mammary sulcus when necessary (9); particularly in major hypertrophies, Lassus combined Ariè's vertical scar philosophy with a lateral areolar vascular flap according to Skoog's method (2).

The limitations of this technique are the extreme projection with a cone shape of the breast and the excessive length of the vertical scar. Another limitation of the single vertical scar techniques is the intra-operative difficulty of setting the limits of the glandular resection differently from the inverted T techniques, as the tissue resection is central and posterior in most cases.

Tab. 1. The "ten S" rule

SINGLE STAGE PROCEDURE
SIMPLE PROCEDURE
SPEEDY PROCEDURE
SAFE PROCEDURE
SENSITIVITY PRESERVED
SHAPE OF CONE
SMALL BREAST
SYMMETRY
STABLE RESULT
SCAR LIMITED

The Lassus technique was further developed by Lejour, who used it in conjunction with liposuction to further improve the shape of the breast (11).

The inverted T scar technique allows for better planning of the amount of tissue removal, a smaller projection of the breast effects with a significant improvement in the definitive shape, and no extension of the vertical scar, which in an age in which bikinis are the rage would be quite limiting. There are many surgical procedures that use this type of scar.

The first description of an inverted T scar technique without detachments of cutaneous flaps was made by Pitanguy in 1959 (12). Strombeck described in 1960 another inverted T technique, allowing a wide glandular resection with a safe nipple transposition (14). Skoog, in 1963, showed the importance of dermal vascularization of the areola and proposed a transposition of the areola-nipple complex on a lat-

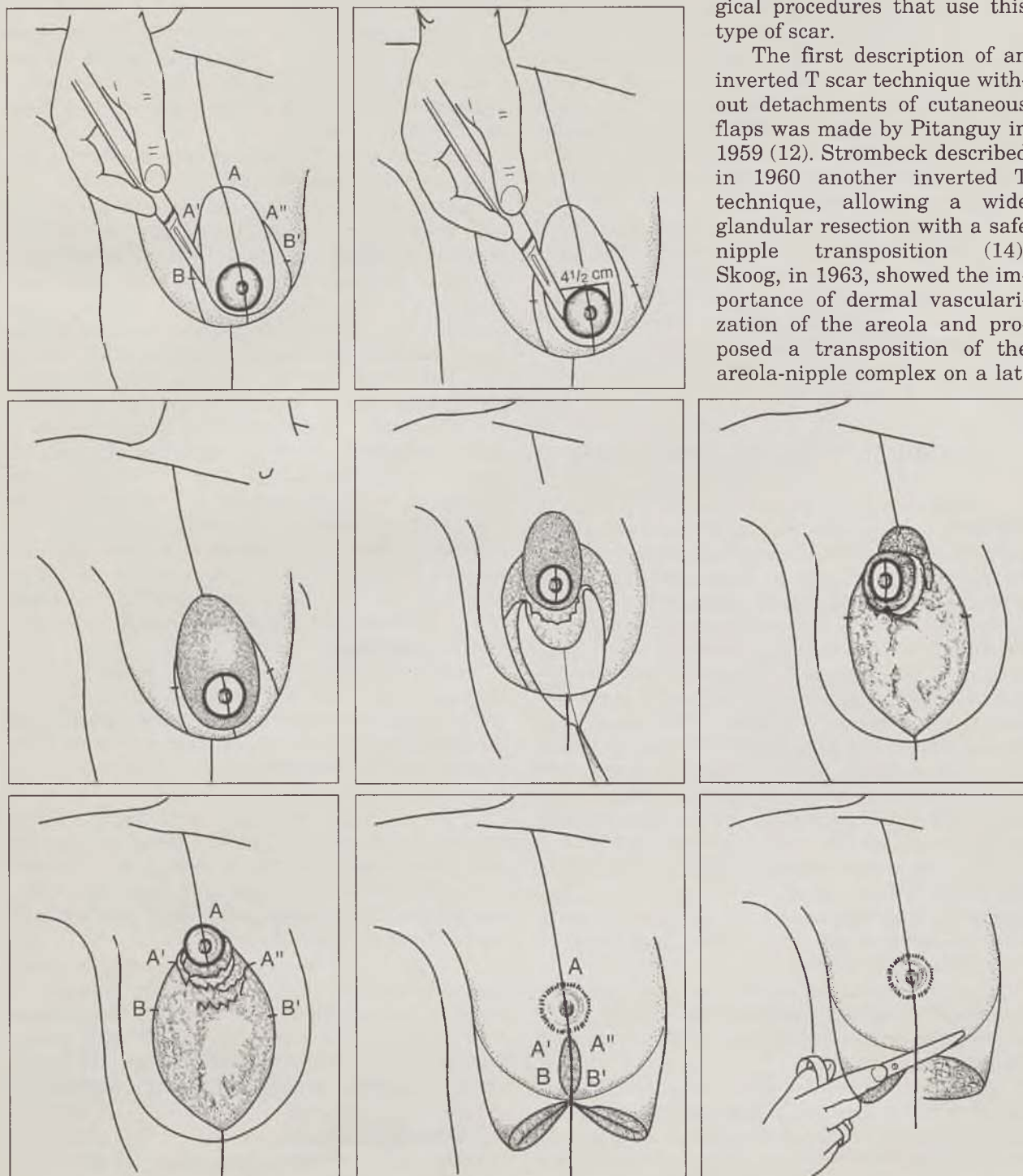


Fig. 1. Description of the surgical technique

eral dermal flap with a total resection of skin, fat and gland, suturing with a T scar (13).

The classification of reductive mammaplasty techniques is based on the kind of scar and on the kind of vascular flap used for the transposition of the areola-nipple complex (2).

According to American authors (2), when choosing the technique for a reductive mammaplasty, the *ten S rule* must be taken into account (Tab. 1).

The operation has to be done in one session only to save the patient the stress of a double operation and an adequate volume reduction must be done; the technique must be quick and easy for younger surgeons too and must be safe for the patient; the tactile sensitivity of the nipple has to be preserved as much as possible, the shape must be as natural as possible and the breast symmetrical; the result must be durable and the scars must be limited.

Taking into account these general principles we adopted, especially with patients who presented with major mammary hypertrophy, a reductive mammaplasty technique with a superior-based mono-pedicled flap and an inverted T scar with the horizontal part limited as much as possible, as described by Lalardrie in 1972 (8) and modified by R. Lauro (10).

DESCRIPTION OF THE TECHNIQUE

Prior to starting the operation, the patient is subjected to a precise clinical investigation and a complete set of blood exams in order to evaluate her general health and to assess the mammary parenchyma. In this way a significant reduction of the pre-operative risk and optimal planning of the surgery to be done are achieved.

Before the patient is anaesthetized, pre-operative drawings are made while keeping the patient in an orthostatic position. This is a fundamental step in the surgical procedures for reductive mammaplasty, because when the patient is put in a supine position, we have a complete loss of the anatomical ratio and without the drawings we could not plan the amount of tissue removal.

The first step is tracing a sign on the jugulus and marking two points 7–9 cm away from that sign along the clavicular line. From these 2 points a line is drawn, which crossing the nipple reaches the submammary sulcus (Fig. 1).

The new position of the areola-nipple complex is marked along this line at a distance of 19–22 cm from the jugulus, according on the physique of the patient.

Around this point we draw an ellipse that includes all the existing nipple-areola complex. Then, we mark the point of intersection between the line that extends from the clavicle to the submammary sulcus and the ellipse, which we call A, and starting from this point we mark two other points on the ellipse at a distance of about

6 cm measured on the drawing of the ellipse itself, A' and A" (Fig. 1).

Starting from these two points we trace two lines reaching the point of intersection between the vertical line descending from the clavicle and the line representing the inferior margin of the breast.

In order to trace these two lines breast can be moved, first to the middle and then to the side, otherwise the breast can be pinched in just one move, in order to assess the amount of tissue removal as best as possible.

Along these two lines we trace, at a distance of 5 cm from A' and A", two further points representing the top of the two flaps that will be closed together in the middle of the submammary sulcus, B' and B" (Fig. 1).

The first operative session consists in making the periareolar incision respecting the dermis.

Later, still respecting the dermis, we go on with the incision of the ellipse drawn around the nipple and with the removal of the epithelium.

Once we have finished with this phase, we proceed to a deep incision of the margins of the shield on the inferior pole, paying attention not to reach the muscular fascia in the middle; in this way the gland, the fat and the skin are completely removed.

Afterwards we prepare the superior pedicled flap, with which the areola-nipple complex will be moved, using the separation of the ellipse from the rest of the gland, keeping a thickness of about 2 cm, until we reach the B' and B" points (Fig. 1).

During the second operative session, at first we pass a 0/0 nylon stitch between the top of the ellipse and the top of the areola, which is moved in the superior pole using a "S" folding of the de-epithelialized flap.

Still using 0/0 nylon, the two points we had marked on the ellipse are connected with each other and also the two points marked on the margins of the shield sculpted on the inferior pole; these two points are also connected to the middle point of the submammary sulcus.

Then we place two multi-holed drains, on the side of the thorax, underneath the flaps. At the end of the operation these drains will be connected to two containers in continuous aspiration. We remove the two remaining "dog's ears" according to the usual method.

We complete the surgery by putting in some reabsorbable Vicryl 2/0 supporting stitches in order to connect the middle and the lateral glandular-adipose flap and suturing the skin using intradermal sutures made of Nylon 3/0. The periareolar incision is sutured using a continuous suture.

After we have controlled the efficiency of the vascularization of the areola-nipple complex, we dress the breast using 2 cm paper Micropore® (3M) plasters, in order to create a light, adhesive support.



Fig. 2. Preoperative (A) and six month postoperative (B) view of a patient (front)



Fig. 3. Preoperative (A) and six month postoperative (B) view of a patient (lateral)



Fig. 4. The limited extension of the scars immediately after surgery



Fig. 5. The flap

The drains are removed during the second or third day after the operation, and the sutures are removed about 15 days later.

METHODS AND MATERIALS

28 patients, presenting with medium to heavy macromasty, were treated. The average follow-up of the patients lasted 20 months.

RESULTS

In all the cases, the aesthetic results were very satisfactory, both for the small extension of the scars and for the shape of the breast (Figs 2–4).

The patients were particularly satisfied with the consistency of the breast. We did not encounter any major complications like extended tissue or nipple necrosis, and only in one case did we encounter a partial necrosis of the areola because of flap stress, in a heavily smoking patient, and with a complete "*restitutio ad integrum*" in quite a short time.

DISCUSSION

As Georgiade and other authors have written, an "all seasons" reductive mammaplasty technique is not available. Several techniques have been described, and each one has its own advantages and limitations (5).

Recently, during the 1998 annual meeting, members of the American Society of Plastic and Reconstructive Surgery questioned the role of various techniques available for reductive surgery of the breast, spoke in favour of inverted "T" techniques rather than in favour of single vertical scars, and showed a preference for methods of nipple transposition using a central- or inferior-based pedicle (6).

Our goal was to demonstrate the simple execution and good aesthetic results of a less-used technique, which employs a superior-based dermo-glandular pedicle in order to preserve the vitality and sensitivity of the areola-nipple complex.

There is no doubt that one of the major complications in reductive mammoplasty is damage to the nipple vascularization (7). An exhaustive study of the vascularization of the breast, made by Marcus (4), showed the main sources of blood perfusion are the *arteria thoracica lateralis* and the *arteria perforantes* coming from the *arteria mammaria interna*.

Arteriae perforantes coming from the *arteriae intercostals*, in the inferior pole of the gland, play a less important role.

Moreover, the closer the branches of the *arteria mammariae internae* and the *arteriae thoracalis lateralis* approach the areola-nipple complex, the more they come to the surface, so that they create a periareolar terminal anastomotic bed.

The width of the superior-based pedicle, prepared according to the technique we use, allows for the preservation of a vascular bed that is more than enough to allow the flap's vitality even in cases of significant transposition.

As could happen in very pronounced macromasties, the very superficial course of the arteries on which our flap is based also permits it to be thinned significantly, helping us in reducing the breast as much as possible (Fig. 5).

Advantages of the described technique are: the aesthetically pleasing shape of the reduced breast, in conjunction with the smallest possible extension of the horizontal scar; the chance for a significant reduction of the breast without any risk; maintenance of the high projection of the breast; the preservation of nipple sensitivity, even in cases of large shifts of the areola; and the absolute vascular independence of the flap, even in cases of flap stress. In fact, cutaneous or glandular necrosis, so extensive that it could deeply change the shape of the breast, would never occur.

The main limitation is the impossibility of restoring normal lactation because of the amputation of milk ducts, which occurs during the separation and the reduction of the dermo-glandular flap.

In our opinion the simple execution and the safety of this technique also permits younger and less experienced surgeons to approach such important surgery with the necessary peace of mind.

CONCLUSIONS

The techniques that prove safe and effective for the solution of this kind of problem are many.

Breast reduction using a mono-pedicled, superior-based flap proves a safe technique in serious gigantomasties. In fact because of the efficiency of vascularization using this type of flap, there is no need to be concerned about necrosis, not even in longer transpositions.

This technique can give very good results, also in medium hypertrophies, in which it is used in conjunction with other equally easy techniques (Ariè, Lassus etc.).

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Address for correspondence:

Paolo Mezzana
Via Ruggero Bonghi 11
00184 Rome, Italy
e-mail: paomezza@tiscalinet.it

THE SURGICAL TREATMENT OF POST-LARYNGECTOMY PHARYNGOCUTANEOUS FISTULAE

Cunha-Gomes D., Kavarana N. M.

Department of Plastic and Reconstructive Surgery,
Bombay Hospital Research and Medical Center, Mumbai, India

SUMMARY

The repair of large post-laryngectomy pharyngocutaneous fistulae presents a challenge to the plastic surgeon. The radial forearm flap is ideally suited for the reconstruction of these large fistulae.

With the help of a case report, this article highlights the etiology and management of large post-laryngectomy pharyngocutaneous fistulae.

ZUSAMMENFASSUNG

Behandlung von pharyngeokutanen Fisteln als Folgen der Laryngektomie

Cunha-Gomez D., Kavarana N. M.

Behandlung von pharyngeokutanen Fisteln, die nach der durchgeführten Laryngektomie aufkamen, stellt eine Anforderung für plastischen Chirurg dar. Zur Behandlung solcher grosser Fisteln ist der radiale Unterarm-Lappen am besten geeignet. Anhand einer Kasuistik sind in diesem Beitrag die Ethologie und Behandlung von pharyngeokutanen Fisteln diskutiert.

Key words: pharyngocutaneous fistulae, bipaddled radial forearm flap transfer

The incidence of pharyngocutaneous fistulae after laryngopharyngectomy surgeries ranges from 12.5 to 37 percent (1, 2). It not only prolongs hospital stay but also delays further treatment required for cancer control. Their reconstruction is a challenge for both the surgeon and the patient. On the part of the patient, understanding of the problem and patience are key points in the successful closure of fistulae.

CASE REPORT

A 65-year-old man radiated for a squamous cell carcinoma of the larynx, underwent a laryngectomy for a recurrence of the same lesion. A primary closure of the pharynx was done during that surgery. A large breakdown of the suture line and skin necrosis ensued. A tracheostomy tube was inserted into the trachea and the bulb intermittently inflated to prevent aspiration of saliva that trickled into the trachea through the necrosed posterior wall (Fig. 1). A feeding jejunostomy procedure was done, and dressings were carried till the patient was ready for surgery (8 weeks).

A bipaddled radial forearm flap was planned; the skin was scarred and stiff from previous sur-

gery and radiation. The mucosal defect was recreated, and the inner paddle was inset into this defect. The forearm fascia taken in excess on one side was used as filler between the pharynx and the trachea in the lower part of the wound. The second paddle of the transfer was folded over to reconstruct the skin defect.

The donor vessels used were the transverse cervical artery and external jugular vein. A revision of the venous anastomosis was required within 24 hours of surgery as the suction drain migrated and obstructed the vein at its base. After this recovery was uneventful. A small leak on the right side healed spontaneously within a week. A conray swallow done post-operatively indicated a smooth passage of dye into the oesophagus and stomach (Fig. 2). Once oral feeds were started, the jejunostomy tube was removed. One year after surgery, the flap is well settled and the patient is on a soft diet (Fig. 3).

DISCUSSION

Various authors have cited the etiology of postlaryngectomy pharyngocutaneous fistulae. The chief among them are: preoperative radiation, shortage of tissue and poor technique (1-12).



Fig. 1. Preoperative photograph of patient with a large post-laryngectomy pharyngocutaneous fistula



Fig. 2. Postoperative conray swallow showing free flow of dye going into the cervical oesophagus



Fig. 3. Postoperative photograph showing a well-healed bipaddled radial forearm microvascular transfer used for pharyngocutaneous fistula reconstruction

Tissue shortage is the prime cause of a breakdown of the pharynx, which has been primarily closed. For adequate tumor excision, a cuff of normal pharyngeal mucosa is removed along with the tumor. The maximum tension occurs in the region of the 3-point stitch, which approximates the lateral pharyngeal walls and the base of the tongue (1, 11). The presence of the nasogastric tube, strong swallowing force and a tight closure are the causative factors for a mucosal breakdown.

Once this happens saliva tracks into the wound contaminating the field. This causes a further breakdown now due to the combination of infection and secondary devascularization. Other sequelae like skin flap necrosis, vessel blowout (carotid, superior thyroid, transverse cervical) and leakage of saliva into the trachea (aspiration) may ensue. This is compounded by poor tissue healing due to preoperative radiation and or hypoproteinaemia.

MANAGEMENT OF PHARYNGOCUTANEOUS FISTULAE

Pharyngocutaneous fistulae are initially treated conservatively. This allows the tissues around the fistula to mature (less oedematous and inflamed). If any surgical procedure is carried out prior to maturation of the surrounding tissues, a certain breakdown can be predicted.

CONSERVATIVE TREATMENT

This includes:

1. Nasogastric or jejunostomy tube feeding: Hypoproteinaemia and reversal of the albumin-globulin ratio has to be corrected prior to de-

finitive fistula closure. Adequate replacement of calories, protein, vitamins and minerals is a priority. Transfusions may be required to raise the haemoglobin level.

2. Wound drainage: If a suction drain is present it should be removed or else it would draw more saliva into the operated field. A corrugated soft drain, placed such that it directs the discharge to the lateral aspect of the neck, should replace this. An antibiotic solution should be frequently used to wash out the skin flaps.
3. If the wound drainage is found to trickle into the trachea either from its mouth or via its posterior wall, then a double balloon tracheostomy tube will need to be inserted.
4. A pressure dressing over the anterior part of the neck, along with the above conservative treatment, helps to seal off small to moderate fistulae.

SURGICAL TREATMENT

Timing of the surgery is important. Surgery is planned only after tissue inflammation and infection have settled down. Any attempt to carry out surgery before this is fraught with a chance of breakdown of the suture lines. This is even more evident when preoperative radiation has been given.

Principles of fistula closure are the same as in other areas of the body.

1. The distal passage (oesophagus) should be patent. It is prudent to rule out a recurrence in the cervical oesophagus especially in bulky tumor excisions.

2. As far as possible scarred and heavily radiated tissue should not be utilised as local flaps.
3. A closure in 2 layers is mandatory.
4. The suture lines of the 2 layers should not lie one on top of the other.
5. The inner lining of most fistulae could be developed from turned down flaps from the edge (see Fig. 1). This may be difficult if the skin is stiff and unyielding due to preoperative radiation.
6. In small and moderate fistulae, a local flap could be used for skin closure (see Fig. 2). In larger fistulae a regional flap brings in new, vascularized tissue.
7. The regional flap chosen should be thin so as not to bulge and obstruct the tracheal opening when the neck is flexed.

Regional flaps – deltopectoral (1, 6), pectoralis major (9, 11, 12), deltopectoral and pectoralis major myocutaneous flap (14), island forehead flap, sternomastoid flap (10, 11, 13), latissimus dorsi flap (11, 12) – have been used for reconstructing these defects. The deltopectoral flap is a 2-staged procedure, while the pectoralis major and latissimus dorsi transfers can be very bulky for the anterior aspect of the neck, especially if the flap is folded. The forehead island and sternomastoid flap may not be of adequate dimensions to resurface a large defect, especially in a post-irradiated patient.

Tab. 1. Causative factors for pharyngocutaneous fistulae post laryngopharyngectomies

Preoperative factors:
1. Preoperative Radiotherapy
2. Poor nutrition – hypoproteinaemia
3. Preoperative tracheostomy with neck skin inflammation and infection
Intraoperative factors:
1. Large tumor size: Concomitant radical neck dissection
2. Tissue shortage: Poor assessment, tight closure of pharynx
3. Suturing technique: Interrupted versus continuous sutures, strangulation of mucosal edges, use of catgut for mucosal closure versus vicryl
4. Tissue handling: Excessive use of cautery, devascularization of mucosal edges
5. Wound drainage: Suction drainage versus non-suction drains
6. Tissue rest: Swallowing, tongue movements

Bipaddled faciocutaneous microvascular transfers (free forearm and free lateral arm flaps) are single staged, well suited for reconstruction of these defects (see Fig. 3). They are thin and conform to the subtle contours of the face and neck (15). The radial forearm flap has a long pedicle, which can reach non-radiated vessels in the lateral aspect of the neck, for anastomosis. Its use in primary pharyngeal replacements is extensively reported and has been found to be a safe and reli-

able method of reconstruction. The donor defect, though a significant disadvantage, is a small price to pay for the correction of this complex defect.

Above all, pharyngocutaneous fistulae may be prevented if their etiology is kept in mind. Tissue supplementation in the form of a vascularized flap, especially in post-radiation cases, would prevent the occurrence of large breakdowns and debilitating fistulae.

Tab. 2. Surgical treatment of pharyngocutaneous fistulae post laryngopharyngectomies

Conservative Treatment	Operative Treatment
Small fistulae	Moderate and large fistulae
Till surrounding tissues "mature" →	Mature tissues
Poor general condition	Leak into the trachea

Tab. 3. Operative strategy for pharyngocutaneous fistulae

Guidelines:
1. Rule out distal narrowing, stricture and recurrence
2. Two layer closure: inner layer preferably mucosal or local turn-over flaps
3. Suture lines should not overlap
4. If the neck skin is scarred, vascularized tissue should be "imported" to the defect
Small fistulae:
Inner layer: Turn-over flap
Outer layer: Rotation/Transposition neck flap
Moderate or large pharyngocutaneous fistulae:
Local flaps: Turn-over flaps
Regional flaps: Deltopectoral flap, pectoralis major flap
Free microvascular transfers:
Radial forearm transfer (bipaddled)
Lateral arm transfer

Tab. 4. Ideal flap for pharyngocutaneous fistula closure

1. Should be bipaddled, dependable, long vascular pedicle
2. Mucosal inner lining
3. Thin – conform with the aesthetics of the neck
4. Should not cover the tracheostome
5. Suture lines should not overlap

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Address for correspondence:

Dr. Dean Cunha-Gomes
Flat 3, Skyscraper-A,
Breach Candy,
Mumbai - 400 026. INDIA.
E-mail: kirdean@vsnl.com

PERMANENT SEQUELAE AFTER BURNS AND TESTED PROCEDURES TO INFLUENCE THEM

Bláha J.

Prague Burn Centre, Faculty Hospital Královské Vinohrady,
Charles University, Prague, Czech Republic

SUMMARY

Although permanent sequelae of deep burns always persist, they can be very favourably influenced if we start soon after the injury. There are several possibilities: very early rehabilitation by positioning and supports prevents the shortening of tendons and ligaments surrounding the large joints and thus reduces post-traumatic oedema. By selecting the correct surgical technique at the right moment, we achieve an optimal course of healing and scar formation. Great attention must be paid to infection and its prevention. After healing it is important to apply compressive aids soon, preferably in combination with silicone and similar materials. For lubrication it is better to use creams with a high water content. Ensure the optimal mental well-being of affected patients. If the patient communicates well, do not hesitate to use psychoanalytic methods to reduce emotional and verbal blocks related to the injury.

ZUSAMMENFASSUNG

Bewährte Maßnahmen zur Verminderung der Dauerfolgen von Verbrennungen

Bláha J.

Die Dauerfolgen von tiefen Verbrennungen kann man vermindern, falls die entsprechende Maßnahmen unmittelbar nach dem Unfall getroffen werden. Es gibt mehrere Möglichkeiten: durch eine frühzeitige Rehabilitation mittels Lageänderungen und Unterlagen kann man der Verkürzung der Sehnen in der Umgebung der grossen Gelenke vorbeugen und die posttraumatische Anschwellung vermindern. Optimaler Verlauf der Heilung und Vernarbung kann durch die Wahl der geeigneten Operationstechnik und der Operationszeit erreicht werden. Von grosser Wichtigkeit ist die Vorbeugung gegen einer Infektion. Unverweilt nach der Abheilung sollten die Kompressionsmittel, am besten in Verbindung mit den Silikonem oder ähnlichen Materialien appliziert werden. Die Haut sollte lieber mit den Kremen mit hohem Wassergehalt gesalbt werden. Psychische Behaglichkeit der behinderten Patienten sollte beachtet werden. Bei den gut kommunizierenden Patienten kann die Psychoanalyse verwendet werden, um die mit dem Unfall verbundene Emotionen und Verbalblöcke zu reduzieren.

Key words: deep burns, scars, rehabilitation, compressive therapy, lubrication, psychotherapy, psychoanalysis

In the treatment of patients with burns we must be interested from the onset in permanent sequelae of the burns and therapeutic procedures. The latter accompany the patient in later life and sometimes influence his further existence in a significant way. Serious burns are not such a frequent injury and with regard to the fact that the appearance of the affected areas is influenced not only by the injury proper but also various therapeutic activities leading to its healing, it is advisable that the patient should be treated in a specialized department. According to our experience attempts at conservative or surgical treatment of burns by health professionals who have no practice in this field distort the statistics of successful treatment and are associated with multiple technical complications and frequently

with infections of the affected area. Every complication protracts treatment, has a negative impact on the health and mental state of the patients and causes deterioration of the prognosis of permanent sequelae.

Superficial burns, i.e. burns grade I and superficial burns grade II, usually do not leave any permanent sequelae, in the worst case only minor irregularities in the skin pigmentation (Fig. 1). Deeper and deep burns, i.e. those of grade II and III, leave sequelae. In general it may be stated that the deeper the thermal injury or the deeper tissue structures succumb to necrosis, the more serious the permanent sequelae. The appearance of the surface after healing depends on a series of interconnected factors.

The reaction to burn injuries is very individual. The range of resulting scars is so different that in some patients we may speak of hereditary predispositions for the formation of unfavourable external scars, while in others despite complicated treatment only minor or negligible permanent sequelae develop. Regardless of these extreme cases the great majority of patients reacts by visible and obvious scars, which differ as to their character not only in different patients, but in extensive affections we can observe a different development of scarring in different parts of the body. In investigating the causes of this remarkable phenomenon it is important to follow the case-history day by day, the procedures day by day and follow up the course of treatment with all complications that occurred. If we process in this way a sufficient number of cases, we shall obtain data that indicate what benefits patients as regards permanent sequelae and what does not.

As has been already mentioned, we must take into account a certain inborn predisposition for scar formation. Furthermore, permanent sequelae depend on the amount of thermal energy absorbed by the affected tissue. We cannot simply evaluate the depth of the burn according to the general three-grade classification. The latter serves only to orient and to express the grade of the burn as it appears on macroscopic inspection during the initial evaluation and subsequent development. It provides, however, only limited information on the amount of absorbed heat.

For example, a burn after exposure to an electric arch without concurrent passage of current seems very deep during the first hours (Figs 2, 3). In addition to the charring of the epidermis and contamination of the surface by oxides of dispersed metals from the conductor, it does not display any signs of vitality during tests of so-called capillary return or tactile sensitivity. If, however, we cool such an affected area for a sufficiently long period and treat it subsequently by a suitable conservative technique, we find as a rule that a superficial or grade II burn is involved, although it appeared at first as a deeper burn. Permanent sequelae are as a rule of minor nature despite a temperature of the electric arch of about 3000 °C. The cause is the very short-term action of a very hot flash. Its duration is several seconds or fractions of seconds. The immense energy is exhausted on the superficial skin layers, when the corneal layer gasifies and evaporates, the epithelium carbonizes and loses all cellular water and along with it also a substantial part of the energy of the arc, and the small remanent of thermal energy more or less damages the surface of the corium and the subpapillary capillary plexus of the corium. (Water has an exceptional capacity to absorb thermal energy during evaporation). From the preserved adnexa the area epithelizes easily, and the superficially damaged corium ensures during the stage of scarring a sufficient firmness; the development of adverse scarring is

rare. In the worst case irregular coloration occurs due to impaired pigmentation after healing of the area.

In cases of burning of a patient's hand by water with a temperature of ca 80 °C during an epileptic fit, and where the exposure lasted several minutes, a very serious affection of superficial and deep layers occurred (Fig. 4). The scald, which at first appears very favourable, deepens during subsequent days, and after several days it is found that the area will not heal without surgical intervention. The permanent sequelae are as a rule quite serious, and rehabilitation is difficult and prolonged. Thus a detailed history of the injury is very important. From what has been said, it ensues that for the severity of permanent sequelae the extent of tissue damage is important, in particular of the corium and other more deeply situated structures.

Repeatedly we can observe that if, after a burn or surgery during collection of an autograft, a certain borderline of the skin is passed, a hypertrophic scar develops (Fig. 5). This is a very important finding for surgical practice and the prognosis of scars. The cause is the cicatricial loss of firmness of the skin in the area of the corium. From practice it is known that after penetrating 1/2–2/3 of the thickness of the corium when collecting a graft, there is very slow healing of the site and almost always the development of a hypertrophic scar. The value of taking off a limited graft unfortunately cannot be expressed in mm because the corium is not of equal thickness in all parts of the body surface, and moreover there are great interindividual differences in the reaction of individual patients. If we transplant a small infant during the first months after birth, the skin is so thin that the optimal autotransplant varies as to its thickness at the borderline of the technical possibilities of dermatomas. The same applies to old patients, chronically sick patients or those treated for prolonged periods with corticoids. There we have to take into account natural atrophy of the epidermis, moreover influenced by corticotherapy, and the concurrent rapid deterioration of dermal adnexa causes a deterioration of spontaneous epithelization at the donor site. This can be partly avoided by taking primarily a more extensive portion of skin than needed to cover the defect, and the superfluous graft is returned to the donor site, meaning that we transplant it again. The resulting effect is very favourable. The area heals quickly and remains almost smooth, without hypertrophy.

We cannot omit the necessity of correctly estimating when to leave the surface to epithelize spontaneously and when to use a surgical approach. This should be the decision of specialists who are adequately experienced in transplantation technique. Unfortunately, we frequently witness neglected deep burns left to heal spontaneously with subsequent development of a mutilat-



Fig. 1. The scald on the back was deep, on the shoulder more superficial. The sharp borderline between the different types of affection is of interest – where the magic borderline at the level of the corium was passed. On the shoulder there will not be any permanent sequelae, on the back impaired pigmentation.

ing hypertrophic scar that frequently disintegrates secondarily. In its high, tough fibrous structure there are very few suppressed immature and non-differentiated vessels that are easily closed, and the whole area which they supplied becomes necrotic. In rare instances we also en-



Fig. 2.



Figs 2 and 3. Burns by an electric arc seem very deep at first, requiring necrectomy and autotransplantation. After correct cooling the condition improved to such an extent that the areas will heal without surgery. Impaired skin pigmentation may be a permanent consequence.

counter in these scars a malignant reverse, and an urgent operation is then life saving (Fig. 6). In reconstruction of inveterate scars the whole area must be excised and replaced by a sound autograft as should have been done much earlier. The other extreme are unnecessarily transplanted superficial burns of the deeper grade II to shorten the patient's hospitalization. This can be done shortly after admission to treatment when it is already obvious which parts will heal spontaneously and which ones would cause problems, but this has to be done professionally with regard to the depth of the injured tissue and the defect has to be covered by a very thin graft which contains only epithelium and the pars papillaris of the corium. We have to realize that by using a dermo-epithelial graft we cover the crevices of vital adnexa in the lower part of the burnt corium, and those will resume activity after 2–3 weeks. If their outlets are covered by a strong and incorporated autograft, the secretion cannot escape freely and retention cysts develop (Figs 7, 8). The



Fig. 4. Prolonged exposure to 80 °C water during an epileptic fit led to damage of the deep layers in the subcutaneous layer. Healing is prolonged, complicated, oedema persists despite compressive therapy, which prevents rehabilitation of minor joints of the hand.



Fig. 5. The same reaction as after a burn can be observed at a donor site. After passing a certain limit when taking a skin graft, hypertrophy of the scar may develop while the more superficial borders do not hypertrophy. We think that in both instances the cause of an excessive reduction in the firmness of the skin at the donor site of the graft is an excessive reparative response of the organism.

latter are infected secondarily, abscesses develop, treatment becomes complicated and the patients are not satisfied. In the permanent sequelae then the influence of infection and a strong overlapping autograft potentiate each other. The solution is again correction either by adjustment of surfaces or intense compressive therapy during the initial weeks after healing (Fig. 9a).

An adverse aesthetic effect is aroused also by transplants with a coloration markedly different from the surroundings (Fig. 9b). We observed repeatedly that if we take an autograft of the full thickness of the skin from the inguinal area and place it in an area irradiated by sun (face, neck, hands), excessive pigmentation of the graft develops and the patient is stigmatized more by a dark spot at a visible site than by the originally uneven but light scar. (A very useful experience is a visit to a nudist beach where we can see clearly why the groin provides pigmented grafts). It is important to choose carefully from where we select the graft and where we want to transfer it. On the face the most favourable effect is produced

by grafts from the inner area of the arm, although their thickness is not quite identical.

As has been already indicated, a serious problem is infection. The loss of the epidermis opens a wide field of action for exogenous (mainly aerogenic) infection (Fig. 10). Although during the first hours the burnt area is sterile due to the release of cellular immunoglobulins, their activity is soon exhausted, and if from the capillary walls sufficient amounts of fibrin effuse into the developing bullae we have to foresee an infection. In addition to aerobic microorganisms – in particular *Sapht. aureus* – also saprophytic bacteria from skin adnexa are involved, and therefore it is important to perforate in time the bullae which develop and evacuate their contents. If we leave the detached epithelium on the burnt surface as a suitable biological cover we can do so only for a period of 3–5 days after the injury. If we do not remove it after this period, saprophytic infection and deepening of the burn occurs. In extensive burns there is moreover the influence of acute shock due to burns. As a result, intestinal bacteria pass across the endothelial barrier into the



Fig. 6a. Older hypertrophic scars necrotize as a result of ischaemisation; they disintegrate and frequently become infected. In the picture: an abscess in the scar with a capillary drain.



Fig. 6b. Repeated disintegrations of hypertrophic scars lead to chronic irritation, which may undergo malignant reversal. In the picture: a carcinoma in the scar after scalding of the skin 50 years previously.



Fig. 7.



Figs 7 and 8. An originally not very deep scald of the chest, which was unsuitably excised and covered by a very thick autograft. The covered adnexa led to the formation of cysts and abscesses. The borders of the thick graft with epithelium beneath them necrotize and separate.

circulation and necroses become infected by the haematogenic route from the transitory zone between vital tissue and necrosis. When evaluating scars in deep burns in relation to the early infection during treatment, *Staphylococcus pyogenes - aureus* is most malignant as well as the now rather rare *Streptococcus pyogenes - beta haemolyticus*. *Staphylococcus pyogenes* is frequently combined with other bacteria which potentiate its adverse effect by their toxins. The latter are particularly bacteria of the intestinal microflora - *Pseudomonas aeruginosa*, enterococci, *Enterobacter*, *Proteus* and *Escherichia coli*. In very deep injuries, in particular after high tension electric current injuries, in exceptional cases the anaerobic flora of Clostridia is also found. Their effect on scarring is difficult to evaluate due to the rare occurrence of the infection and the generally mutilating and frequently loss involving injuries.

Thus if we summarize factors that cause the development of adverse scars after burns, they are as follows:

- a) burns grade IIb and III in general,
- b) burns with prolonged exposure to the thermal agent (hot rolling press, loss of consciousness during the action of heat),
- c) unsuitable surgical technique,
- d) infection of injured area in particular by *Staph. pyogenes*,
- e) patient's disposition to develop hypertrophic scars and, last but not least,
- f) mental factors ensuing from the situation under which the injury occurred and the type of patient.

The latter and hitherto not yet discussed circumstances must be elucidated in more detail.

A very important fact is the type of patient who suffered the injury. If he or she is a so-called biophil-oriented person with an optimistic approach to serious life events and confidence in the attending staff, the resulting scars will be very acceptable and rehabilitation will cause no problems. The affected patient usually will not need any subsequent surgical operations to optimize function and appearance; the scars will stabilize rapidly and without complications. Many of these patients do not have to use even special compressive devices although deep injuries with autografts of the skin were involved.

According to our experience, very acceptable permanent sequelae are also seen in patients with social problems, those with a tendency towards chronic alcoholism, in particular if the injury occurred in a state of inebriation, and also patients who regularly take so-called hard drugs. Also in mentally ill patients who caused their injury during a suicide attempt, we usually do not encounter serious problems during scarring and stabilization of scars. As regards permanent sequelae among the group of suicides, those patients are best off who meant their attempt as a demonstration to achieve some objective and were, according to their own opinion, successful



Fig. 9a. Unprofessionally performed autotransplantation of area IIb with a very thick graft, which moreover has a coarse network on a visible part of the body. The patient attended the Burns Clinic for a reparative operation: the whole graft was removed and the area was evened out.



Fig. 9b. Markedly hyperpigmented autograft, taken in the groin and inserted after excision and release of scars on the palm. If such a transplant is placed in the face, it is frequently more striking than the scar which it replaces.



Fig. 10. Unsuitably treated superficial burn that is easily infected and subsequently deepens. It is useful to remove fibrin bullae by the 3rd-5th day after a burn and cover the areas by another suitable cover. Fibrin beneath the bulae is a cultivation medium for saprophytes in the adnexa and aerogenic infection - most frequently *Staphylococcus pyogenes - aureus*.

in their activity: the target was achieved, the unbearable situation was resolved.

REHABILITATION OF PATIENTS WITH BURNS

Rehabilitation after burns is divided into two basic groups: physical rehabilitation, psychic rehabilitation.

Physical rehabilitation serves the maximum maintenance of the mobility of the patient's joints to preserve muscular function. We can divide it into early and late rehabilitation.

Mental rehabilitation is focused on the possible optimal reintegration of the patient into society with a clear perspective of future work and social integration. And similarly as in physical rehabilitation, we can divide it into early and late rehabilitation.

Early physical rehabilitation

It is started as soon as possible after the injury. In minor burns this is immediately after regression of the painful stage and after termination of the period of cooling of the burnt surfaces (face, neck, hands). In serious burns we start rehabilitation already during the period of the acute stage, i.e. the period of acute burn shock. Its extent depends, however, on the site of the burns and the general condition of the patient.

Minor burns can be treated in a high percentage of cases in out-patient departments. If the burn affects the upper extremities – most frequently the hands – we recommend to position the affected area to facilitate the outflow of venous blood and lymph from the injured area. The position on the vertex of the head or at least in a sling, if the mobility of the extremities is restricted was suitable. As a rule, the patient himself knows the best position according to the painfulness of the affected areas. We recommend to keep the lower extremities in a recumbent position supported by suitable soft material (a cushion) to facilitate the flow of blood and lymph to the heart. Walking should be limited to as little as possible with regard to the greater possibility of infection of injuries of the lower extremity. This applies even more to diabetic patients.

Post-injury oedema causes deterioration of the blood and lymph circulation; the removal of metabolic products from the injured area is retarded, and the medium acidifies due to the accumulation mainly of lactic acid and thus irritates the nerve endings in tissues. To this we have to add also the compression of nerve fibres by the oedema and hydrostatic pressure of the blood column. This applies in particular to burns of the lower extremities. In addition to unpleasant painful sensations, oedema also causes the deepening of originally more superficial burns. The slower circulation leads to the formation of microthrombi in the subpapillary plexus and possibly also in the subdermal plexus, and if this weakened tis-

sue is affected by a secondary infection, necrosis develops rapidly, from a superficial burn a deep one develops that can no longer be treated conservatively and it is necessary to make a surgical intervention – necrectomy – and possibly a dermal autograft. Permanent sequelae are the rule.

If there are problems with adherence to the suggested regime and if the situation of the patient's family permits, we recommend possible short-term hospitalization.

In burns of the face and neck we adjust the bed into a semi-sitting position with slight back bend of the head. Immediately after the injury we cool the areas by means of compresses for a sufficient time, i. e. as long as they give the patient relief. In grade I burns where there are no bullae it is sufficient to cool the areas for 2–3 hours; in solar dermatitis, however, much longer, sometimes for more than 48 hours. The deeper the burn, the longer the period of cooling it requires. The most frequent affection is grade II a and in hospitalized patients we terminate cooling after 18–24 hours. Concurrent administration of analgesics and antihistamines (promethazine) is suitable for prevention of early post-injury oedema. Facial oedema also has, in addition to possible deepening of the areas, a very important psychological aspect. The face is the "visiting card" of man, and the smaller the oedema and deformity, the more favourably the patient experiences his injury. Oedema of the eyelids and the impossibility to communicate with the environment is another complicating injury and certainly does not promote the course of therapy. Oedema of the lips makes food and fluid intake impossible and also causes discomfort during therapy. Cooling must be done very carefully, respecting principles of asepsis because the open area after removal of the bullae is freely accessible to external infection and the latter deepens the superficial burn and threatens the patient with permanent sequelae. This has again a very important sociological and communicative impact on the patient. This problem will be discussed in detail in the section on mental rehabilitation.

The anterior part of the neck is frequently burnt along with the face. It is important to emphasize to the patient from the first moments of the injury that for the further development of areas at this location, it is extremely important that he should keep the head in a slight backward bend. He will thus prevent maceration of contact areas in the natural folds of the skin on the neck, their deepening by pressure and infectious complications. If the burns are deeper, or deep oedema also affects as a rule the flat m. platysma, its individual fibres necrotize and succumb to fibrotization, scarring and shortening. Rehabilitation after healing of this area is extremely difficult and calls for special procedures, materials and frequently also reconstructive surgery, in particular if the patient's cooperation is not optimal. In this case we recommend to the patient

that from the beginning he should not use a head support and in particular that he should not use a soft cushion. The latter due to its consistency adjusts to the shape of the head, and if the pinnae are also affected, it deforms and compresses them. This leads to ischaemic chondritis, sequestration of cartilages and scarred deformities, which again cause marked social stigmatization of the patient.

In hospitalized patients we position burns in the area of the upper extremities in slings made from sterile towels, or we use as support polyurethane blocks packed in sterile towels. In burns of the hands we always ensure a well-shaped bandage and carefully respect basic rules of bandaging technique. The thumb must always be separated from the other fingers. The fingers are positioned in a physiological position – slight semiflexion in all joints – separated from each other by an adequate layer of bandages to prevent maceration of contact surfaces of individual fingers. The wrist is maintained in slight semiflexion or straight. It proves useful to apply a suitably shaped splint, which moreover maintains the selected position of the hand and also protects it against possible mechanical impacts that are painful for the patient. Already at this stage we can select slightly elastic bandage material that is available in our distribution network under the name PEHA Crepp. It shapes even complicated areas of the body very well, it does not press and tighten, and moreover by slight compression it reduces the development of early post-traumatic oedema. It also makes possible slight mobility of the affected area, which is very important for subsequent rehabilitation procedures. If a patient with burnt hands is able to look after himself at least partially, the psychological effect also plays a part as the patient does not have to rely completely on the assistance of others. This factor is repeatedly emphasized by patients.

If burns of the hands require surgery with necrectomy and subsequent autotransplantation, the above-mentioned positioning after surgery is particularly important. We observed repeatedly that unsuitably bandaged fingers in complete extension or even slight hyperextension (in particular due to incorrect application of the fixation bandage) cause great problems to the patient during rehabilitation after healing (Fig. 11). The local finding then creates an impression as if the affected hand permanently remembered the position immediately after surgery and subconsciously considered it as optimal. It is of no avail to explain logically to the patient how he should rehabilitate and what position the hand and fingers should take. It is a subconscious reaction that recedes very slowly, and in some cases it can be helped only by very vigorous rehabilitation procedures, which of course also involve some pitfalls.

The lower extremities also have some peculiar features, starting with injuries, through surgical

procedures and ending with rehabilitation. As mentioned already, immediately after burns we position patients to facilitate the flow of lymph and venous blood from the lower extremities. The same procedures are respected during surgery and the initial stages of rehabilitation. The greatest problems are created by spontaneously healed burns of deep grade II. If the patient starts to walk too soon on the fragile surfaces, serous bullae are formed and the fragile epithelium breaks, the area becomes infected and frequently poorly healing granulation areas develop. The cause is very simple. After removal of the superficial necrosis in burns of grade IIb (surgically or conservatively), the pars papillaris of the corium is also removed. It was destroyed by the burn. After epithelization of the remaining necks of the dermal adnexa, the newly formed epithelium becomes attached to a flat, very thin layer of granulation tissue formed by a dense capillary network and free cellular elements with the ample participation of fibroblasts. Because so far the saw-like structure of the papillary layer of the corium has not been created, the epithelium is not fixed to the connective tissue and even minor mechanical strain becomes threatening for it. In the lower extremities, moreover, the hydrostatic pressure of the blood column and poorly drained lymphatic spaces dominate. Minor blood and lymphatic capillaries break, and the emerging sanguinolent fluid breaks away the epithelium. Due to the high protein content, it is also an excellent nutritive medium for ambient bacteria that complete the disaster. In the initial stages, when it is necessary for the patient to start rehabilitation, we resolve this controversial situation by careful application of elastic bandages over a light soft gauze bandage. If the patient is in bed, the bandage need not be applied. When, however, the moment approaches when he should stand up and the hydrostatic pressure will burden the fragile epidermis, the patient applies, either by himself or with the assistance of a nurse, a bandage and reinforces the healed areas. After termination of exercise, he releases the bandages. Important support is also offered by this compression to patients with affections of the superficial or deep venous system, as known from general surgery. There this rule applies even more.

Early rehabilitation is also important from another aspect. Muscular activity releases endorphins, which reduce the threshold of pain. The patient does not perceive pain or pressure in the healed areas and does not require administration of analgesics, sedatives or antihistamines. Because he moves, walks and can partly look after himself, he also becomes mentally better balanced and possible complications are reduced to a minimum. Minor dressings do not require anaesthesia and his immune system is not weakened.

In extensive burns, early positioning of the upper extremities in wide slings made from gauze



Fig. 11. Fingers bandaged in hyperextension after surgery maintain this unsuitable position for a long time and are very resistant to rehabilitation. Long-term application of a suitably shaped splint is necessary.

is used, with a 90° sideways extension of the arms and slight forward extension. The lower extremities are then suspended in a slightly elevated position with the legs 20° apart. The trunk is supported by a polyurethane mattress from the shoulders to the buttocks. The head is maintained in a mild backward tilt to prevent contractures of the anterior area of the neck (Figs 12–14). In burns of the back we place the patient on his stomach or in special air beds (SSI Clinotron).

The same procedures are used during surgery and in the initial stages of rehabilitation. As sup-



Fig. 12.

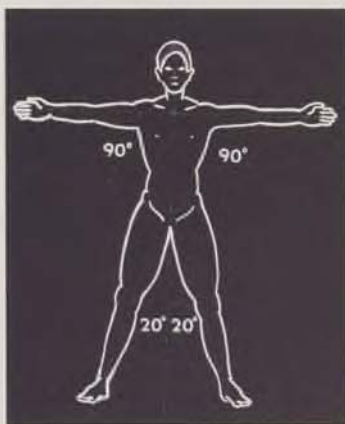


Fig. 13.

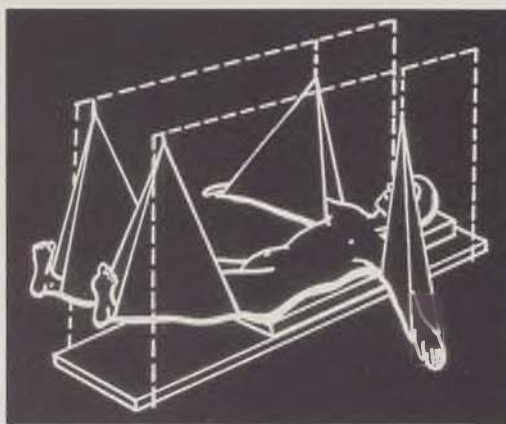


Fig. 14.

Figs 12–14. The three presented patterns illustrate optimal positioning of extensively burnt patients already during the first day after injury.

port we most frequently use polyurethane prisms beneath the knees and legs above the Achilles tendon in slight semiflexion of ca 5° or slings prepared from sterile gauze. In burns of the feet it is necessary to prevent shortening of the triceps of the leg with permanent plantar flexion, which is a very serious complication in rehabilitating the gait after healing of the burn. We insert into the patient's bed a suitable firm support to ensure that the planta is in a standing position. The possibility of early rising from bed and rehabilitation of gait is ideal. Bandaging by means of elastic bandages prevents the development of hypostatic oedema, it hastens the venous and lymphatic circulation in the lower extremities, and by compression it prevents the development of haematomas beneath not yet firm skin transplants or fragile newly formed epithelium of spontaneously healed areas, in particularly in deep burns grade II. There, very frequently serious or sanguinolent bullae are formed, the thin epithelium breaks, the area becomes secondarily infected and poorly healing granulation areas develop. An elastic bandage is also a very important aid after surgical operations, as it prevents blood losses and the development of haematomas beneath autografts. It also prevents their possible shifting after an unsuitable movement.

Late physical rehabilitation

Late rehabilitation is started at the moment when the transplants are firmly incorporated and the donor areas epithelized. We rehabilitate in particular the large joints of the upper extremities and the small joints of the hands. As for the lower extremities, we pay particular attention to restoring an independent gait using elastic bandages or special elastic slip-ons and stockings, which may be individually made for the patient, or else we select some suitable type produced by commercial firms.

The main impediments to the restoration of normal mobility of the burnt area are:

a) deep post-traumatic oedema caused by persistent lymphostasis in the subcutaneous layer as the lymphatic system regenerates very late, partly due to the immaturity of newly formed capillaries

b) shortening of the muscle fibres, fascia, mus-

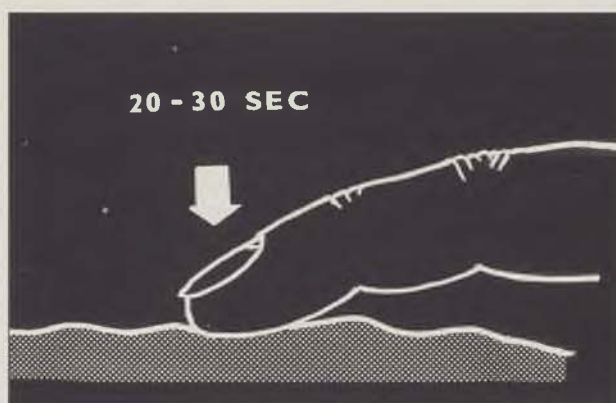


Fig. 15. Pressure massage is implemented at selected sites by the finger tip for a period of 30 s; then we shift to the neighbouring tough spot. In extensive areas it is necessary to combine this massage with an elastic compressive aids.

cular capsules and tendons due to inactivity and unsuitable positioning. Fear of pain leads to subconscious relief positions of the affected area, as a rule in a median position of the large joints and then specific deforming positions of the small joints.



Fig. 16a. Rigid-pressure technique with Duracryl splints for dental prostheses. The acrylate material does not irritate; it is easily processed mechanically, and when applied beneath an elastic mask it compresses tough resistant scars.



Fig. 16b. Combined material – polypropylene foam thermally processable and Orthopaedic band age X-Lite made in Belgium. Both materials can be combined well. Polypropylene foam is soft and the X-Lite ensures a stable shape of the splint. Optimal temperature for processing is 110 °C.

On the feet there is a tendency towards shortening of the m.triceps surae and ensuing plantar flexion. The latter subsequently makes exercising the gait difficult and must be prevented by support for the soles and by maintaining a rectangular position in the talocrural joint. On the hands there is a special type of deformity – the “swan neck” position. This is characterized by volar flexion in the wrist and dorsal flexion in the MP articulation, and by flexion in the proximal PP joint (sometimes both) and extension of the distal PP joint. The thumb is then usually in adduction and extension. The ideal prevention is careful splinting in the early stages after injury.

Tested rehabilitation techniques

Pressure massage

It serves the expression of deep post-traumatic oedema in the area of the joints and prevents the development of hypertrophying scars. It is implemented as follows: we press with the finger tip the particular site for 30 seconds, and then we expel a deep oedema from the scar or rehabilitated area (Fig. 15). Then we shift a finger width to a neighbouring area and repeat the same technique. We always proceed from the periphery towards the heart and thus shift the oedema back into the circulation. When the oedema is reduced we start with rehabilitation of the joints, articular capsules and tendons and the appropriate muscle groups.

Elastic compression

Pressure massage is very effective but time consuming, and thus it is only used in areas with a particularly adverse course of scarring. In other parts of the burnt area we use compression by a special elastic aids prepared from elastic non-irritating materials such as elastic bandages, elastic tubular aids with a width corresponding to the compressed area (Lastogrip, Raucopress) or individually prepared elastic aids, T-shirts, slips, gloves etc. made to measure for individual patients. The material must be sufficiently pervious, non-irritating, and easily laundered (processed crepe polyamides etc.).

Rigid compression

On sites with a complicated shape or those with very tough and prominent scars, resistant to simple elastic compression, we place suitably shaped compression splints (Figs 16a,b). They are prepared from non-allergenic plate thermoplasts (acrylates, polypropylene, polyurethane, Sanplast) that are precisely shaped for certain minor areas, or we select casting polymers used in the health services (acrylates etc.).

Special materials

Very recent scars, shortly after epithelization of the burn, can be positively influenced by silicone materials (Sil-K, Topi-gel...). Frequently, even elastic compression is not necessary, never-

theless a combination of both potentiates their effects and the results are much better. A similar effect is also exerted by the gel material Medigel or Silipost. The elastic jelly-like material contains mineral oils that are non-aggressive to the skin surface and do not cause allergic reactions. They influence the surface of the scars similarly as silicone materials (Figs 17, 18). They optimize gas exchange and modify the exchange of water vapours on the surface of the recent scar, they pacify the surface of the newly formed epithelium and mitigate the inflammatory reparative reaction in deep burns, Silicone and gel materials exert a favourable effect by their physical properties on the surface of recent scars where there is not yet a functional keratin layer and the preserved skin adnexa do not yet fulfill their function. Due to this the epithelium and superficial part of the recent scar suffers from dehydration and is easily damaged mechanically (Fig. 19). This leads as a rule to minor rhagads or eczema, and the areas are then secondarily infected and disintegrate. The mentioned materials replace the function of the immature keratin layer, and then pacification of the scar does not display an



Fig. 17.



Figs 17 and 18. On fresh, well-healed hypertrophic scars, silicone elastomer foils or gel containing mineral oils can be applied. They have a favourable effect on the reparative inflammatory process, and hasten the differentiation of the scar beneath the immature epithelium.

inadequate tendency of hypertrophy. The range of similar materials is steadily being extended and at present covers the entire mentioned problem. However, none of the last-mentioned preparations should be applied to an unhealed area or a secondary abrasion. They do not allow penetration of early secretion and encapsulate possible infection. This leads to the development of deep defects and secondary disintegration of the healed area by infection in the wound.

In some instances physical techniques do not suffice and pharmaceutical treatment must be used. We found the administration of the corticosteroid Kenalog into extremely hypertrophic scars useful (Fig. 20). There are essentially two forms of administration. Either the selected dose of the preparation is administered in a mixture with a local anaesthetic, as a rule at a ratio of 1:1, or else after local anaesthesia of the particular area from another syringe, Kenalog is administered



Fig. 19. Result of mild experimental compression by a combination of Medigel and an elastic slip-on. At the site of application of the gel plate, the oedema is markedly reduced and the scar improved. After this experience the whole scar was treated in the same fashion.



Fig. 20. Minor hypertrophic scars can be treated by the administration of Kenalog. Under local anesthesia the preparation is administered closely beneath the epithelium and a depot is created. The latter is left in place till the scars dissolve in it, then the remnants of the white sediment are removed. The marked vascular pattern in the scar and surroundings is a sign of the activity and effective action of the preparation. The scar is checked regularly at 3-week intervals.

into the scar (best subepidermally) to create a small whitish depot which then exerts a long-term effect on the scar and dissolves deep fibrous structures. The patient must be regularly monitored to prevent excessive resorption of the corium, thus weakening the mechanical firmness of the scar. As a rule the scar is absorbed within 2–3 months, but the reactions are very individual. If the scar does not respond to the corticoid administration its character can be altered by cryodestruction under local anaesthesia. The scar does not disappear completely but is reduced by ca 30 % and then after healing usually responds to the administration of Kenalog.

Stretching

Physical rehabilitation must not be painful and must not interfere with basic surgical stages in the treatment of deep burns, i.e. the period of necrectomies (risk of haemorrhage) and the period of skin autografts (movement interferes with the connection of vessels to the transplanted skin graft, haemorrhage from the donor areas). Active movement and an adequate physical load release muscular endorphins, and the course of treatment is then less painful and better tolerated. Among the techniques that remedy cicatricial contractures, stretching proved very useful. It is used in many sports in which elasticity is emphasized as well as joint mobility (gymnastics, material arts, aerobics). The principle involves gradual and patient stretching of shortened areas of the body. Rapid movements have no effect on releasing contractures. The scar consists of spirally wound collagen fibres, in which the individual bends have to be removed from each other by systematic exercise and thus prolong the tough strip. It is important to stretch the scar slowly at the borderline of pain and carefully to avoid ruptures on the surface of the scar, with a duration more over 30 seconds per exercise. Only then does the scar slowly begin to protract. Exercise must be repeated many times per day for short periods. The patient needs psychic support during exercise because the result that he achieved on the previous day is almost gone the next morning, and he has to start without the effect of the previous day. Nevertheless, after a certain time the results are manifested and persist. Then progress from day to day is more marked, and the efficiency with which favourable results are achieved increases rapidly. According to our experience, the worst period of contracting scars is about 3–4 months after the injury. If the patient successfully overcomes this period and does not despair, the results are usually very good. The great majority of patients resolves the motor restrictions by this technique and surgical correction is not necessary. If the position is very difficult, in cooperative patients a minor resistant remnant of the scar is released, but most of the release is due to correct rehabilitation.

Lubrication

Deep burns lead to functional or anatomical loss of skin adnexa, in particular sweat and sebaceous glands. Both types of adnexa are of basic importance for the optimal function of the recent scar and freshly healed area of the burn (Fig. 21). In deep grade II burns it is a temporary condition before adnexa from the preserved basal parts regenerate and start to fulfill their important function, i.e. to maintain a moist and elastic body surface and to create on the surface of the keratin layer a thin protective film that prevents the penetration of bacteria. When dermoepidermal grafts are used, the basal parts of adnexa are not transferred but after some time some functional glands develop (Fig. 22). If we use autografts in their full thickness, they are already completely functional after 1–2 months following incorporation, and it is not necessary to lubricate them.



Fig. 21. Inadequately lubricated spontaneously epithelized grade IIb burns on the back itch considerably, are scaly and the oedema persists for a long time before preserved skin adnexa start



Fig. 22. Lubrication in healed and epithelized granulation areas in the vicinity of grafts is particularly important.

Adnexa are not present here and practically never regenerate. If the area is not properly lubricated, it becomes too dry and the surface desquamates. Beneath the scales rhagads are formed that may become secondarily infected and result in the disintegration of the scar.

After many years of experimenting we elaborated the technique of combining light superficial massage with the application of creams containing as much as 50 % water. Mere lubrication only substitutes for the function of the sebaceous glands and omits the sweat glands. It is possible to use a whole ointment base such as Ambiderman, Synderman or Leniens, including complicated creams that contain disinfectants and regenerating substances. Ointment bases are particularly very useful in allergic patients who are sensitive to aromatic or other constituents of commercially available creams. During the last 15 years we did not have a favourable experience with lard. After its application the surface of the scars is polished, tense and obviously dehydrated, and long-term application led to the development of allergies and eczemas. It is useful to check patients regularly, in particular during the initial period of healing when the use of a particular cream may prove unsuitable after 3–4 weeks and local irritation may develop. It is necessary to change the preparation and follow-up its effects.

Immediately after application to the area, the patient should have a pleasant sensation without burning or irritation of the scar surface. It is not possible to provide exact advice on the period of lubrication; in some patients 2–3 months are sufficient, in others a year does not suffice. An individual procedure must be selected after examination of the skin surface and the degree of maturity of the scar, based on deep local oedema and the loss of red coloration. Colour balance with the environment is a signal that the capillaries of the granulation tissue in the scar have completely differentiated into functioning arteries and veins and that the lymphatic system has also regenerated.

Psychic rehabilitation

This focuses on the reduction or complete elimination of disorders that developed by psychological means as a result of the burn injury. The disorders may pertain to psychic as well as somatic functions. The main emotion in people with extensive burns is fear of death. The impossibility of resolving the situation by oneself leads to depression. Both these conditions must already be handled at an early stage, shortly after the injury. It is possible to use suitable preparations (alpha-blockers, antihistamines, antiphobic drugs, antidepressants) that eliminate the action of high levels of mediators released by the injury into the circulation and reduce the period of acute shock.

If the patient is willing to communicate, the use of psychotherapy is very effective. It should be focused on recollecting the circumstances of the injury, recognition of the cause of injury and a final evaluation, i.e. recognition must be achieved by the patient. In a similar way, in cases of very complicated rehabilitation, we can relieve the patient when we observe psychic blocks even

in simple and non-pretentious procedures. We found repeatedly that the problem arises in the first moments after injury, when the patient is faced for the first time with his injury and also the environment expresses its opinion (possibly saviours etc., either laymen or professionals). Opinions expressed during the period shortly after the injury have a fundamental impact on further treatment and later also on rehabilitation. If sentences are used such as "It is very bad", or "You will look awful", "That arm is fit for amputation", "With this nothing can be done" the therapeutic procedure is severely blocked and rehabilitation proceeds slowly. Permanent sequelae are marked, and the patient has difficulties to become reconciled with them. Subconsciously he is guided by the primary information, which frequently is unsuitable. If the patient is capable of psychoanalysis and after a guided conversation he is able to repeat these sentences and thus to eliminate them, the advance in treatment is incredible. During these conversations, the patients sometimes repeat even rash conclusions of the attending staff during hospital treatment or in the surgical theatre. It does not matter that he is under anaesthesia. He hears and perceives emphasized sentences as reflections on him. If they contain negative information it burdens his biophil orientation and causes a deterioration of the prognosis. Nevertheless, it must be emphasized that this is treatment for communicative patients and that it is very time consuming. A primary talk immediately after injury usually takes 2–3 hours before a satisfactory result is reached. Conversations in the stage of rehabilitation last 6 and more hours, and they must be divided into several parts with approximately two-day intervals between individual visits. Occasionally it happens that after elimination of a substantial mass of emotions associated with the injury, the patient recollects another event that occurred previously, sometimes very long ago. Sometimes it is an experience that he could not have had in this life; the intensity is sometimes immense, and after repeated experience the patient gets rid of many complaints; sometimes he even changes his hitherto unsuitable lifestyle. This, however, does not occur frequently. It is also possible that after the introductory talk when the patient is not yet able to eliminate the main emotional block, he is invited to attend further therapy after two days. When he comes he may say that he experienced his traumatic experience during the night in a dream, and during the controlled return to the moment of the injury, we find that the blocking emotional charge is released and the patient is quite relaxed.

As has been mentioned, this is therapy only for very communicative patients. Others must be treated with regard to the extent of cooperation. We focus attention on detailed information on the state of the treatment, possible complications and necessary further procedures. We elucidate the

unpleasant aspects of surgical operations. We carefully reduce pain by administration of analgesics. During the rehabilitation period we focus on the prognosis of the patient's social and work integration. We make use of the positive effect of different members of the family or the patient's good friends. Special care is required in patients with affections that are visible and are located on obvious parts of the body, i.e. face, neck and hands. These patients are threatened by the DF-syndrome (disfigured face syndrome).

In psychotic patients and decompensated delirious alcoholics, the intervention of a psychiatrist with appropriate pharmaceutical treatment

is necessary. Regular check-ups and changes of treatment go without saying. Also relatively frequent are suicide attempts with an inflammable liquid. These patients need extra care from the nursing staff and a psychologist and psychiatric supervision. We can never rule out the danger of repeated suicide attempts by another technique.

Address for correspondence:

*J. Bláha
Prague Burn Centre
Šrobárova 50
100 34 Prague 10
Czech Republic*

APOLOGY

I would like to apologize for my unintentional oversight in failing to obtain to list the names of surgeons who operated on patients presented in the figures that are part of the article „Brest Reconstruction as an Integral Part of Brest Carcinoma Therapy (a self-present final report of a research project IGA MZ ČR)“ published in *Acta Chirurgiae Plasticae*, 43, 2, 2001, pp. 42-53. The surgeons were M. Dušková (Figs 5, 7, 9A, 10), J. Měšťák (Fig. 6), M. Tvrdek (Fig. 8), A. Nejedlý (Fig. 9B) and K. Dlabal (Fig. 11). The main reason for the oversight was that investigation of the results of the surgeries was not the objective of

the project and did not form the contents of the published article. The figures served above all as illustrations of the methods used.

Therefore, I would like to express at the same time my sincere thanks also to all my other colleagues from the Clinic of Plastic Surgery, as an investigation with sufficient numbers assembled within a short period of time called for inclusion of all patients with the mentioned diagnosis treated at the Clinic of Plastic Surgery in Prague in 1993–1996, regardless of the surgeon who performed the operation.

Prague July 25, 2001

Markéta Dušková, M.D., Ph.D.



OPTICAL NON-CONTACT 3D PROFILOMETRY OF THE PALATE IN SUBJECTS WITH CLEFT LIP AND/OR PALATE

Trefný P.¹, Šmahel Z.², Formánek P.³, Müllerová Ž.⁴, Vítová L.⁴

¹Institute of Dental Research, General Faculty Hospital

²Department of Anthropology, Faculty of Natural Sciences, Charles University

³Institute of Thermomechanics, Academy of Sciences of the Czech Republic

⁴Department of Orthodontics, Faculty Hospital Královské Vinohrady
Prague, Czech Republic

SUMMARY

Within the framework of a research project concerning hard palate morphometry in facial clefts, optical non-contact 3D profilometry based on the Fourier transform method was applied. The article discusses the principle of Fourier transform profilometry, the procedure for image acquisition and processing, as well as the merits of this method in the study of palate morphology.

ZUSAMMENFASSUNG

Optische berührungslose 3D Profilometrie bei Patienten mit Lippen- und Gaumenspalten

Trefný P., Šmahel Z., Formánek P., Müllerová Ž., Vítová L.

Im Rahmen eines Forschungsprojektes, das die Gaumenmorphologie bei Patienten mit Lippen- und Gaumenspalten betrifft, wurde eine optische phasenmessende 3D Profilometrie, die auf der Fourier-Transformation basiert, verwendet. Dieser Beitrag stellt das Prinzip der Methode, das Verfahren der Bildverarbeitung und die Vorteile der Methode bei der Untersuchung der Gaumenmorphologie vor.

Key words: optical profilometry, Fourier transform method, palate morphology, cleft lip and palate

Cleft lip and palate, one of the most frequent congenital developmental defects (1 per 500 neonates), involves a serious affection of the face with aesthetic, functional and psychological consequences. The afflicted upper jaw is hypoplastic, and after surgery of the palate it is characterized by inadequate growth in the anterior direction and is narrow in the transverse dimension. These changes are the main cause of the most serious orthodontic anomalies and impaired sagittal jaw relations. The severity of the deviations depends on careful surgery and suitable procedures and methods of treatment in general. The results of different therapeutic programmes, from the aspect of growth and development of the jaws and the development of orthodontic anomalies, have been described in numerous studies.

The shape of the palate is also altered after surgery. The palate is shallow, narrow and short, which is one of the reasons for impaired speech. A shallow palate also implies a lack of space for

the tongue, which is pressed downwards, and this can contribute to posterior rotation of the mandible and impaired vertical jaw relations that are difficult to resolve orthodontically. The different relief of the palate contributes to abnormal articulation and impaired formation of consonants, which in the Czech language, with the exception of six, are formed by contact of the tongue with the anterior portion of the hard palate.

In contrast to the great many publications focused on the development of the jaws, in particular roentgencephalometric ones and metric analyses of dental casts, only a few studies have been devoted to the formation of the palate proper. This is, no doubt, due to the difficulties in objective evaluation, which call for sophisticated methods (see below).

Within the framework of a research project concerning hard palate morphometry in facial clefts, optical non-contact 3D profilometry based on the Fourier transform method was applied.

The aims of the mentioned project are numerous. First, to establish hard palate morphology and metrics in subjects with cleft lip and/or palate and their relation to the cleft type. Second, to determine to what extent is hard palate morphometry influenced by different methods of surgical treatment. Third, to investigate long-term changes in the shape of the palate under defined therapeutic conditions from the time of palate surgery up to adulthood. Fourth, to analyse speech development in relation to the shape of the palate etc. For the latter, most significant task, the only suitable patients are those in whom speech deviations developed only on the hard palate or in whom this deviation can be unequivocally differentiated from deviations that developed for other reasons. Articulographic and electropalatometric measurements will make it possible to record articulation sites of the tongue with the palate during sound formation and to trace them into 3D reconstructions of the palate. It will also be possible to correlate the character and extent of pronunciation disorders with deviations in the shape of the articulation sites of the palate and to derive demands on surgical and orthodontic treatment to achieve a favourable shape of the palate. Some findings assembled abroad cannot be applied, as the conditions differ for phonetic and phonological reasons in different languages. From this aspect Czech is one of the most complicated languages. It may be added that even in healthy subjects, 3D data on the development of morphology and palate shape are not available in the literature.

The point of the article is the principle of Fourier transform profilometry (FTP), technical equipment, the procedure of image acquisition and processing, as well as the merits of this method in the study of palate morphology.

EVOLUTION OF OPTICAL NON-CONTACT 3D MEASUREMENT TECHNIQUES

Topometric and photogrammetric metrologies are the fundamental and most powerful optical techniques for the 3D image processing. Measuring scenes and objects are recorded and analysed in three dimensions. Topometric techniques as well as photogrammetric ones are both based on the principle of optical triangulation: Photogrammetry is working by means of stereoscopic views from different camera positions, whereas topometric metrologies use illumination with structured light.

Shadow moiré topography, a topometric method for displaying and measuring the shape of objects in three dimensions, was developed in 1970 (10, 11). In order to overcome some significant limitations of the moiré method, Fourier transform profilometry was introduced by Takeda in 1983 (12). In the following years, modifications and refinements of this technique were made in order to broaden the range of its application, to

improve the accuracy and to accelerate and automate the procedure of data acquisition (Spatial Code Method, Phase Shift Method).

During the last decade, computer technology, optical technology, image hardware, and image processing technology have experienced great progress toward high speed and performance. Therefore, optical non-contact 3D measurement devices have entered a new stage for practical use. They can handle various object surfaces, and usually they are more accurate and quicker than what is required.

Currently, there are many sophisticated (and usually very expensive) modular topometric systems on the market that fulfil the requirements of a wide spectrum of applications in both research and development, including medicine and dentistry. Optical measurement techniques were used in order to construct 3D models of the human jaw for diagnostic and treatment purposes (15) to study facial growth (7), to determine tooth movement during orthodontic treatment (14), and to obtain qualitative and quantitative measurements of composite fillings (3).

PRINCIPLES OF FOURIER TRANSFORM PROFILOMETRY

Among the optical measurement methods developed as a practical product, the moiré technique was the first one. In the moiré method, a grating is placed over an object and obliquely illuminated. As the light passes through the grating, shadows are projected on the object surface. If the shadows cast on the object are viewed through the grating, beating will occur between the spatial frequencies of the shadow and the grating itself, resulting in the formation of moiré fringes. Each of the moiré fringes represents a group of points on the object surface that are of the same distance from the grating.

Moiré contouring technique was originally developed for fringe analysis by simple observation rather than automatically by a computer. For this purpose it is necessary to distinguish automatically between a depression and an elevation from a contour map of the object, to assign fringe orders automatically including those separated by discontinuities, to locate the center lines of broad fringes by correcting unwanted irradiance variations caused by nonuniform light reflection on the object surface, and to interpolate the regions lying between the contour lines.

As mentioned above, Fourier transform profilometry was introduced as an attempt to overcome the drawbacks of the moiré method. The principle of FTP is as follows:

An equispaced plane grating pattern is projected on an object to be measured. The projection lighting is provided by the light source of the projector. If the object to be measured is a flat surface located at a reference plane, the recorded grating is an image of parallel straight lines with



Fig. 1. Image of the reference plane with projected grating pattern.



Fig. 2. Image of the palate with deformed grating pattern.



Fig. 3.



Fig. 4.

Figs 3 and 4. Moiré images of a low palate. Only a few manual corrections are required before image processing (detection of edges between fringes and spaces).



Fig. 5.



Fig. 6.

Figs 5 and 6. Moiré images of a high palate. Fusion of moiré fringes makes further processing of the image impossible.

a certain distance between them. However, if the object surface is not in the reference plane and the surface is not flat, the original grating pattern is deformed depending on the curvature of the surface. Thus, the distance between the grating lines changes and the lines are no longer straight.

If we look at the change in the light intensity of the grating image, the image of a surface in the reference plane is a reference wave with a certain frequency and the image of a measured object is a deformed wave with its phase modulated. As the phase carries information about the 3D shape of the object, the FTP method calculates the phase difference between the reference and deformed waves for each individual pixel of the image.

Figure 1 shows an image of a reference plane where the straight grating lines serve as reference signals for determining the absolute phase values to be converted into a height distribution. Figure 2 shows an image of the palate with a deformed or phase-modulated grating pattern.

In the FTP method, the optical geometry is similar to that of projection moiré topography, but in contrast to the moiré contouring technique, the grating image projected on an object surface is recorded directly. Since FTP does not use moiré fringes, it is free from all the difficulties associated with the moiré contouring technique. The FTP method is capable of fully automatic distinction between a depression and an elevation on the object surface. There is no requirement for assigning fringe orders and interpolating data in the regions between contour fringes. The technique is free from errors caused by spurious moiré fringes generated by the higher

harmonic components of the grating pattern. Another great advantage of FTP is that it has a much higher sensitivity than the conventional moiré technique. It can detect a shape variation much less than one contour fringe in moiré topography. Whereas in the moiré technique the height distribution information is given only along a discrete set of contour lines, FTP gives the height information at all picture elements. This is the reason that FTP does not need interpolation as is necessary in moiré topography.



Fig. 7.



Fig. 8.

Figs 7 and 8. Image of an unaffected palate and its subsequent 3D reconstruction using FTP.



Fig. 9.



Fig. 10.

Figs 9 and 10. Image of an isolated cleft palate and its subsequent 3D reconstruction using FTP.



Fig. 11.



Fig. 12.

Figs 11 and 12. Image of an unilateral cleft lip and palate and the subsequent 3D reconstruction of the palate using FTP.

3D MEASUREMENT OF THE PALATE

Previous studies concerning 3D measurement of palate morphology were entirely based on the conventional moiré method (2, 4, 5, 8, 9, 13). Probably due to a lack of appropriate software for image processing and analysis, the maximum height of the palate and the position of the highest point were only manually registered. The maximum height of the palate was simply determined as the sum of moiré fringes between the highest point and the point representing the basal plane, multiplied by the distance between the fringes.

We have tested the applicability of the moiré method for the 3D measurement of the palate with limited success. In addition to all the difficulties associated with the automated analysis of moiré images of the palate, there is another serious disadvantage of this technique that restricts its use for palate analysis. In low palates, it is only sporadically necessary to manually correct the fringes on the image (Figs 3 and 4). In contrast, in high palates that exhibit a steep slope of the alveolar ridge in the lateral parts, frequent fusions of the moiré fringes come up that make further processing of the images impossible (Fig. 5 and 6). We have therefore turned our attention to Fourier transform profilometry, which has proven to be more suitable for this measuring task.

The appliance for acquiring the images for FTP consists of a CCD camera, slide projector and a device for setting the palate cast. The palate cast, made of dental stone, is placed on a modified stand head. This head can be easily shifted and tilted in three planes and allows one to adjust the palate cast into the exact required position. A plane grating etched in the chromium layer on a coated glass plate is used. The distance between lines (grating constant) is 0,5 mm and the line and space width relation is equal. A 250-W slide projector with an 85-mm lens projects the grating onto a palate cast surface. The deformed grating pattern is recorded by a CCD camera with a resolution of 2,5 million pixels and transferred into a computer.

Before measuring an image of a palate cast, an additional image of the reference plane is required for calibration purposes. Based on these two images, software for image processing separates different frequency components by the Fourier transform method, calculates the relative phase difference, unfolds the relative phase into the absolute phase and calculates the X, Y and Z coordinates from absolute phase information and the calibration results. Figures 7–12 show the 3D reconstructions of an unaffected palate and two palates with different types of cleft.

The software for the image analysis has just been developed. Based on three manually selected reference points on the alveolar ridge that

determine the palate axis and the basal plane, it should be possible to automatically construct the transversal as well as sagittal profiles in pre-defined planes and to measure them in detail.

Considering the merits of Fourier transform profilometry in displaying and measuring the shape of objects in three dimensions, as well as the efficiency of the software for image analysis, this method has the potential to acquire comprehensive data concerning palate morphology and metrics in facial clefts.

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Address for correspondence:

P. Trefný
Inst. of Dental Research
Vinohradská 48
120 60 Prague 2
Czech Republic
E-mail: trefnyp@post.cz

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DEVELOPMENT OF INTRACRANIAL RELATIONS IN PATIENTS AGED 10 TO 18 YEARS WITH CLEFTS OF THE LIP AND PALATE, USING CLUSTER ANALYSIS

Velemínská J.¹, Müllerová Ž.²

¹Department of Anthropology and Human Genetics, Charles University,
Faculty of Natural Sciences, Prague

²Department for Cleft Defects, Stomatological Clinic,
Charles University Hospital Královské Vinohrady, Prague, Czech Republic

SUMMARY

The investigation is based on a longitudinal cephalometric investigation of lateral teleroentgenographic pictures of male patients with a complete unilateral cleft of the lip and palate. Using cluster analysis the authors investigated the relationship of 75 craniofacial characteristics of size, shape and position during the time interval from 10 to 18 years of age. The main objective of the work was to characterize the development of intracranial relations during the pubertal spurt and compare the final condition in adulthood with a control group.

The angle of the cranial base and its effect on the position of the mandibular joint did not change during the investigation period. The relationship between the rotation of the mandible and the inclination of the upper alveolar process with the protrusion of different parts of the skeletal profile also remained constant. Up to adulthood, the rotation of the mandible developed independently of the sagittal intermaxillary relations. The relationship between the sagittal intermaxillary relations and other parts of the face did, however, change. Before the onset of puberty it was influenced most by the reduced length of the maxilla. The inadequacy of maxillary growth was balanced during this period by a change in the shape and position of the mandible. Its adaptative capacities could not compensate later for this uneven development of the jaws potentiated by the pubertal growth spurt. Due to this the intermaxillary relations deteriorated at the end of development in the majority of patients. The association of the restricted vertical maxillary growth with its retroposition was manifested only in adulthood.

Intracranial relations of the control group differed from those in the group with clefts. Sagittal intermaxillary and dental relations were not associated in healthy men. As individual probands were not linked by any restriction of growth or development, no close relationship developed between the shape characteristics of the lower jaw, which is the main compensatory adaptative mechanism.

ZUSAMMENFASSUNG

Entwicklung der intrakraniellen Relationen bei den Patienten mit Lippen- und Gaumenspalten im Alter von 10–18 Jahren, mit Verwendung der Cluster-Analyse

Velemínská J., Müllerová Ž.

Diese Studie basiert auf der longitudinalen, kephalometrischen Betrachtung von lateralen Fernaufnahmen bei Männern mit kompletten, einseitigen Lippen- und Gaumenspalten. Mithilfe der Cluster-Analyse wurden die Verhältnisse von 75 kraniofazialen Parameter im Alter von 10–18 Jahren analysiert. Die Studie wurde mit der Absicht vorgenommen, die Entwicklung der intrakraniellen Relationen während der Pubertätsakzeleration ermitteln und der Endzustand im erwachsenen Alter mit der Kontrollgruppe vergleichen.

Der Winkel der Schädelbasis und ihrer Einfluss auf die Position des Kiefergelenkes änderten sich nicht während der gefolgten Zeitspanne. Genauso die Relation zwischen Rotation des Unterkiefers, Inklination des maxillären Alveolarfortsatzes und Protrusion der einzelnen Teile des Skelettprofils blieb konstant. Rotation des Unterkiefers entwickelte sich bis zum erwachsenen Alter unabhängig von sagittalen intermaxillären Beziehungen. Während der gefolgten Zeitspanne änderte sich aber die Relation zwischen sagittalen intermaxillären Beziehungen und anderen Gesichtspartien. Vor dem Pubertätsanfang wurden die sagittale intermaxillären Beziehungen hauptsächlich durch die reduzierte Länge der Maxilla beeinflusst. Mangelhaftes Wachstum der Maxilla wurde in dieser Periode durch eine Änderung der Form und Position des Unterkiefers kompensiert. Unregelmäßige Entwicklung der Kiefer, die durch die Pubertätsakzeleration noch potenziert wurde, überstieg aber die Kompensierungsfähigkeit des Unterkiefers. Die Mehrheit von Patienten wusste dadurch am Entwicklungsende fehlerhafte sagittale intermaxilläre Beziehungen auf. Beziehung zwischen vertikalem Wachstum der Maxilla und ihrer Retroposition machte sich erst im erwachsenen Alter bemerkbar.

Hinsichtlich intrakranieller Relationen, die Patientengruppe mit Lippen- und Gaumenspalten unterschied sich nicht von der Kontrollgruppe. Sagittale intermaxilläre Beziehungen und dentale Beziehungen hängten in der Kontrollgruppe nicht zusammen. Denn das Wachstum des Fazialskelettes bei den Probanden der Kontrollgruppe nicht beschränkt wurde, eine Interaktion der einzelnen Abmessungen des Unterkiefers, die seine Form kennzeichnet und ein kompensatorischer und adaptiver Mechanismus darstellt, wurde nicht festgestellt.

Key words: cleft lip and palate, intracranial relations, cluster analysis, X-ray cephalometry

The investigation is based on the work of Šmahel and Škvařilová (4) and Velemínská (5). Šmahel and Škvařilová assessed intracranial relations by means of a correlation analysis of metric characteristics in healthy adult males. In the work of Velemínská (5) the author tested the possibility of using multivariation methods for evaluating the same problem in ten-year-old patients with a complete unilateral cleft of the lip and palate. Cluster as well as factor analysis proved useful when seeking associations between partial structures of the skull. They supplemented each other, and their combined use contributed to the definition of some basic and specific principles of craniofacial relations and compensatory and adaptive mechanisms in clefts.

The objective of the present work is a comparison of the intracranial relations of cleft patients aged 10, 15 and 18 years, followed up on a longitudinal basis. We focused our attention in particular on the problem of the developmental association of sagittal intermaxillary relations and the rotation of the mandible with other facial parameters. Adult patients were moreover compared with a control group of adult men. For illustration of the dendrograms, we selected cluster analysis as the method.

MATERIAL AND METHODS

The work is based on a roentgencephalometric longitudinal investigation of 48 boys with complete unilateral cleft of the lip and palate without other associated malformations, treated at the Clinic of Plastic Surgery in Prague. The patients were measured at the ages of 10, 15 or 18 years. The last age group comprised only 26 probands. The mean age of the 10-year-old patients was 10 years and 1 month, of the 15-year-olds 15 years and 1 month, and of the 18-year-olds 18 years and 10 months. All were born between 1972–1978. For comparing the intracranial relations of adult patients to those of adult men without the affection, we used a control group of 37 men aged 18 to 30 years (mean age 23 years, 11 months).

Primary cheiloplasty was performed in the majority of patients by Tennison's method (83 %), in exceptional cases by Veau's method (17 %), at an average age of 9 months. Both methods were always associated with periosteoplasty using a 5–7 mm wide and 15–20 mm long periosteal flap obtained from a lateral maxillary segment. The patients were subjected to palatoplasty at an average age of 5 years and 2 months, always by the method of retroposition with pharyngofixation. In about one-third of the patients, a tonsillectomy was performed or, in exceptional cases, an adenotomy.

Secondary corrective procedures were implemented in patients with persisting soft tissue deformities. These surgical operations, however, do not influence the shaping of the skeletal profile.

All mentioned operations were performed by the same team of surgeons. Twenty-five patients of the group were treated by means of fixed appliances and 23 by removable appliances to achieve correct alignment of the teeth in the dental arch, proclination of the upper dentoalveolar process and achievement of maxillary overjet.

The work is based on craniometric analysis of long distance pictures of the head taken under

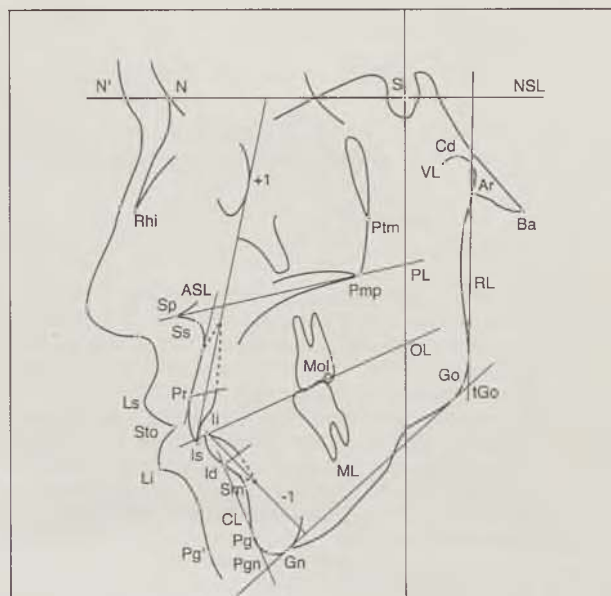


Fig. 1. Cephalometric points and reference lines used in this study

Ar (articulare) – intersection of inferior contour of the cranial base and posterior contour of the ramus; **Ba** (basion) – most posteroinferior point on the clivus; **Cd** (condylion) – most superior point on the condylar head; **Go** (gonion) – point on the angle of the mandible determined by the axis of ML/RL angle; **Gn** (gnathion) – lowest point of the mandibular symphysis; **Pgn** (prognathion) – point on the mandibular symphysis farthest from Cd; **Pg** (pogonion) – most anterior point on the bony chin; **Pg'** (soft pogonion) – most anterior point on the soft tissue chin; **Sm** (supramentale) – deepest point on the anterior contour of the mandibular symphysis; **Id** (infradentale) – point of the gingival contact with the lower central incisor; **Ii** (incision inferius) – incisal tip of the lower central incisor; **Is** (incision superius) – incisal tip of the upper central incisor; **Mol** (molare) – tip of the posterior cuspid of the lower first molar; **Pr** (prosthion) – point of gingival contact with the upper central incisor; **Ss** (subspinale) – deepest point of the subspinal concavity; **Sp** (spinale) – tip of the anterior nasal spine; **Pmp** (pterygomaxillare palatinum) – point of intersection of the palate plane and fissura pterygomaxillaris; **Ptm** (pterygomaxillare) – most inferior point of the fossa pterygopalatina where fissura pterygomaxillaris begins; **S** (sella) – centre of sella turcica; **N** (nasion) – most anterior point on the fronto-nasal suture; **N'** (soft nasion) – intersection between NSL and soft profile contour; **Rhi** (rhinion) – most anteroinferior point on the nasal bone; **Ls** (labrale superius) – margin of the vermillion of the upper lip; **Sto** (stomion) – point of contact of the upper and lower lip; **Li** (labrale inferius) – margin of the vermillion of the lower lip; **NSL** – line through N and S; **VL** – perpendicular to NSL through S; **PL** – line through Sp and Pmp; **OL** – line passing through the midpoint between incisal tip of the upper and lower central incisors and posterior cuspid of the first lower molar; **+1** – axis of the upper incisor; **-1** – axis of the lower incisor; **CL** – line through Pg and Id; **ASL** – tangent to the maxillary alveolar process through Pr; **ML** – tangent to the mandibular body through Gn; **RL** – tangent to the mandibular ramus through Ar; **tGo** (tangenta gonion) – intersection of ML and RL line.

standard conditions (lamp-object distance 370 cm, object-film 30 cm, enlargement 8,1 %). The craniometric analysis is based on the points and reference lines shown in Fig. 1. In case of double outlines the centre between the left and right part was indicated. For statistical processing of the assembled data the statistical system Stat-Soft was used.

Using a digitizer, 75 signs, 22 linear dimensions, 28 characteristics of positions and shapes and 15 dental and some special parameters were assessed. Overjet (Is-Ii) is defined as the distance between the cusps of the upper and lower incisors measured parallel with the occlusion plane; overbite (Is+Ii) is the distance between the cusps of the upper and lower incisors assessed perpendicular to the occlusion plane. The dimension Ls+Li indicates the prominence of the upper lip in relation to the lower one, assessed at points Ls and Li as their perpendicular distance in relation to the line N'Pg'L. Pr+Id is the difference between point Pr and Id after their perpendicular projection to the modified occlusion plane that passes through the centre of the distances of the upper and lower incisors and the peak of angle PL/ML (if Pr is posterior to Id, the value is negative). Ss+Sm is the difference between points Ss and Sm after their perpendicular projection to the mentioned modified occlusion plane (if Ss is posterior to Sm, the value is negative).

The mutual craniofacial relations were evaluated by cluster analysis. Cluster analysis divides signs into groups based on their mutual distance, in our case *1-r* (Pearson), i.e. from the correlation matrix of the investigated signs. Its role is to seek agglomerations that in one group are mutually resembling objects, while dissimilar objects are in different groups. The result of the analysis is a dendrogram that makes detailed investigations of mutual relations of its branches possible. We preferred this method to factor analysis as it is more instructive. Due to the coloration of important branches of dendrograms, it is possible to trace the development of the four most important intracranial relations throughout the follow-up period: sagittal intermaxillary relations (green colour), rotation of the mandible (red colour), shape of the mandible (yellow) and flexion of the cranial base (blue colour). By means of columns in the dendrograms, characteristics that express directly are unified; the coloured lines indicate their association with other dimensions.

RESULTS

Intracranial relations at the age of 10 years (Fig. 2)

Sagittal intermaxillary relations at the age of 10 years (Pr-N-Id, Ss-N-Sm, Pr+Id, Ss+Sm, Is-Ii) determine the convexity of the face (N-Ss-Pg) and are greatly influenced by the reduced length of the maxilla (Ss-Pmp, Sp-Pmp). The dendrogram illustrates the close relationship of these dimen-

sions with those which characterize the shape of the mandible (RL/NSL, -1/ML, CL/ML, S-Ar-tGo) but not its size. The characteristics of the shape of the mandible are probably the main adaptive mechanism of this structure in ten-year-old patients and are closely associated with the position of the lips in relation to the soft profile (Ls-N'Pg'L, Sto-N'Pg'L, Li-N'Pg'L).

Rotation of the mandible is not associated with the sagittal intermaxillary relations. The dimensions that express it (S-tGo%N-Gn, S-Go%N-Gn, N-tGo-Gn, ML/NSL) are part of an extensive branch of the dendrogram. It describes the relationship to the inclination of the upper alveolar process (+1/NSL, +1 /PL, ASL/PL) and the relationship with the majority of angular dimensions that express the position of different parts of the skeletal profile in relation to the cranial base (S-N-Sm, S-N-Pg, S-N-Gn, S-N-Pr and others).

Flexion of the cranial base (N-S-Ba) is most closely related to the dimensions that record the position of the mandibular joint (N-S-Cd, N-S-Ar), the position of the mandibular angle (N-S-Go) and the prominence of the chin (N-S-Pgn). This branch has a certain association with the branch of the anterior heights of the face (N-Rhi, N-Sp, N-Ss, N-Pr) and the inclination of the occlusion plane (OL/NSL). The remaining linear dimensions are more mutually associated, only the longitudinal characteristics in the area of the cranial base (N-S and Pmp-Ba) are accumulated, due to a different type of growth, in another branch.

Some dental characteristics express the relationship of the two jaws (Is+Ii, +1/-1) and are due to the great interindividual variability and the possible effect of orthodontic treatment concentrated in a special free branch of the dendrogram.

Intracranial relations at the age of 15 years (Fig. 3)

Sagittal intermaxillary relations at the age of 15 years are less mutually connected than in the younger age group. The dimensions related to the point nasion (Ss-N-Sm, Pr-N-Id) after puberty agree less with the dimensions related to the modified occlusion plane (Ss+Sm, Pr+Id). There is not even a direct relationship with the length of the maxilla, nor a connection with the shape of the mandible. There is, however, another interesting fact: the shape of the mandible (RL/NSL, -1/ML, CL/ML, S-Ar-tGo) is influenced in the 15-year-olds by the length of the maxilla as well as the length of the branch of the mandible (Cd-Go). The restricted growth of the maxilla thus influences the compensatory-adaptive mechanism of the mandible. Depending on the success of this compensation during puberty, the primary growth restriction is then manifested or not manifested in the relation of the two jaws and occlusion.

Rotation of the mandible and its relationship with the surrounding parameters does not change as compared with the previous age group. The

condition is also stable as regards the flexion of the cranial base in relation to the other structures. More marked changes were not recorded in the agglomeration of linear and dental dimensions.

Intracranial relations at the age of 18 years (Fig. 4)

The dendrograms at the ages of 15 and 18 years do not differ much. The sagittal intermaxillary relations in patients with clefts, similarly as in the two previous age groups, form in adulthood one branch of the dendrogram. The Ss-N-Sm dimension differs most from the other dimensions. There appears a new association of sagittal intermaxillary relations with the inclination of the palatine plane (PL/NSL) and thus also the upper anterior heights of the face (N-Rhi, N-Sp), which was not recorded before adulthood was reached. Some characteristics as regards the shape of the mandible (CL/ML, -1/ML) are associated with the position of the lips in relation to the soft profile and the position of the incisors in relation to the skeletal profile. We did not demonstrate any association of these adaptive capacities of the characteristics of the mandible as regards shape with the sagittal intermaxillary relations nor with the length of the maxilla.

Rotation of the mandible, even at the age of 18 years, does not change its relations with the surrounding structures. To the dimensions associated with this rotation the posterior height of the face was added (S-Go, S-tGo). Flexion of the cranial base is associated with some anterior facial heights (N-Pr, N-Sm) and with the position of the mandible in relation to the cranial base (N-S-Cd, N-S-Ar, N-S-Go, N-S-Pg, RL/NSL).

On the appropriate dendrogram we found a branch that can be interpreted as an association of the retro-position of the maxilla (S-N-Sp, S-N-Ss, S-N-Pr) with the reduced maxillary length. This association was not observed in other age groups.

Intracranial relations in the 18-year-old control group (Fig. 5)

Sagittal intermaxillary (Ss-N-Sm and Ss+Sm) and interalveolar relations (Pr-N-Id, Pr+Id) are not included together with dental relations in the same branch of the dendrogram. Dental relations (Is-Ii) or overjet is most closely associated with overbite (Is+Ii) and forms a special small branch of the dendrogram. This agglomeration is closest to the maxillary length (Ss-Pmp, Sp-Pmp) and the length of the anterior cranial base (N-S).

The less branched arm corresponds to the rotation of the mandible. Rotation there is associated with the magnitude of both longitudinal dimensions of the mandible (Pgn-Go, Cd-Go) and with the inclination of the upper alveolar process and upper incisors in relation to the NS line. As compared with the situation in cleft patients of the same age, we did not find any relationship

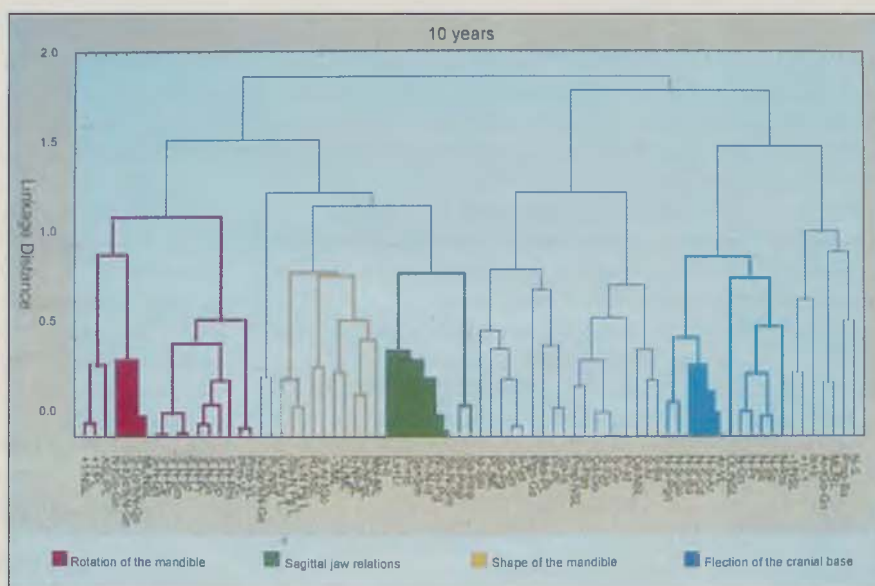


Fig. 2. Tree diagram for 75 variables, complete linkage 1-r, 10 years.

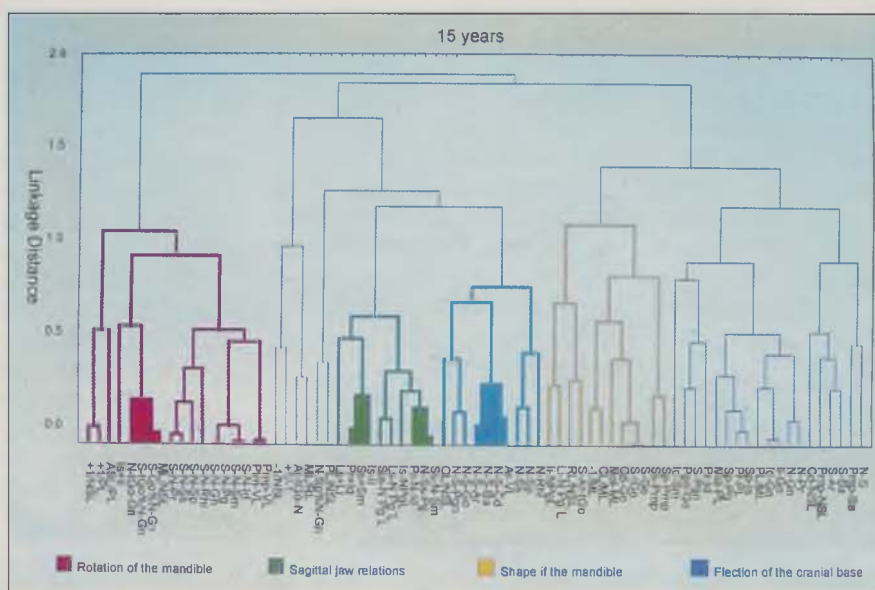


Fig. 3. Tree diagram for 75 variables, complete linkage 1-r, 15 years.

between rotation and the position of the mandible in relation to the cranial base (N-S-Cd, N-S-Ar, N-S-Pg).

The branch that described in an overall way the shape of the mandible was not found. The position of the lips in relation to the soft profile (Ls-N'Pg'L, Li-N'Pg'L) is formed together with the position of the incisors in relation to the skeletal profile (Is-NPgL, Li-NPgL).

The flexion of the cranial base is related to the position of the maxillary joint (N-S-Cd, N-S-Ar), to the palatine plane (PL/NSL) and thus also to some anterior facial heights (N-Sp, N-Ss). These structures are associated with sagittal intermaxillary relations in 18-year-old patients with clefts.

In the appropriate diagram there remain the two largest branches not coloured. One of them unifies the majority of anterior facial heights, the

second one in particular angles that express the position of individual parts of the skeletal profile in relation to the cranial base.

DISCUSSION AND CONCLUSIONS

The results of cluster analysis revealed that this method describes in a meaningful way the association of dimensions at several levels. Least interesting, but nevertheless logical, is the unification of dimensions according to their classical classification by size, shape and position. Mutually closer are characteristics of sites that are in the same direction (e.g. heights) as those that are in different directions (e.g. height and lengths). These findings are consistent with the study of Šmahel and Škvařilová (3).

Sagittal intermaxillary relations in patients at the age of 10, 15 and 18 years correspond in the dendrograms always to one agglomeration. The appropriate branch always comprises all dimensions that express the relations directly or are closely associated with them. With advancing age of the patients, the different dimensions that express mutual maxillary, interalveolar and dental relations become less and less associated. Most remote becomes the dimension Ss-N-Sm, which is best suited for prediction of sagittal intermaxillary relations (6).

In the age group of 10-year-old patients, the sagittal intermaxillary relations are greatly influenced by the reduced maxillary length. In the older age groups we did not find this relationship. The reduced length of the maxilla and these impaired sagittal intermaxillary relations are compensated for by changes in mandibular shape. The latter include the changed inclination of the branch of the mandible in relation to the NS line, the changed inclination of the lower incisors and the angle of the chin. This compensatory adaptive mechanism of the mandible after termination of the pubertal spurt very often does not suffice to compensate for the increasing longitudinal charac-

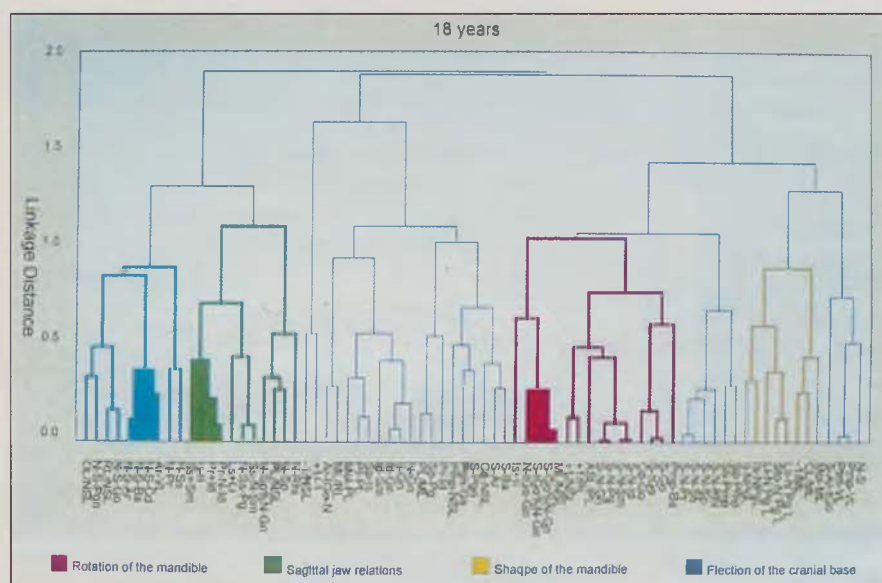


Fig. 4. Tree diagram for 75 variables, complete linkage 1-r, 18 years.

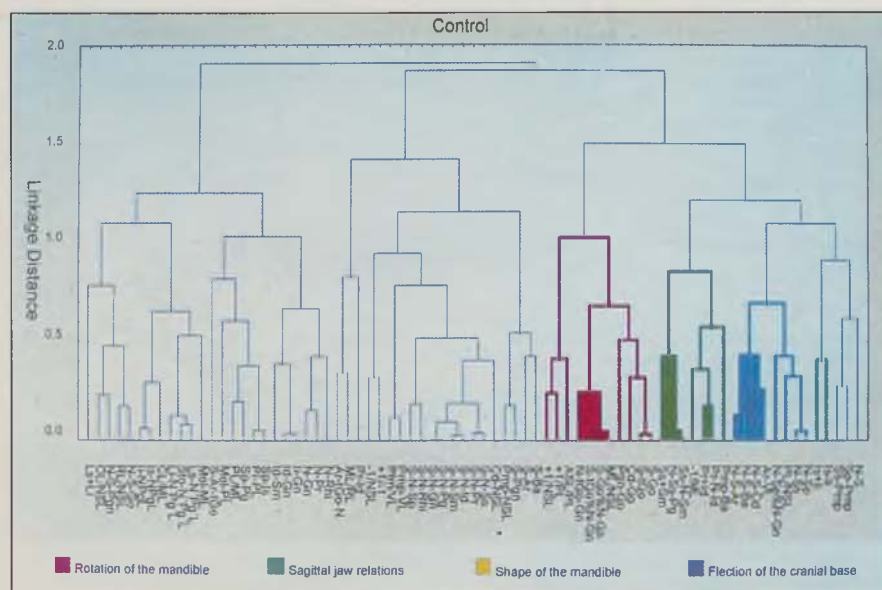


Fig. 5. Tree diagram for 75 variables, complete linkage 1-r, control.



teristics of the mandible, and thus the mutual position of the jaws develops independently. The mutual position of the jaws has an impact on the mutual position of the lips and their position in relation to the soft profile. In adulthood the final state of sagittal intermaxillary relations is associated with the reduced vertical growth of the maxilla that is one of the basic facial deviations of patients with clefts.

Sagittal intermaxillary relations expressed in various ways in a control group of healthy adult men are associated much less than in all age groups of patients with clefts. In probands there is no growth restriction conditioned by size or shape, therefore no branch of the dendrogram unifies the dimensions that can compensate for possible deviations.

The rotation of the mandible is expressed by several dimensions. These are two angular dimensions, N-tGo-Gn and ML/NSL, and the ratio of the posterior facial height expressed as a % of the anterior height S-tGo%N-Gn (S-Go%N-Gn resp.). In order to represent on the dendrograms all these dimensions as a single branch, the angular dimensions were calculated to 360°. The dendrogram is prepared on the basis of the *I-r* distance between individual parameters, thus the positive and negative, even if closely correlated, would be visualized as at least two apparently non-associated branches (e.g. a reduction of angular characteristics and an increase of the above mentioned characteristic S-tGo%N-Gn corresponds to anterior rotation). Calculations of this type made the dendrograms more instructive and simpler, while other associations were concealed by this manipulation. The lower anterior facial heights closely positively correlated with the original angles (an increase of the angle causes an increase of the anterior facial heights), and by calculation of the angular dimensions this relationship disappeared from the curves. We did not observe concealment of other important associations as a result of this mathematical manipulation.

The relationship of the rotation of the mandible to the remaining facial structures did not change throughout the investigation period in patients with clefts. This is associated with the inclination of the upper incisors and the entire alveolar process in relation to the palatine plane and position of different parts of the skeletal profile in relation to the anterior cranial base. In adult patients the rotation is moreover influenced by the length of the mandibular branch. The relationship of mandibular rotation with the position of the skeletal profile to the cranial base is lacking in the control group.

The flexion of the cranial base is associated with the height of the skeletal profile and the position of the mandible in relation to the neurocranium. These relations were the most stable ones throughout the investigation period. The majority of associated angles has its peak at point S and correlates very negatively with the angular dimensions with the peak at point N. Our dendrograms do not illustrate this negative mutual relationship for reasons explained above. In the control group the flexion of the cranial base correlates most closely with the position of the mandibular joint. This association is described by Anderson and Popovich (1) and is consistent with the results of Šmahel et al. (2).

Cluster analysis enabled us to seek relations between topographically and developmentally different structures of the skull. By means of the resulting dendrograms, we evaluated which structures participate in processes of mandibular rotation, flexion of the cranial base and sagittal intermaxillary relations and how these processes develop. Based on some associations as regards shape inside the mandible, it is possible to describe its compensatory and adaptive abilities for preserving the maxillary overjet. At the same time interindividually variable and unstable signs that can be influenced by orthodontic treatment became apparent.

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Address for correspondence:

Jana Velemínská
Viničná 7
128 44 Prague 2
Czech Republic

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LETTER TO THE EDITOR

APPLICATION OF HEPARIN IN THE LOCAL TREATMENT OF BURNS

Troshev K., Dimitrov R.

Soon after studying the method of Dr. Saliba (3) for the early treatment of burns with heparin, we have applied it in 50 outpatients with non-extensive superficial burns. The test of capillary return was positive (1).

The study group comprised 37 females and 13 males, aged 38 years on average (range from 17 to 60). This group of patients was selected purposely in order to make a more precise and trustworthy study because the method was new and unknown for us. We did not find any publications about its use in Europe, independently of the publications by Dr. Saliba (4), nor about the use of this method elsewhere in the world (USA, India, Russia). We treated the study patients from the first dressing until complete epithelization.

The heparin solution was prepared according to the method of Dr. Saliba (3). We are impressed by the fact that the necessary quantities diminish with every subsequent dressing until the disappearance of the pain. In contrast to Dr. Saliba, we applied the dressings and the heparin solution only once every 24 hours. The average dose for the full course of treatment for one patient is 15 ml heparin solution (Fig. 1). The pain disappears or decreases to a minimum, making analgetics unnecessary, 10 minutes after the applica-

tion of the heparin solution. Only two patients needed one tablet of Panadol each during the first 24 hours.

The wound surfaces remain fresh pink without the formation of a coating. On the second day, epithelial islets appear as well as epithelization from the wound edges. Wounds with an average surface of 11,75 sq. cm are healed on the 7th day (Fig. 2). We selected burns with small surface areas and made precise measurements of their di-

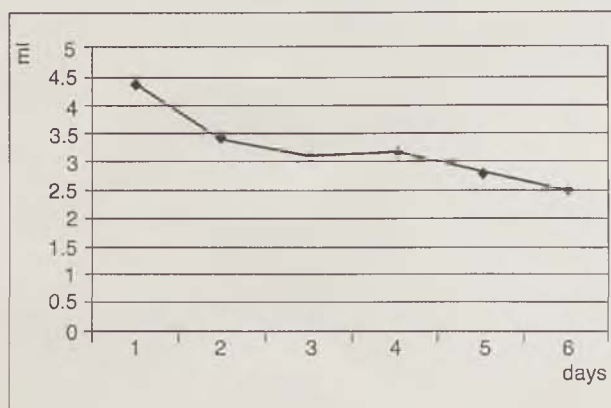


Fig. 1. Average amount of heparin solution in ml during six days of treatment.

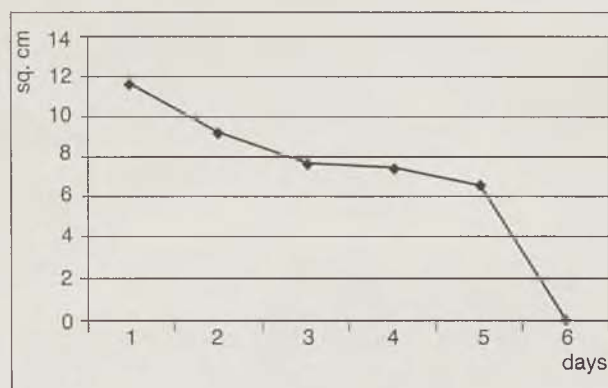


Fig. 2. Average surface of the wound in sq. cm during the treatment.

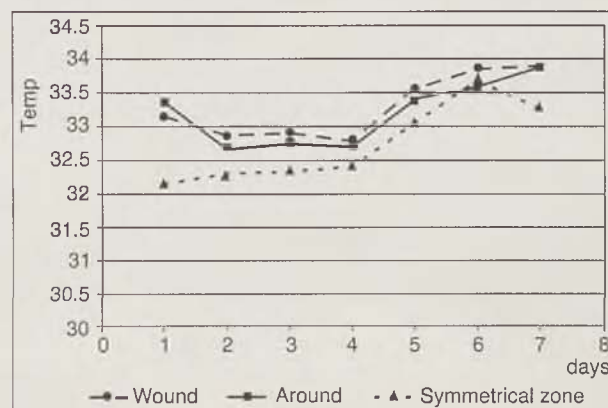


Fig. 3. Local temperature in degrees centigrade in the wound, around it and in a comparable zone (healthy skin) during the treatment.

mensions. The average surface area was progressively decreasing from the first dressing until complete epithelization. This decrease in the surface area of the wounds was our reason for decreasing the amount of the heparin solution.

The question of pain is a delicate one because of different individual sensitivities. Our patients provided us with firm subjective information about the intensity and characteristics of their feelings of pain. We did not use other more precise methods for its characterization.

We studied the local temperature with an electrothermometer on contact points in the centre of the wound, in a 2 cm surrounding zone and in comparable places on healthy skin after the application of the heparin solution. The highest temperatures were observed in the centre of the wound, lower in the surrounding zone and the lowest in the comparably located distant areas of healthy skin. During the period of treatment, the temperature levels in the three locations changed simultaneously (Fig. 3).

Some differences do arise in other interesting aspects. The temperatures in the three locations remain lower than the skin temperature of healthy people without burns, the control group (5), which we accept as normal, during the entire period of treatment until complete epithelization. The quantitative numerical data were statisti-

cally analyzed by the method of variations analysis (2). The minor fluctuations during the seven days of observation are statistically significant at the level of $p < 0.05$.

We have not compared the period of epithelization with that of other methods of treatment. The treatment with heparin solution according to the method of Dr. Saliba insures a painless and complication-free course of healing in non-extensive superficial burn wounds.

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Address for correspondence:

Konstantin Troshev
Dept. of Burns and Plastic Surgery
44, Alexander Batenberg str.
9000 Varna, Bulgaria

Editors comment:

A whole array of remedies have been used in the treatment of burns through the ages. The author has been using Heparin topically in not-extensive superficial burns with reference to the symposium at the ISBI Congress in Jerusalem in 1998. In the ISBI journal *Burns* 27 (2001) has been published by Dr. Saliba an extensive review on "Heparin in the treatment of burns". There has been several times pointed out the beneficial effect of Heparin in pain relief and blanching of erythema when application is repeated several

times about every 5 minutes for a total of 30 minutes. Thus the method is not new. Its efficacy is difficult to prove by measuring local temperature, by estimating the intensity of pain sensation and by speed of epithelization in out-patients who must arrive to the hospital every day to have the Heparin dressing changed. This frequent change of dressing on out-patient basis brings about – apart from other inconveniences – also danger of early wound infection.

SOUHRNY

Extraanatomická rekonstrukce jícnu

Tvrdek M., Pařko P.

Autoři prezentují případ 53letého pacienta se spinokarcinomem hrudní části jícnu. Hrudní část jícnu byla resekována a vzniklý defekt byl vzhledem ke komplikacím řešen v několika etapách. Nejprve byl interponován žaludek, dále pak byl učiněn pokus o rekonstrukci tračníkem a kličkou tenkého střeva. Všechny tyto pokusy

o rekonstrukci skončily neúspěšně a výsledným stavem byla ezofagostomie a výživná jejunostomie. Vzhledem k celkovému stavu pacienta, předchozím výkonům a rozsahu defektu byla provedena etapová extraanatomická rekonstrukce tubulovanými laloky.

Redukční mammaplastika s proximální dermo-glandulární stopkou: naše zkušenosti

Valeriani M., Mezzana P., Madonna Terracina F. S.

Autoři použili techniku redukční mammaplastiky s horní dermo-glandulární stopkou, kterou popsal v roce 1972 Lalardrie a modifikoval Lauro. Touto technikou bylo operováno 28 pacientů se střední až těžkou hypertrofií prsu. Ve všech případech byl estetický efekt uspokojivý a komplikace, ve smyslu významné nekrózy tkáně, nebyly zaznamenány. Tato metoda se v případech těžké gigantomastie osvědčila jako

bezpečná a efektivní, jak z důvodu kvalitního cévního zásobení laloku, tak z důvodu možnosti provádění rozsáhlých transpozic areolomilárního komplexu bez nebezpečí vzniku komplikací. Technika může být použita i v méně závažných případech ve spojení s obdobně snadnými metodami. Její jednoduchost umožňuje přistoupit k tomuto typu výkonu i mladším, méně zkušeným chirurgům.

Chirurgické řešení faryngeokutánní píštěle jako následku laryngektomie

Cunha-Gomez D., Kavarana N. M.

Náprava velké faryngeokutánní píštěle, vzniklé v důsledku laryngektomie, představuje pro plastického chirurga výzvu. K rekonstrukci těchto velkých píštělí je ideální radiální lalok

z předloktí. Na příkladu kazuistiky jsou v příspěvku diskutovány etiologie a řešení faryngeokutánní píštěle jako následku laryngektomie.

Trvalé následky po popáleninách a osvědčené postupy při jejich ovlivňování

Bláha J.

Přestože trvalé následky po hlubokých popáleninách vždy zůstávají, je možno je velmi příznivě ovlivňovat, začínáme-li velmi časně po úraze. Máme několik možností: Velmi časnou rehabilitaci polohováním a podkládáním předcházíme zkrácení šlach a vazů v okolí velkých kloubů a redukuje se poutingový otok. Volbou správné operační techniky ve správnou dobu dosahujeme optimálního průběhu hojení a jizvení. Velkou pozornost je nutno věnovat infekci a před-

cházet jí. Po zahojení je třeba aplikovat velmi časně kompresivní pomůcky, nejlépe v kombinaci se silikonovými a jim podobnými materiály. K promašťování používáme raději krémy s vysokým obsahem vody. Dbáme na optimální psychickou pohodu postižených pacientů. Pokud pacient dobře komunikuje, neváháme použít psychoanalytické metody a redukovat emoce a verbální blokády, fixované na úraz.

Optická bezkontaktní 3D profilometrie u jedinců s rozštěpen rtu a/nebo patra

Trefný P., Šmahel Z., Formánek P., Müllerová Ž., Vítová L.

V rámci výzkumného projektu, který řeší otázku morfologie a metricky tvrdého patra u rozštěpových pacientů, byla použita optická bezkontaktní 3D profilometrie, založená na

Fourierově transformaci. Příspěvek představuje princip metody, proces získání a zpracování snímků patra a vyzdvihuje výhody této techniky při studiu morfologie patra.

Vývoj intrakraniálních vztahů u pacientů s rozštěpem rtu a patra v časovém období od 10 do 18 let za použití klastrové analýzy

Veleminská J., Müllerová Ž.

Studie je založena na longitudinálním kefalometrickém sledování laterálních telerentgenových snímků pacientů s úplným jednostranným rozštěpem rtu a patra mužského pohlaví. Za použití klastrové analýzy byl sledován vztah 75 kraniofaciálních charakteristik velikosti, tvaru i pozice v časovém rozmezí od 10 do 18 let. Hlavním cílem práce bylo charakterizovat vývoj intrakraniálních vztahů během pubertálního spurtu a porovnat konečný stav v dospělosti s kontrolním souborem.

Úhel lebeční báze a její vliv na pozici čelistního kloubu se během sledovaného období neměnil. Konstantní zůstal také vztah rotace dolní čelisti s inklinací horního alveolárního výběžku a s protruzí jednotlivých částí skeletálního profilu. Rotace mandibuly se až do dospělosti vyvíjela nezávisle na sagitálních mezičelistních vztazích. Vztah sagitálních mezičelistních vztahů vzhledem k jiným částem obličeje se ale měnil.

Před začátkem puberty je nejvíce ovlivňovala redukovaná délka maxily. Růstová nedostatečnost maxily byla v tomto období vyvážena změnou tvaru a pozice dolní čelisti. Její adaptační schopnosti později nestačily kompenzovat tento nerovnoměrný vývoj čelistí umocněný růstovým pubertálním spurtem. Následkem toho se sagitální mezičelistní vztahy ke konci vývoje zhoršily u většiny pacientů. Souvislost omezení vertikálního růstu maxily s její retropozicí se projevila až v dospělosti.

Intrakraniální vztahy kontrolního souboru se od rozštěpových souborů lišily. Sagitální mezičelistní a dentální vztahy spolu u zdravých mužů nespojovalo žádné omezení růstu ani vývoje, nevyvinul se zde těsnější vztah mezi tvarovými vlastnostmi dolní čelisti, který představuje hlavní kompenzačně-adaptační mechanismus.

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Supplementa časopisů České lékařské společnosti JEP v roce 2001

■ Monitorace v anesteziologii, resuscitační a intenzivní péči

Laboratoř u lůžka nemocného – Point of Care Testing /POCT/

Práce sester na ARO a JIP

(Anesteziologie a neodkladná péče)

V rámci 12. ročníku časopisu Anesteziologie a neodkladná péče vychází I. supplementum 2001, jehož náplní jsou práce předních klinických a biochemických odborníků na téma monitorace v anesteziologii, resuscitační a intenzivní péče, význam a poslání laboratoře u lůžka nemocného – Point of Care Testing (POCT). Dále je do čísla zařazeno několik článků sester o práci na ARO a JIP při péči o nemocného v neodkladném stavu, kdy jeho život je vážně ohrožen. Dokonalé sledování pacienta, rychlé vyhodnocení jeho stavu i změn v průběhu nemoci, správné nasměrování k poznání diagnózy, a tím k včasnému rozhodnutí léčby, může odvrátit zhroucení stavu nemocného. Vedle sledování ošetřovaného je velice cenná včasná laboratorní diagnostika. K tomu účelu vznikla laboratoř, která je umístěna v blízkosti lůžka pacienta a která poskytne závčas kvalitní informace. Práce s těmito přístroji vyžaduje, aby pracovník byl zaškolen a seznámen s přístroji pro rozsáhlejší činnost laboratoře, přitom výsledky musí být správně vyhodnoceny a být pod kontrolou centrální laboratoře. Takováto zařízení mají jistě přednosti, ale mohou přinést i určitá rizika, která by mohla vzniknout při nesprávném postupu prací s přístrojem a špatném vyhodnocení.

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(Česká revmatologie)

Supplementum je věnováno především nejvýznamnější současné celosvětové aktivitě, tj. Dekádě kostí a kloubů. Jsou zde v plném rozsahu publikovány přednášky, které zazněly na zahajovacím sympoziu Dekády konaném v kongresovém centru Nemocnice Na Homolce v roce 2000. Texty jsou věnovány různým aspektům medicínské a sociální závažnosti chorob pohybového ústrojí včetně revmatologické, ortopedické a rehabilitační problematiky. Jsou doplněny přehledem dvou nověji používaných protizánětlivých léků a také dvěma nově vypracovanými standardy léčebné péče pro polymyalgia rheumatica a syndrom bolestivého ramene.

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(Česko-slovenská pediatrie)

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(Vnitřní lékařství)

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