THE EUROPEAN SOCIETY OF MEDICINE
Medical Research Archives, Volume 13 Issue 7

REVIEW ARTICLE

Surgical Skin Incisions Result in Optimal Scars When Made Parallel to Main Folding Lines

Gottfried Lemperle, MD, PhD

Retired plastic surgeon, Division of Plastic Surgery, University of California, San Diego, CA. 200 West Arbor Drive, San Diego, CA 92103-8890
Present home: Wolfsgangstr. 64, D-60322 Frankfurt/Main, Germany
Tel. +49-69-1302-4217

*lemperle8@aol.com

OPEN ACCESS

PUBLISHED
31 July 2025

CITATION
Lemperle, G., et al., 2025. Surgical Skin Incisions Result in Optimal Scars When Made Parallel to Main Folding Lines. Medical Research Archives, [online] 13(7). https://doi.org/10.18103/mra.v13i7.6662

DOI
https://doi.org/10.18103/mra.v13i7.6662

ISSN
2375-1924

ABSTRACT

Women and young adults often judge the success of an operation based on the condition of the remaining scar. Optimal scars are the hallmark of plastic surgeons, while all other surgical specialties blame scar formation on the patient. If you look at the direction of the collagen fibers in histological images of the dermis, you will see that they adapt parallel to the later skin folds on head, torso and limbs and form wrinkles with age.

However, since it is not possible to examine the skin of all areas histologically, we have made use of a little-known fact: the striae distensae of all humans, both women and men, run in the same directions, perpendicular to the main folding lines or tension lines of the skin. On the basis of visible stretchmarks (striae distensae) in the skin, which always appear in the same direction in men and women against skin tension, we demonstrated these Main Folding Lines on other parts of the body of children and young adults which are well-established on face and abdomen.

In a former publication, the direction of striae distensae on photographs of 213 individuals were transferred to a human template. This striae-composite was compared with 276 images of incisions in our clinical data base of our scars, scar revisions, and scars from the Internet. They were put in opposition to well-known Langer´s lines along with descriptions of Pinkus' "main folding lines" and Kraissl's lines but were running perpendicularly to the direction of the underlying muscles. Langer´s lines are still the recommendation and matrix for surgical incisions in most surgical text books, even if they were never meant as those by their first describer, an anatomist in 1861.

In order to achieve minimal scarring, we should look at the direction of collagen fibers within the dermal matrix – and surgeons should attempt to place incisions parallel to skin tension lines, i.e. in in skin folds or skin creases. Main Folding Lines (MFL) should be used in elective incisions in children, adolescents, and young women as guide for the prevention of later visible hypertrophic or hypotrophic wide scars.

Keywords: Skin incisions, striae distensae, main folding lines, surgical incisions.

Introduction

Women and young adults often judge the success of an operation based on the condition of the remaining scar. Plastic surgeons are therefore frequently confronted with corrections of conspicuous scars. However, they know as little about the direction of the main folding lines as other surgical specialists do about the optimal direction for their incisions. This article therefore aims to show the direction in which the first skin incision can be made in order to leave scars that are as invisible as possible in young patients.

Minimal invasive and endoscopic surgeries have revolutionized thoracic, abdominal, and orthopedic surgery, and have become today´s gold standard, resulting in much smaller scars. However, children and adolescents are still prone to develop hypertrophic scars, which could be prevented by surgical incisions in the direction of the main folding lines of the skin. The list of ineffective treatments for scars is long, including heparin -, panthenol-, and silicone creams, needling rollers, and laser therapy. The only effective treatments are early pressure dressings and corticosteroid injections in hypertrophic scars, or surgical excisions of broad indented hypotrophic scars.

It often takes decades for better methods to find their way into standard textbooks. Surgical and orthopedic textbooks do not mention natural folding lines for optimal surgical incisions. The purpose of this publication is to facilitate the determination of optimal incision lines perpendicular to the direction of striae distensae. This correlation has been demonstrated in an earlier publication of 2014[1].

HISTORY OF SURGICAL INCISION LINES

During the past century, thirty-eight various guidelines have been developed regarding elective incisions[2,3]. Most surgical textbooks include Langer's "cleavage lines" of 1861[3], (Fig.1) or a slight modification, such as the incision proposed by Kocher in Ref. 3 (Fig.2).

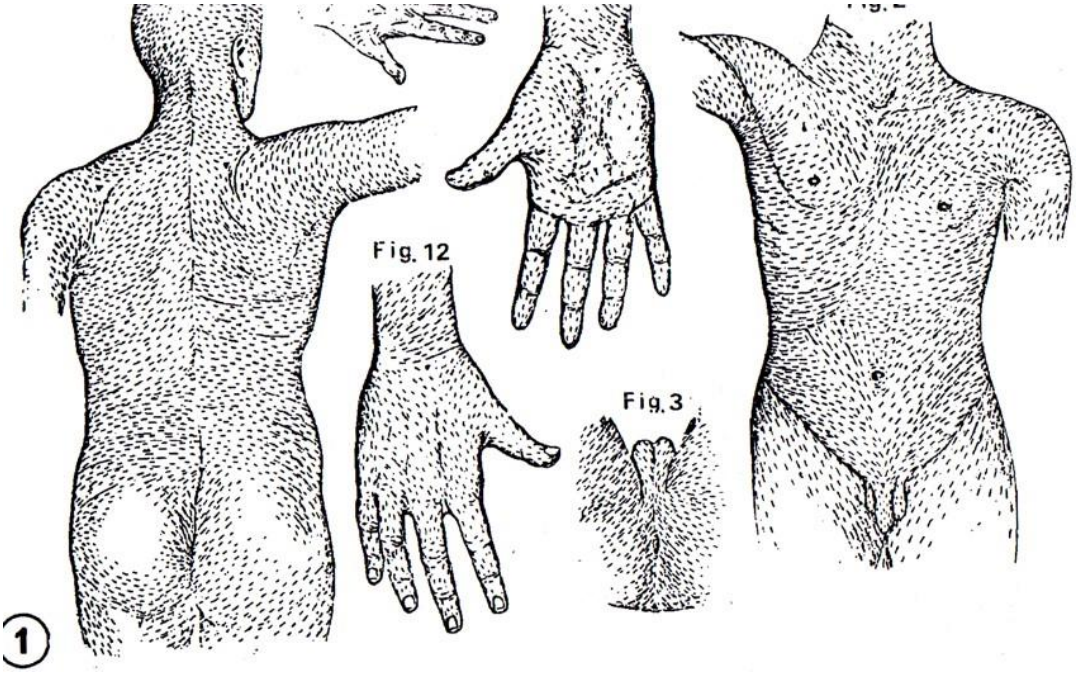


Fig. 1. Some Langer's "cleavage lines" run oblique or perpendicular to the recommended "Main Folding Lines" on forehead, lower abdomen, buttocks and extremities Langer´s cleavage lines run parallel to the "Main Folding Lines" over neck, shoulders, upper abdomen and back and therefore correctly in the direction of the proposed "tension lines"[2].

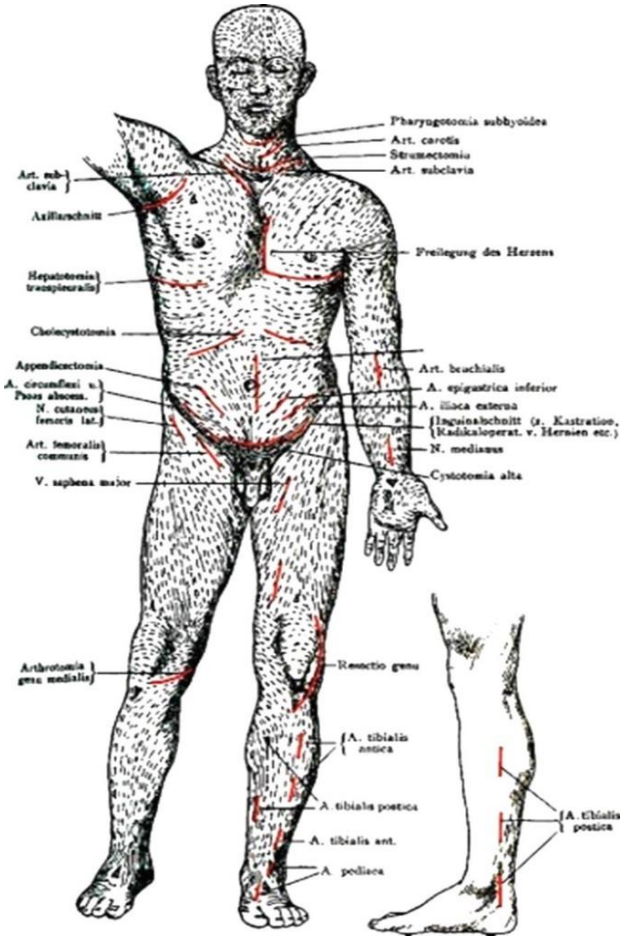
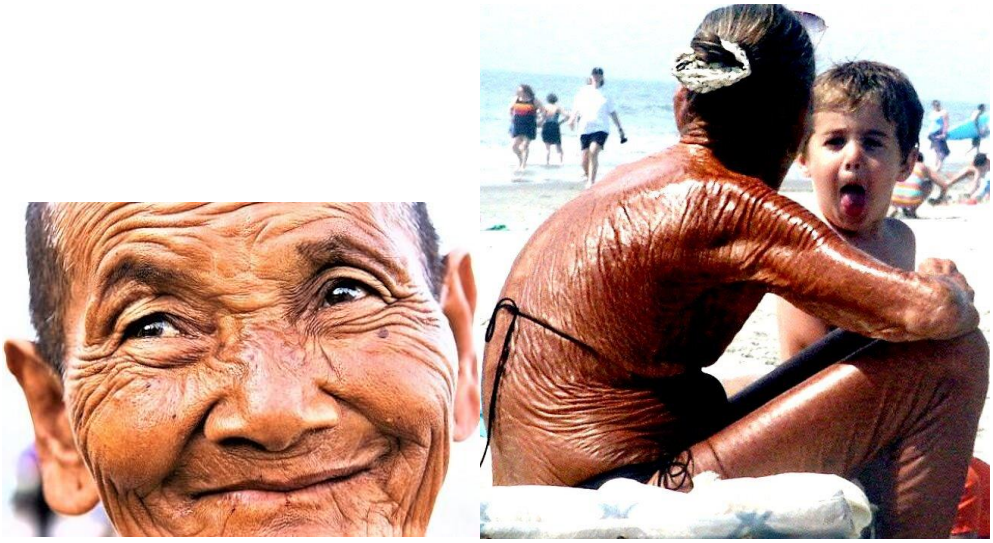


Fig. 2 Kocher recommended "Langer´s cleavage lines" for all surgical excisions and incisions. However, Especially on extremities of children and adolescents, lengthwise running scars often become hypertrophic[3].

Kraissl's "incisions run perpendicular to muscle action" of 1951[7,8] despite the fact that these incisions run oblique or even perpendicular to skin folds on forehead, cheeks, breasts, and abdomen. They run vertically across the ante-cubital region, the wrist, thigh, and distal regions of the extremities, although concordant on neck, shoulders, back and buttocks.

The concept of using natural striae distensae for optimal incision lines is new[1,9] and proves the natural folds which appear only later in age. (Figs 3 and 4). They are an extension to the earlier presentations of Kraissl[7,8] and to Borges´ "relaxed skin tension lines"[5,10,11] which cannot be seen on the skin of children and young adults. Therefore, new oblique, horizontal or partly circumferential directions for incisions on extremities have to be proposed.



Figs. 3 and 4 If all patients would present with those clear folding lines, the choice of skin incisions would be easy.

HISTOLOGY OF TENSION LINES

The presence of tension lines and normal wrinkle lines in the skin depends on the interrelation between elastic fibers and collagen fibers, as well as on the anchorage of collagen bundles one upon another (Fig. 5).[12] While the collagen fibers underlying Langer's cleavage lines are arranged irregularly and interweaving, they are direction.

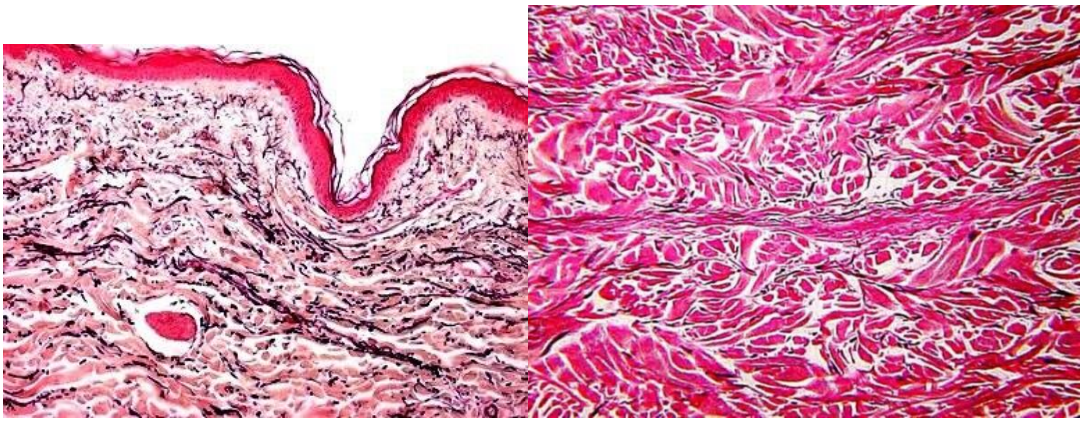


Fig. 5. A skin fold with reduced collagen fibers underneath, running parallel to the fold and cut perpendicularly to the fold. Elastic fibers (black) are running diagonally to the fold.

Fig. 6 Tight collagen fibers in the dermis, cut perpendicularly to the virtual "tension lines". The collagen bundles are held together by fine black elastic fibers, which run horizontally here.

The fibroblasts in striae possess a contractile phenotype more akin to myofibroblasts[13,14] and the elastic fiber network proximal to the epidermal-dermal junction appears to be more prone to destruction in active striae. The collagen lattice can be ruptured under the influence of steroids and especially estrogens. The newly synthesized collagen becomes reorganized by tension and is aligned in the direction of the presumed stress. The same happens in wound healing and therefore striae are considered dermal scars (Fig. 6).[15,16]

STRIAE DISTENSAE

In 1927, dermatologist Felix Pinkus was the first to question Langer's lines as a guide for skin incisions and he described the "main folding lines" (Fig. 7) as the ideal direction for elective incisions.[9] However, these drawings are too confusing to serve as instructions for the surgeon on where to make the incisions. He also described and illustrated the location of striae (Fig. 8), but did not relate them to skin incisions. Unfortunately, the publication in a German dermatological textbook[9] did not reach the surgical community.

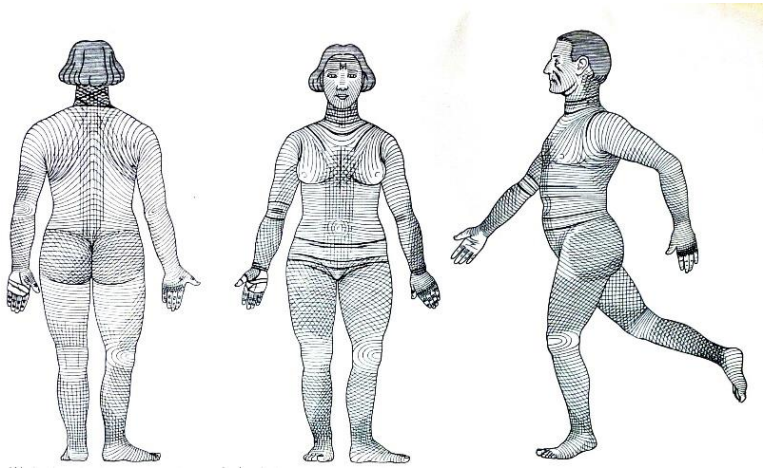


Fig.7 Pinkus' "main folding lines" (MFL) of the skin facilitate optimal incision lines. These drawings, however, are irritating to a surgeon because they are not clearly defined at the extremities[9].

Striae distensae or striae gravidarum are seen in many patients and can often act as a guide in planning elective incisions. Regardless of their etiology and slight variation, they have the same direction and clinical appearance (Figs. 8 and 9).

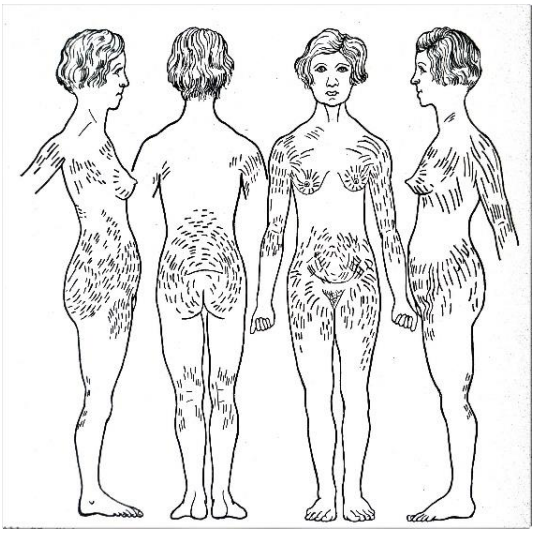


Fig. 8 drawing of collected striae gravidarum by Pinkus in 1927[9].

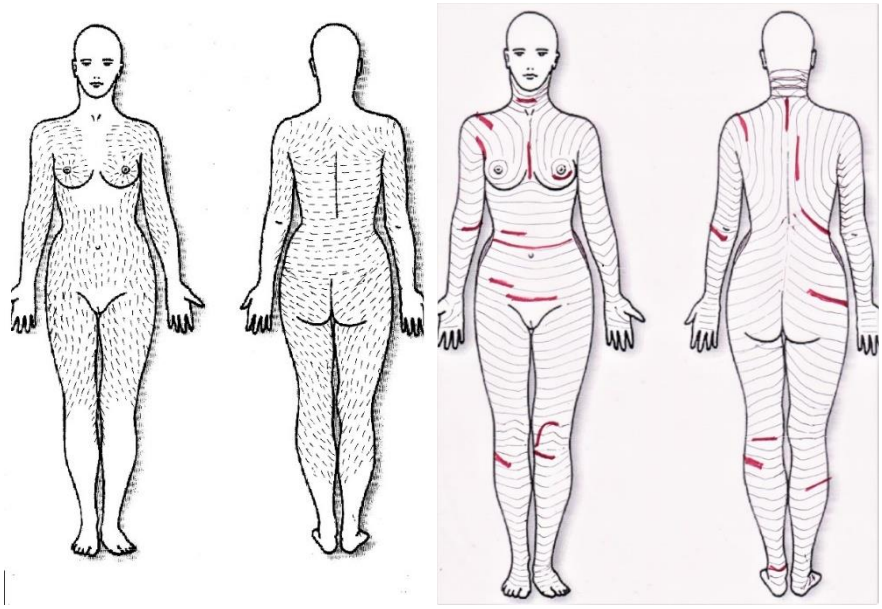
Striae distensae are characterized by linear, smooth bands of atrophic skin that are reddish at first and ultimately turn pale. In young adolescents, they can appear during growth spurts on hips, inner thighs, and female breasts, as well as on shoulders, lower back, and outer thighs of boys without measurable changes in their hormone levels[16] Eighty percent of adolescents in Korea show striae: in girls more pronounced on buttocks, thighs and calves, and in boys on buttocks, knees and lower back[17].

During pregnancy, striae distensae appear in the abdominal skin often during the first months of pregnancy and before tension is caused by the growing fetus and uterus. Obesity, oral contraceptives, and breast augmentation can also cause striae in a small percentage of women[18]. The widest and deep red striae are seen in Cushing patients and in those under chronic systemic or local cortisone therapy (Figs. 9a and b)[19].

Fig. 9 a and b Extreme striae distensae in a 14-year-old boy with encephalitis, treated with common doses of dexamethasone over 9 months[16].

Materials and Methods

In a former publication [1], a total of 213 photos were examined of patients with striae as adolescents, during and after pregnancy, diagnosed with "linear focal elastosis"[20] and after Cushing's disease or steroid use and abuse. Sources included our own image files (78 pictures) as well as an extensive Internet Google search on 'stretch marks' and 'striae' (135 pictures). All relevant striae were copied onto blank human templates and 3 overall direction charts were created (Figs.10a and b).



Figs 10a and b A compound of striae lines collected from 213 photos of patients with different underlying etiology. The resulting "Main Folding Lines" (MFL) run perpendicular to the striae lines.

Regardless of their etiology, all striae demonstrated a similar clinical appearance and same direction in both male and female skin. Furthermore, the direction of the lamellae in patients with linear elastosis was the same as the skin's main folding lines across the entire body.[20] In addition, 276 images of unknown surgical incisions and scars were retrieved from the Internet, their direction and width were compared to the main folding lines and the following compound was designed. Together with an orthopedic colleague, we see the resulting red incision lines as an opportunity to open the skin in patients who want the scar to be as invisible as possible (Fig. 11 a and b). This allows in every area of the body further preparation to be carried out in a backdrop-like fashion.

Fig. 11a and b Recommended surgical incisions along the main folding lines (MFL) with sparing major cutaneous nerves and vessels, of course. (Fig.11a is taken from "Ästhetische Chirurgie", ecomed-Verlag, Landsberg)

Results: The Optimal Direction of Surgical Incisions

FACE AND NECK

Disturbing scars from surgical mistakes must be kept at an absolute minimum in the face, where existing folds and wrinkles[4,21] determine the logical direction of an incision or a fusiform skin excision (Fig.12). For young patients, mimic movement of the face or a textbook on facial incisions[3,10] may serve as a guide for optimal directions.

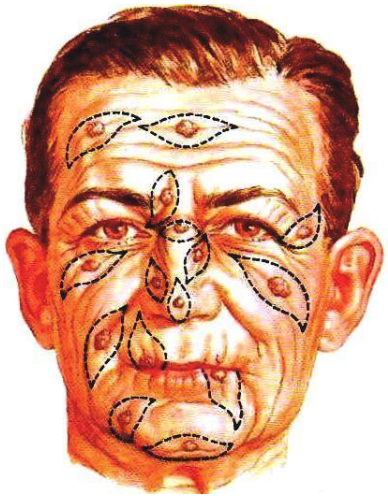


Fig. 12 "Main Folding Lines" in the face and the logical directions of excisions (drawings by Frank H. Netter 1994)

Incision lines on the neck should run horizontally and preferably inside existing horizontal neck folds as high as possible. The "Kocher collar incision" for goiter surgery[2] dates back to the late 19th century, when women were wearing high-necked dresses or heavy jewelry. (Fig. 13)

Figs. 13. Typical "Kocher´s collar incision" over the sternal notch may leave a hypertrophic scar. The thyroid is easier approached through an incision in the lower cervical fold.
Fig. 14 Very obvious vertical tracheotomy scar against "main folding lines" of actor Elizabeth Taylor (photo: Douglas Kirkland 1961)

Vertical tracheotomy incisions against the folding lines of the neck are often followed by ugly contracted scars (Fig. 14). Incisions for tracheotomies[22], thyroidectomies, or for access to cervical discs should always be done higher up in the lower horizontal neck fold and clear of the jugulum[9] in order to avoid hypertrophic scarring (Fig.14). The same problem of hypertrophic scarring can occur on the necks of young people, where incisions should always be made horizontally (Fig. 15)

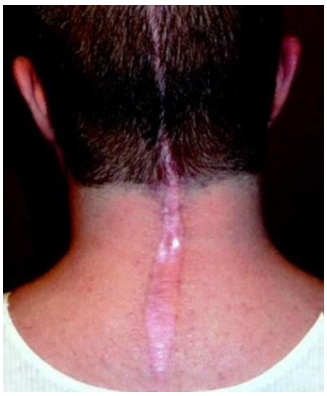


Fig. 15 In young patients, vertical incisions in the dorsal neck may develop hypertrophy since the folding lines run horizontally. Above the scapula, however, they run vertically.

SHOULDER AND ARM

Striae observed in body builders and in patients with linear focal elastosis or Cushing syndrome all point in one direction: horizontal over pectoral and deltoid muscles. Viewed from the front, the main folding lines therefore appear vertical between neck and shoulders, but in reality, if viewed from the side, they are virtually horizontal.

Wide and hypertrophic scars often develop over the shoulder, over the AC-joint and after open reposition of a clavicle fracture (Fig.16). Therefore, in young patients anterior incisions across the joint and deltoid muscle should be avoided in favor of posterior vertical incisions between axilla and upper arm head.

Fig. 16 This typical hypertrophic scar after fixation of a clavicle fracture could have been prevented with a shorter vertical incision in the main folding lines (look at the fine impressions !)

On the arms, striae don't develop straight vertically, but somewhat obliquely from the anterior axilla to the inner elbow (Fig.17). The tension lines on the upper arm and forearm are not perpendicular to the muscle pull[8] or circumferential, but somewhat oblique and proceed over the joints into the horizontal skin folds. Longitudinal and vertical incisions to expose a bone fracture on the upper arm must be avoided in favor of oblique and semi- circumferential incisions, which will heal inconspicuously.

Fig. 17 Striae in a body builder and a Cushing patient run parallel to the direction of the muscle bundles: therefore, all incisions on extremities should be made oblique but not interfere with major nerves and arteries.

In planning an incision, the direction of the underlying cutaneous nerves and larger blood vessels must be considered. Larger cutaneous nerves of the extremities may run perpendicular to a recommended incision and must be preserved.
The "Pinch-Test"[9] is an easy and practical tool to find "Main Folding Lines" in old and middle-aged people, but less valuable in children and adolescents. The skin has to be reasonably loose, movable, and must slide over the underlying muscle fascia to create folds in the concerned area (Fig. 18). In addition, one can measure the thickness of the subcutaneous fat layer.

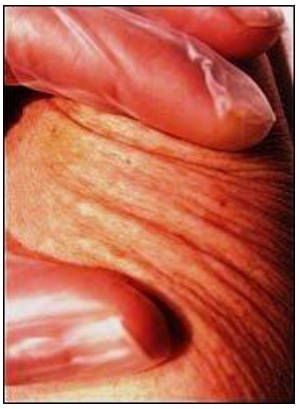


Fig. 18 The "pinch-test" is an easy way to find the best direction for a surgical incision or excision on the extremities of adults and older patients, but less valuable in children, younger women, and obese patients.

Longitudinal scars on the radial quadrant of the distal forearm skin envelope are typically observed to be wider than those on the ulnar quadrant and have an increased incidence of hypertrophy. The main folding lines on the forearm appear different in pronation and supination. Forearm rotation movements may produce differential skin tensions within the forearm skin envelope, and this may lead to differential scarring patterns.[23] Since the forearm is seen either from the inside or outside, incisions should be planned obliquely on the outer side in pronation and on the inner side in supination.

The tension lines of the skin run horizontally across the back of the hand, i.e. perpendicular to the extensor tendons! For this reason, horizontal incisions should be made in young women whenever possible (Fig. 19)

Fig. 19 On the dorsum of the hand, horizontal incisions will fall into the "main folding lines" where blunt spreading the tissue will preserve nerves and vessels.
Fig. 20 In the volar hand, visible folding lines are used to prevent hypertrophic scars.

Wound healing in the hand is good in general, especially in the palm. Attention must be paid to the vascularity of the raised flaps in order to prevent tip necrosis and palmar incisions should be done inside the natural creases. (Fig.20) Vertical incisions should be avoided or hidden in the ulnar thenar or on the sides of the fingers.

CHEST AND BREAST

Striae over the upper chest develop mainly laterally in a horizontal direction over the pectoral muscle and run further horizontally over the deltoid muscle to the front of the horizontally stretched arm (Fig.17). Therefore, the lines on the chest are oblique and become more circular towards the arm, while gravitational forces and movement of the mammary gland may alter this pattern. Women, who have been sleeping on the side for many years, develop "main folding lines" in their décolleté, which originate parallel to the clavicles and run in form of a 'V' towards mid sternum.

Therefore, incision lines should be chosen either parallel to the sternum or further caudally, and in the case of skin tumors in women, circumferential in a distance around the areola, i.e. obliquely towards the sternum. Spontaneous keloids, like the well-known "butterfly keloids", are believed to originate from simple skin pimples and spread horizontally over the sternum often in the direction of the striae.

Fig. 21 In children and adolescents open heart surgery may cause severe hypertrophic scarring,
Fig. 22 In children and adolescents, vertical sternal incisions in heart surgery could be avoided by a hidden horizontal "clam-shell-incision".

A lateral incision through the rib cage is always performed horizontally or slightly obliquely parallel to the ribs. In young female patients, the incision should be hidden anteriorly in the respective sub-mammary fold.

In the breast, striae radiate from the areola outwards (Fig.23), therefore optimal incisions run circumferentially. In augmentation mammoplasty, peri-areolar[25] horizontal axillary, or sub-mammary incisions are performed routinely. After reduction mammoplasty, the often inconspicuous vertical scar may be due to the right angle of the incision line on the Wise pattern (Fig. 24) relative to the real or virtual direction of the radial striae on the breast: The wound edges of the vertical scar run parallel to the tension lines, but the horizontal edges run perpendicular to the Main Folding Lines. Therefore, the horizontal scar sometimes becomes hypertrophic.

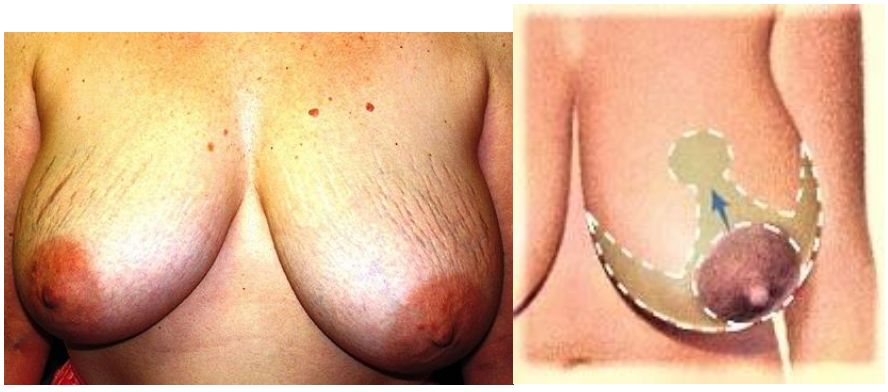


Fig. 23 Radial mature striae postpartum above and below the nipple.
Fig. 24 For reduction mammaplasty, commonly the "Wise Pattern" is us

ABDOMEN

There are two ways to open the abdominal cavity in elective general surgery: vertically or transversely. Striae distensae always develop perpendicular to the abdominal skin folding lines (Fig. 9), therefore, skin incisions should be made horizontally wherever possible (Fig.11a). It has long been shown[26] that wide transverse incisions along the natural folds of the upper abdomen not only yield optimal access to all organs, but also result in improved healing with significantly less complications than vertical incisions through the linea alba.

A meta-analysis of various clinical studies[27] has postulated that a transverse approach is superior in regard to postoperative complications. This discrepancy between existing recommendations from clinical trials and clinical practice may be explained by a general mistrust of clinical studies or an unwillingness to accept a change for familiar procedures (Figs 25a and b).

After healing, the mean width of scars was found to be 8.3 ± 1.4 mm for midline incisions, while the mean width of scars after transverse incision was 3.3 ± 1.2 mm.[27] However, general surgeons continue to use the traditional vertical midline incision in 90 % of patients (Figs. 26), despite the additional risk of midline hernias in up to 17% in elderly obese patients with multi-morbidities.[28] Rectus abdominis atrophy is a rare complication following transverse incisions.

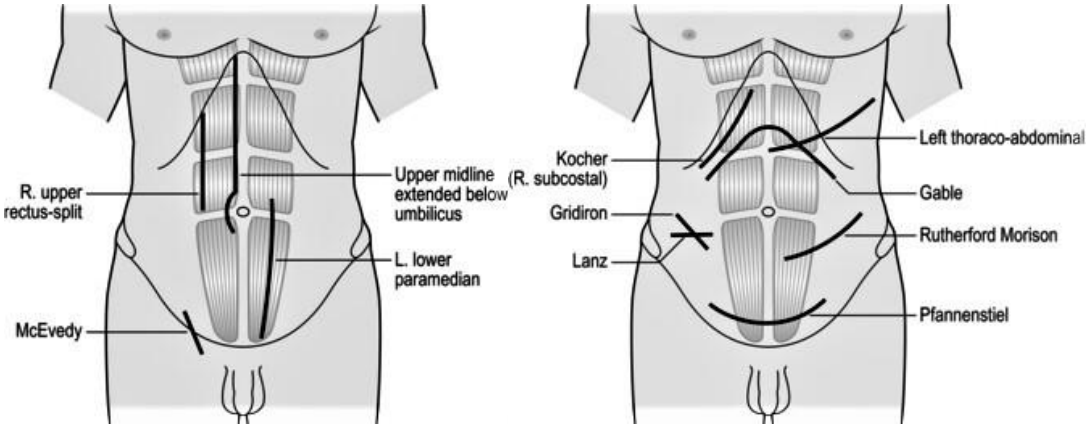


Fig.25a and b Most abdominal incisions are still perpendicular to the main folding lines, even if some surgeons are using wide horizontal incisions in patients with acute abdominal pain (from iknowledge: R.E. D'Souza and R. Novell: Pancreatectomy and Whipple 2015)

Fig. 26 Incisions in abdominal surgery are still performed vertically, i.e. perpendicularly to the main folding lines. In adolescents, vertical midline incisions often result in hypertrophic scars, which then widen under triamcinolone injections.

Unsightly vertical scars after open gallbladder- and appendix removal have become obsolete due to modern endoscopic surgery. Old scars are best revised by a longer, but ultimately less obvious, fusiform horizontal excision (Fig.27a and b).

Fig. 27a and b Vertical para-rectal hypertrophic scar after cholecystectomy, corrected by horizontal conversion in the main folding lines.

BACK AND BUTTOCK

The simple experiment of approximating the scapulae and extending the arms will reveal many folds in elderly people (Fig.4). This generally

vertical pattern in the upper back is altered by the flexion of the head into transverse lines in the neck. In contrary, incisions in the back should be performed vertically in the midline or para-medially (Fig.11), except in women, where they can be hidden beneath a horizontal bra or bikini strap. Elevating a myocutaneous latissimus dorsi flap must be performed according to the defect. The skin island can often be designed horizontally to hide the scar behind a bra. Towards the lateral rib cage, incisions are made obliquely, following the direction of the ribs.

On the back and over the buttocks, the anti-striae lines differ from the Langer and Kraissl lines in a right-angle fashion. Some adolescents develop inconspicuous striae in an oblique direction over hip and gluteus muscle (Fig.28), it is therefore recommended to consider skin incisions in hip joint surgery in children and adolescents in an oblique direction, as an exception parallel to the fibers of the gluteus maximus between posterior iliac crest and trochanter major (Fig.29).

Mini-invasive incisions in total hip arthroplasty are a marketing tool for patients refusing a large lateral or anterior incision as a hip prosthesis flag.[28] An incision in the direction along the folding lines would produce the best scars.

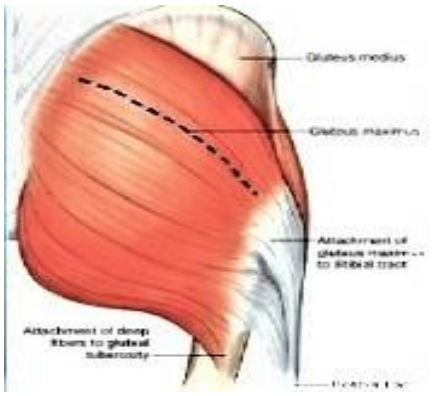


Fig. 28. As an exception, striae distensae over the buttocks run perpendicular to the muscle fibers of the underlying gluteus major muscle.
Fig. 29. Common incisions for hip surgery run vertically. A more oblique incision parallel to the fibers of the gluteus maximus muscle will result in less conspicuous scars.

LEG AND FOOT

Inconspicuous striae often develop at the inner thigh and posterior knee in a vertical direction (Fig. 30) and only rarely on the anterior surface of the thigh, where they develop vertically. Above the knee, horizontal folding lines surround the patella and should be used for the excision of suprapatellar fat pads and half-circular incisions either medially or laterally to the patella (Fig. 13b), rather than the commonly used vertical incision straight across the knee (Fig.30).

Fig. 30 Common vertical scar after knee replacement surgery.
Fig. 31 The wide opening to the joint after a horizontal incision would have prevented this conspicuous vertical scar.

On the lower leg across the calf, striae generally run vertically and in an oblique direction from lateral proximal to medial distal. The skin folds on the lower extremities are analogous to those of the upper limbs. Therefore, oblique incisions from medial proximal to lateral distal over the calf and oblique incisions from proximal posterior to distal anterior over the fibula, are recommended in young patients with selected indications or oblique direction. Both wound edges can then be undermined bluntly preserving larger nerves and vessels.[30] To access joints, tendons, or fractures through oblique incisions, no fear for the blood supply is indicated since the arteries are running in random pattern within the skin. Over the dorsum of the foot, shaped incisions will result in improved healing over straight vertical ones.

Since striae do not develop on feet, "Main Folding Lines" become easily visible during movement of the foot. After bending the foot, the skin can be incised in a horizontal (Fig. 32)

Fig. 32a and b A horizontal approach to a ruptured Achilles tendon as in club foot surgery (Cincinnati approach) will prevent frequently seen hypertrophic scars.

Discussion

In many areas of the body surface, the described "main folding lines" run closely to the Langer lines, with which they are often confused. Langer lines were created by static forces in the skin of cadavers. The normal wrinkle lines are produced by dynamic forces acting on the skin of a living person.

If we exclude Langer lines as historic and not primarily intended as recommendation for the direction of skin incisions, we are left with three well known publications on skin incisions and optimal scarring: Pinkus described main folding lines produced by 'pinching' skin in 1927.[9] Kraissl recommended incisions perpendicular to the lines running perpendicular to Langer's lines, especially as they cross joints and facial folds.[8]

In normal folding lines, the predominant orientation of collagen fibers is parallel to the folds and wrinkles. Collagen bands in scars also form parallel to the wound edges, regardless of scar location. Striae distensae develop perpendicular to the direction of the strongest tension on the skin, and nature reveals that the tension lines or main folding lines are perpendicular to the striae. "Relaxed tension lines" cannot be seen through the skin and folds appear only later in age.

Surgeons, who have difficulty to identify striae or later skin folds in young patients, may use the graphics in this publication as guidance.

Here is an example on the neck of a young female patient with pterygium colli of two z-plasties, where incisions along the hypothetical tension lines healed normally, but those contrary to the tension lines (or better: main folding lines) healed differently with hypertrophy.

Figs. 33a and b. Proof of our recommendation in a "pterygium colli" corrected with two Z-plasties on each side. The scars within the neck´s horizontal folding lines are almost invisible; those perpendicular (vertical) to them became hypertrophic.

Conclusion

Non-observance of skin tension lines can cause widening or hypertrophy of scars. A linear incision develops a wider gape if it occurs parallel to striae rather than transversely to them. "Relaxed skin tension lines"[10,11] seems a hard to imagine and therefore confusing expression, while "Main Folding Lines"[9] are easier to see, imagine and understand. The simplest rule for making optimal incisions in the most favorable direction is to follow natural wrinkle lines. If these cannot be seen, "pinching" the skin or moving the joints on the extremities will show them. "Proper incisions come together naturally and improper ones tend to gape" (Th. Kocher 1892).[2]

Conflict of Interest Statement:

The author has no conflicts of interest to declare.

Funding Statement:

None.

Acknowledgements:

None.

Disclosure:

The corresponding author has nothing to declare.

Authors contribution:

This manuscript was a clinical extension of a prior article of 2014 relating the direction of surgical incisions to the direction of striae distensae.

References:

1. Lemperle G, Tenenhaus M, Dieter Knapp D, Lemperle SM. The direction of optimal skin incisions derived from striae distensae. Plast Reconstr Surg. 2014;134:1424-1434.

2. Kocher T. Textbook of Operative Surgery (3rd English ed.). London: Adam and Charles Black 1911:p.30.

3. Borges AF, Alexander JE. Relaxed skin tension lines, z-plasties on scars, and fusiform excision of lesions. Brit J Plast Surg. 1962;15:242-253.

4. Langer K. On the anatomy and physiology of the skin, I. The cleavability of the cutis [Translation from German in 1861]. Br J Plast Surg. 1978;31:3–8.

5. Carmichael SW. The tangled web of Langer's lines. Clin Anat. 2014;27:162-168.

6. Wilhelmi BJ, Blackwell SJ, Phillips LG. Langer's lines: to use or not to use. Plast Reconstr Surg.1999;104:208-214.

7. Kraissl CJ, Conway H. Excision of small tumours of the skin of the face with special reference to the wrinkle lines. Surgery. 1949;4:592-600.

8. Kraissl CJ. The selection of appropriate lines for elective surgical incisions. Plast Reconstr Surg. 1951;8:1-28.

9. Pinkus F. Die Faltung der Haut, in Pinkus F: Die normale Anatomie der Haut. Jadassohn's Handbuch der Haut und Geschlechtskrankheiten Vol 1, Berlin: Springer 1927:4-76.

10. Borges AF. Elective Incisions and Scar Revision. Boston: Little, Brown 1973:5-10.

11. Borges AF. Relaxed skin tension lines (RSTL) versus other skin lines. Plast Reconstr Surg. 1984; 73:144-150.

12. Piérard GE, Lapière CM. Microanatomy of the dermis in relation to relaxed skin tension lines and Langer's lines. Am J Dermatopathol. 1987;9:219-224.

13. Viennet C, Bride J, Armbruster V, Aubin F, Gabiot AC, Gharbi T, Humbert P. Contractile forces generated by striae distensae fibroblasts embedded in collagen lattices. Arch Dermatol Res. 2005;297:10-17.

14. Arem AJ, Kischer CW. Analysis of striae. Plast Reconstr Surg. 1980;65:22–29

15. Courtiss EH, Longacre JJ, deStefano GA, Brizio L, Holmstrand K. The Placement of elective skin incisions. Plast Reconstr Surg. 1963;31:31-44.

16. Alshaiji JM, Handler MZ, Schwartzfarb E, Izakovic J, Schachner LA. Unilateral striae distensae affecting the right axilla in a 16-year-old boy: brief report. Pediatr Dermatol. 2014;31:617-618.

17. Cho S, Park ES, Lee DH, Li K, Chung JH. Clinical features and risk factors for striae distensae in Korean adolescents. J Eur Acad Dermatol Venereol. 2006;20:1108-1113.

18. Basile FP, Volpe A, Basile AR. Striae distensae after breast augmentation. Aesth Plast Surg. 2012;36:894–900.

19. Rotsztejn H, Juchniewicz B, Nadolski M, Wendorff J, Kamer B. The unusually large striae distensae all over the body. Adv Med Sci. 2010;55:343-345.

20. Jeong JS, Lee JY, Kim MK, and Yoon TY Linear focal elastosis following striae distensae: Further evidence of keloidal repair process in the pathogenesis of linear focal elastosis. Ann Dermatol. 2011;23(Suppl 2):S141–S143.

21. Lemperle G, Holmes RH, Cohen SR, Lemperle SM: A classification of facial wrinkles. Plast Reconstr Surg. 2001;108:1735-1750.

22. Lim SY, Kwack WG, Kim Y. Comparison of outcomes between vertical and transverse skin incisions in percutaneous tracheostomy for critically ill patients: a retrospective cohort study. Crit Care. 2018;22:Article # 246.

23. Russell CJ, Bush JA, Russell GW, Thorlby A, McGrouther DA, Lees VC. Dynamic skin tension in the forearm: effects of pronation and supination. J Hand Surg Am. 2009; 34:423-431.

24. Bedard P, Keon WJ, Brais MP, Goldstein W. Submammary skin incision as a cosmetic approach to median sternotomy. Ann Thoracic Surg.1986; 41:339-341.

25. Shrotria S. The peri-areolar incision - gateway to the breast! Eur J Surg Oncol. 2001;27:601-603.

26. Halm JA, Lip H, Schmitz PI, Jekeel J. Incisional hernia after upper abdominal surgery: a randomised controlled trial of midline versus transverse incision. Hernia 2009;13:275–280.

27. Bickenbach KA, Karanicolas PJ, Ammori JB, et al. Up and down or side to side? A systematic review and meta-analysis examining the impact of incision on outcomes after abdominal surgery. Am J Surg. 2013;206:400- 409.

28. Heller L, Chike-Obi C, Xue AS. Abdominal wall reconstruction with mesh and components separation. Semin Plast Surg. 2012;26:29-35.

29. Leunig M, Hutmacher JE, Ricciardi BF, Impellizzeri FM, Rüdiger HA, Naal FD. Skin crease 'bikini' incision for the direct anterior approach in total hip arthroplasty: a two- to four-year comparative study in 964 patients. Bone Joint J. 2018;100-B(7):853-861.

30. Andermahr J, Jubel A, Elsner A, Schulz-Algie PR, Schiffer G, Koebke J. Die Hautspaltlinien und die Schnittführung bei Fußoperationen. Orthopäde 2007; 36:265–272.