British Journal of Plastic Surgery (1978), **31**, 3-8

ON THE ANATOMY AND PHYSIOLOGY OF THE SKIN
I. The cleavability of the cutis

By Professor K. LANGER
Corresponding member of the Royal Academy of Science
(with 3 illustrations)

Presented at the meeting of 26th April 1861

(Translated from Langer, K. (1861). Zur Anatomie und Physiologie der Haut. I. Uber die Spaltbarkeit der Cutis. Sitzungsbericht der Mathematisch-naturwissenschaftlichen Classe der Kaiserlichen Academie der Wissenschaften, **44**, 19.)

DUPUYTREN[1] observed that a round bodied awl when thrust through the skin produced not a round stab wound but a linear cleft. He made this observation in a young man who, intent on suicide, had stabbed himself 3 times over the heart. His doubt whether the wounds had been made with the awl, as the patient maintained, or by a penknife blade, led Dupuytren to test and verify the matter in cadavers. He found that the clefts resulting from stabbing (with the awl) have different orientation in different parts of the body and because of the tension in the skin, may be narrowed or broadened depending on whether the pull is in the direction of the cleft or across it. The stab of a round bodied awl causes merely a separation of the fibres in the skin.

Malgaigne,[2] recognising the value of this observation, also investigated the matter and confirmed the assertions about the direction of the clefts in different parts of the body without, however, as he himself said, finding any general rule about the direction of fibres in the skin. He encouraged further studies and recommended the technique as a suitable method of studying the textural relationships of organs. Finally he indicated the importance which a knowledge of the texture of the skin has in the practice of surgery, drew attention to the distortion of skin wounds and had seen for himself as an operating surgeon how the degree of wound retraction varied with the direction of the incision.

The matter appeared to me so important that I resolved to undertake more extensive investigations. I began on the assumption that, if the clefts were placed as closely as possible, they would show a definite relationship to each other in the various parts of the body and it would be possible to group the clefts into lines and areas arranged topographically in a similar way to the already known pattern of the hairs. These lines which, as was realised from the outset, were an expression of the fibre pattern of the skin, would furnish much, until now unknown, information not only about the texture of the skin but about its elasticity and capacity for swelling[3] because they provide a technique of orientating the dermal tissue and differentiating the lengthwise incision from the transverse.

Indeed the first studies undertaken towards this end confirmed my assumptions and afterwards I proved the facts on quite a large series of cadavers of different ages and different constitutions; I am publishing here for the time being only those results which refer to the cleavability of the dermal tissues.

The instrument which I used in most of my studies was a 2-2½ cm long sharp spike

[1] Uber die Verletzungen durch Kriegswaffen. Aus d. Franz, 1836, p. 27.
[2] Traité d'anatomie chirurgicale, 1859, 1, p. 76.
[3] Editorial note: The "capacity for swelling" (Quellungsvermögen) is the subject of Langer's 4th article and refers to the behaviour of skin when treated with acetic acid.

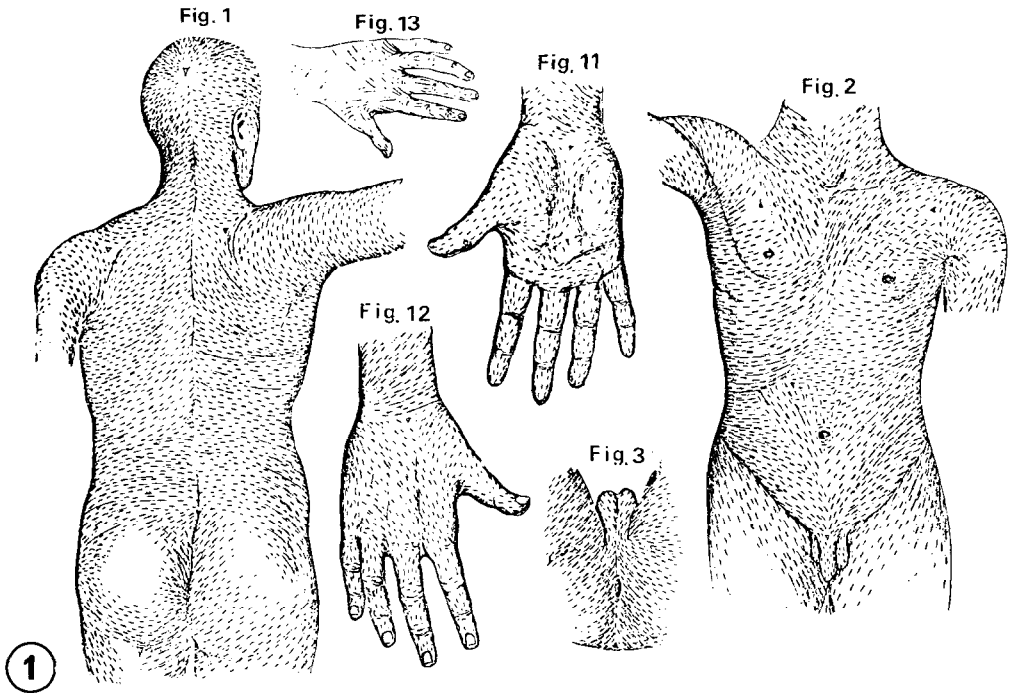
Fig. 1
Fig. 13
Fig. 11
Fig. 2
Fig. 12
Fig. 3
1

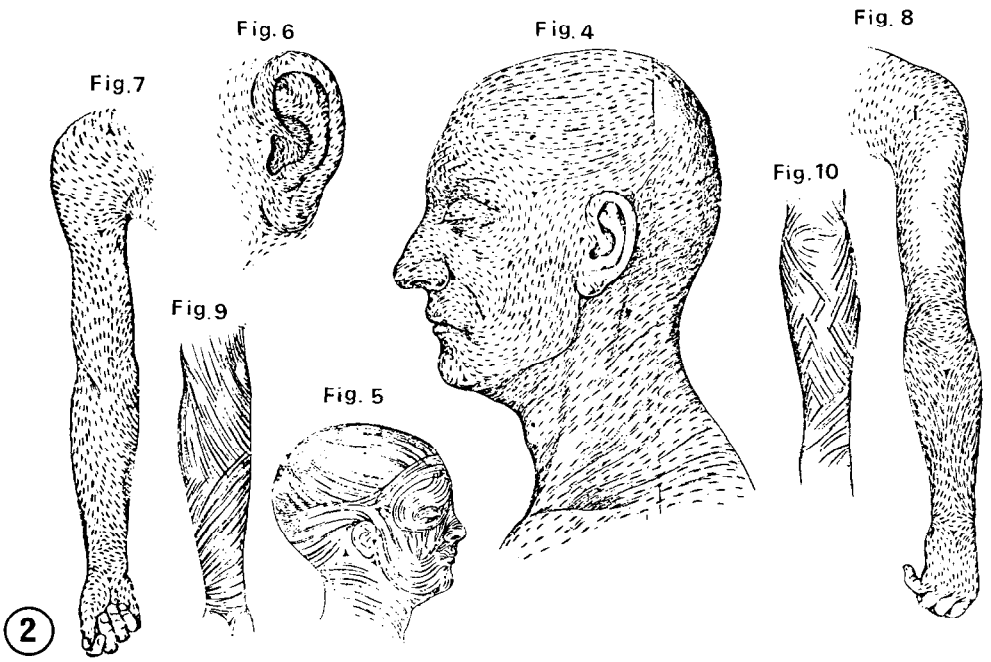
Fig. 6
Fig. 4
Fig. 8
Fig. 7
Fig. 10
Fig. 9
Fig. 5
2

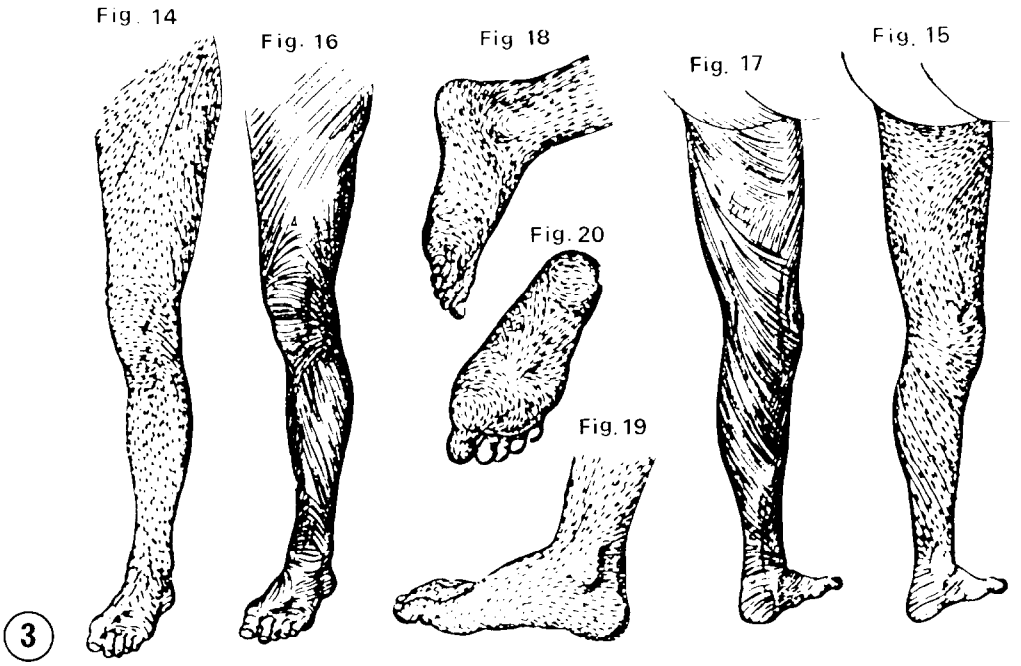

Diagram 1

FIGS. 1 and 2. On the left side of each figure the lines shown are from an adult cadaver; those on the right side are from the cadaver of a 2½-year-old boy.

FIGS. 11 and 12. The lines on the hand of an adult.

FIG. 13. A variant pattern from another adult hand drawn more diagrammatically;

Diagram 2

FIG. 4. The pattern of lines on an adult head and neck.

FIG. 5. The lines on the head of a neonate drawn diagrammatically. (Cadavers of the newborn make good controls because they provide more regular clefts and the soft underlaying bones give little hindrance to the penetration of the awl.)

FIGS. 7 and 8. Taken from a thin adult cadaver.

FIGS. 9 and 10. From another adult showing variations in the pattern of the lines and drawn more diagrammatically.

Diagram 3

FIGS. 14, 15, 18, 19, and 20. The patterns of lines on the leg and foot taken from adult cadavers.

FIGS. 16 and 17. Variations in the pattern drawn diagrammatically from the cadaver of a 3-year-old child.

symmetrically ground to a conical point and some 2 mm in diameter at the base. In order to see whether the same results would also be achieved with a spike of larger dimensions, I used one which was 13·2 cm long and 1·2 cm in diameter at the base; when the latter was driven in to the hilt it also gave a linear wound cleft. The spikes were always kept sharp and well greased and invariably stabbed into the skin at right angles; at any part of the body where bone lay under the skin, after the tissues had been pierced to the bone the spike was further advanced obliquely. Any tension on the part of the skin under study was avoided if at all possible although as a rule it had no influence on the result; only on areas of very thin skin which were strongly stretched in a crosswise direction, did the stab produce a ragged edge to the wound; otherwise I have not observed any modification in the direction of the stab clefts in cadavers. On the upper part of the anterior surface of the thigh, I constantly observed an oblique direction in the clefts running downwards from lateral to medial and these always remained the same in different positions of the hip joint and thus with different tensions on the skin. If the thigh was adducted, I produced with the spike well defined narrow clefts; when the thigh was abducted I obtained more gaping wounds, occasionally even round holes, but when the leg was again adducted, the stab wounds re-assumed the form of a cleft. If however a strip of skin was excised parallel to the direction of its clefts and strongly stretched transversely with forceps it was possible to produce clefts in the direction of the stretching force, and so at right angles to the original clefts; otherwise excised skin always gave the same cleft orientation. With delicate skin and a blunt point on the spike, ragged wound edges occurred in places while a sharp instrument produced a clean cut cleft immediately beside them. As a rule the orientation of the cleft is the same on the inner aspect of the skin as on the outer; on very thick skin particularly on the back, I sometimes observed a different orientation of the clefts inside and out and even one at right angles to the other but the inner was always only in a thin layer. I shall leave this circumstance meanwhile.

For the first experiments, I recommended the use of thin-skinned bodies; cadavers of fat children produced the nicest and simplest results although, so far as the orientation of their clefts is concerned, they constantly differ on many parts of the body from those of adults. The skin of the elderly, skin stored in alcohol, and even properly tanned leather also show the original cleaving properties. In pieces of skin swollen in acetic acid, if they were not macerated, stab clefts could still be produced which were, to begin with, more gaping and round until tension was applied.

In order to learn the relationship between the clefts and the arrangement of the tissues, I took some pieces of skin which had been punctured many times on the cadaver, fixed them in tanning solution and studied parts of them under the microscope. One little piece from the upper region of the anterior thigh, which after fixation had been stretched in the direction of the clefts and dried, showed in thin flat sections the fibres under the papillae in the form of a lattice work with very extended rhomboidal meshes. The fibres were also grouped very tightly and interwoven in bundles. The long axes of the lattices all had the same orientation as those of the stab clefts. Similar sections from the anterior part of the hairy scalp where the stab clefts are also sharply defined and directed towards the crown of the head, showed the same arrangement of the dermal fibres; the skin had not been stretched and the spaces were therefore broader and in each space was the cross section of a hair follicle.

A longitudinal incision in the direction of the stab clefts through the thickness of the thigh skin showed along its length bundles of fibres running somewhat obliquely upwards and arranged in layers; between neighbouring layers of the longitudinal fibre bundles I found cross cut fibre bundles. These transversely sectioned pieces of fibres were sometimes shorter, sometimes longer, depending on the direction and the tension applied when the skin was stretched.

An incision at right angles to the direction of the stab clefts shows virtually all the bundles obliquely cut.

Pieces of leather which have not been stretched when drying, show in sections parallel to the surface the same lattice-work arrangement of the fibres. The fibres themselves however are partly wavy and partly curly. Longitudinal and transverse incisions are not so markedly different in so far as more cross cut bundles occur in the longitudinal incision and more numerous lengthwise bundles are met with in the transverse incision.

In similar sections of a transversely stretched piece of leather, the structure is looser and the meshes shorter and more rectangular; under strong tension the appearance of the longitudinal incision may be transformed into that of the transverse incision.

The microscope studies leave no doubt that the cleft orientation of the corium is dependent on the fibre arrangement; the stab clefts are manifestly nothing more than a widening of the meshes of the corium fibres which, later, when the broader part of the spike is thrust in, are still more enlarged by tearing. The rhomboidal form of the meshes makes it also obvious why, when for example the leg is adducted or abducted, the meshes of the criss-crossing bundles are sometimes broadened and sometimes narrowed. In the abducted position the meshes are more square; in the adducted position they are long, stretched, rhomboidal.

It appears that the fibres of the dermis are not arranged in this kind of parallel fashion on all parts of the body since one encounters places where the cleavage lines are crossed by others more or less at right angles so that the regular uniform cleavability of the tissues is lost and torn wounds occur. These have rarely a four-sided and usually a three-sided shape to their margin. The three-cornered stab wound is mostly regular, rarely irregular, frequently like an equilateral triangle and sometimes shaped like the point of an arrow. These angular wounds demarcate with surprising accuracy the boundaries of areas containing longitudinal clefts: for example (Figure 1 : Diagram 1) at the upper spinal angle of the scapula and (Figure 2: Diagram 1) in the upper part of the lateral chest wall.

According to the way in which the fibre bundles meet each other, the area of decussation is sometimes bigger, sometimes smaller and therefore the area which shows triangular wounds greater or less. In such areas stab clefts with different orientation also occur as if the continuations of the criss-crossing bundles became aligned.

In the same way as the clefts and their orientations are limited to certain localities, so too is the occurrence of ragged triangular stab wounds, and thus if the stabs are sufficiently close to each other on larger selections of the body, patterns like a kind of tattoo appear whose shape shows great regularity and within certain limits is reproducible in all individuals. The patterns become more clear cut when the clefts running in the same direction are arranged in lines with each other.

While in certain parts of the body, I observed constantly the same orientation of the clefts, for example at the joints, and apart from minor variations also in the face, on the back and chest, other areas of the body showed several variations, for example the central area of the forearm and lower leg and the anterior abdominal wall. In this connection it was of interest to me to find that these variations appeared to depend on the constitution of the cadaver. On very thin individuals, I found as a rule simpler relationships on the extremities than in robust suicides or those dead of a rapidly fatal disease. Perhaps this was due to the constitutional changes as the limbs increased and decreased in volume but I was not able to confirm this.

Greater importance in any case attaches to those variations which I have observed in embryos and the newborn. Fine sharply ground spikes cleave the skin of embryos even when these have been stored for some time in spirits of wine. The direction of the clefts

however in many places deviates so remarkably and constantly from those observed in grown-ups that in figures none other than growing children and adults will be illustrated.

Editorial note. Here follows a detailed description of the direction, course and relationship of almost every line. For the plastic surgeon there is little to be learned that cannot be observed in the illustrations. I have, however, extracted some references to the illustrations and added captions; there were none in the original.