MEDICAL PRACTICE

Aspects of Plastic Surgery

Scars

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British Medical Journal, 1974, 2, 648-651

A scar is the result of wound healing, modified by the nature, site, and orientation of the wound, and the method and skill of its repair. In the healing of an unrepaired wound three processes influence the final scar: wound contraction; epithelial migration; and scar maturation (and its anomalies, hypertrophy and keloid, contracture, and stretching). Surgical repair of the wound bypasses the first and second of these.

Wound Contraction

Wound contraction is distinct from scar contracture. It starts within days of injury, before much collagen has been laid down. The wound edges are drawn inwards as far as the laxity of adjacent skin permits, without appreciable shortening of their perimeter. So the wound tends to assume a stellate or elongated linear form.

This property of wounds is widely neglected, not least by plastic surgeons to whom primary skin closure is an honoured principle (contraction ceases if the wound is repaired with a thick skin graft). Nevertheless, it does form the basis of Hamilton Bailey's recommended treatment of the fistulous skin over tuberculous cervical glands by wide excision without repair, and of the standard procedure of wide skin excision for fistula-in-ano, and of McCash's "open palm" principle after fasciectomy for Dupuytren's contracture. In each case an unrepaired wound heals to form a linear scar.

Epithelial Migration

Where wound contraction is limited by lack of available loose

surrounding skin, for example, on the leg or the scalp—healing takes place by inward migration of epithelium from the margins. But after advancing two or three centimetres from the original wound edge, cell proliferation tends to become disorderly. Healing is incomplete or unstable. Over a period of years this disorder can progress to malignant change, forming a squamous cell carcinoma (Marjolin's ulcer).

Scar Maturation

Collagen is the basis of scar tissue. Initially it is laid down in a rather haphazard way in a highly vascular environment. Over some months much of the collagen is reabsorbed and the remainder is remodelled with diminishing vascularity the scar assumes its mature form. Thus all scars pass through a phase before settling down, when to a varying degree they are red and lumpy. They do not react well to surgery during this phase, and any tidying up is best left until maturation is complete. Facial scars often improve so much spontaneously during six to 12 months after an accident that the apparent need for surgical revision vanishes.

Scar Hypertrophy

Scar hypertrophy is the name given to the inappropriate production of an excess of collagenous tissue during the immature phase, associated with excessive vascularity. The scar becomes raised, red, broad, and lumpy, and it itches—especially in the warm. As the scar matures the excess of collagen is reabsorbed, vascularity diminishes, and it becomes pale, flat, and supple. But the hypertrophic scar takes abnormally long to mature (often two years or more), and its earlier bulk leaves it permanently broad.

While hypertrophy may affect any sort of scar, particularly if it has an unfavourable site or orientation, it is an almost invariable and distressing sequel of burns and scalds of dermal depth—especially in children. Janzcekovic has shown that it can be prevented in such burns by tangential excision of the de-

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vitalized surface layers of the skin within a few days of injury, and immediate skin grafting. Despite its proved value, this method is not widely practised: firstly, it means subjecting the patient—often a child, whose burn may heal without any surgery—to a big operation involving substantial blood loss; and secondly a long operation which is not quite an emergency is difficult to fit into a scheme of planned theatre lists at short notice.

Keloid

A keloid resembles a hypertrophic scar, and cannot always be distinguished by clinical examination or by histology. It differs from it in that the abnormal deposition of collagen often extends beyond the limits of the original wound, sometimes as claw-like processes (the cheloides of Alibert, who gave it its name); and the scar never matures, the excess bulk persisting, and sometimes increasing, throughout life. The incidence and severity of keloid are much greater in coloured than in white races, though affecting only a minority of individuals even in groups with a high general liability. In a susceptible individual a scar is likely to become keloid if it is in one of the areas of high susceptibility (see table), and especially if it has an unfavourable orientation. The same local factors often govern the incidence of scar hypertrophy in patients not liable to keloid.

Though superficially resembling a neoplasm, the keloid shows a pattern of recurrence after surgery quite contrary to that expected of a new growth. Complete removal is followed very commonly by recurrence in even more florid form; but partial excision kept within the limits of the scar epithelium covering the keloid does not lead to renewed activity. The neces-

Relative Susceptibilities of Different Regions of the Body to Keloid

Susceptibility	Body region
High	Pre-sternal area Upper back
High to moderate	Deltoid area Beard area (both sexes) Ear Pubis
Moderate	Front and sides of chest Upper limb, pre-axial border
Moderate to low	Abdomen Lower back Scalp and forehead
Low	Central face Lower limb Upper limb, post-axial Palms and soles Genitalia

sary provoking stimulus seems to be injury to the skin's epithelial adnexae, which are not present in the scar.

The most effective treatment is a course of intralesional injections with the fibrolytic corticosteroid triamcinalone acetate (Adcortyl), either alone or combined with surgery. This has replaced the potentially more hazardous and less effective use of x-ray treatment. Injections are given at monthly intervals and must be strictly limited to the keloid. Infiltration of the subcutaneous tissues may lead to disfiguring local fat atrophy. At first the keloid is tense and resists injection. This difficulty can be overcome by pushing the needle through the hard mass and withdrawing almost to the skin before injection. The fluid spreads readily into the keloid from the needle track. The outcome of successful treatment is always a conspicuously

Fig 1 (a)

Fig 1 (b)

FIG. 1A—Simple Z-plasty. The distance between the two points X and Y on the scar is increased from 4 cm to 7.5 cm. FIG. 1B—Four-flap double Z-plasty. The distance separating X and Y is increased from 4 to 11 cm.

broad though flat scar, unless injection is combined with surgical excision.

Contracture

An immature scar has three special properties: if allowed to relax, even for part of the time, it contracts rapidly; if subjected to continuous even tension, it stretches slowly; and if stretched intermittently, it becomes hypertrophic, and remains immature. All these properties disappear when the scar matures. If a scar can be prevented from contracting while it is immature, it will not do so subsequently, even though it is relaxed. In this respect split skin grafts behave like scars. If they are splinted on the stretch until they are mature (generally three months), they show no tendency to contract subsequently.

Contracture in a scar crossing a joint restricts the range of normal movement. The deforming power is more or less proportional to the extent of the scar; if it is broad as well as long—for example, after a burn—it can draw the parts into postures beyond their normal range, even causing dislocation or restriction of growth. Limb scars provide the most favourable conditions for splintage, and this is a common precaution after skin grafting burns of the extremities. Thereby contracture can be prevented altogether. Moreover, if contracture has started it can be reversed by traction or serial plasters, splintage being continued until the scar is mature.

An established contracture needs surgical release. If it is broad this means either cross cut, or sometimes excision of the whole area of scar, to restore full mobility, and grafting of additional skin. These grafts must be splinted to avoid recurrence of the deformity. Grafts cannot be splinted effectively on the face, so very thick skin grafts may be used here, being less liable to contract. A contracted linear scar can be lengthened by local rearrangement without introducing any additional skin. The method most commonly used is the Z-plasty or one of its modifications. Splintage is not necessary after correction by rearrangement.

Stretched Scars

Skin tension exerting continuous traction across the breadth of a scar can cause it to widen. Tight elastic skin is a feature of youth and lax skin of old age. Consequently, to the chagrin of the plastic surgeon, it is very difficult to make good scars for a child, though easy for an old person. This stretching force can be countered to some extent if the mature collagen lattice of the dermis is carefully approximated with buried sutures before closing the skin.

Site and Orientation of the Wound

A good scar is one which has matured rapidly without contracture or increase in width, and without forming more collagen than is necessary for its strength. To achieve this ideal it must firstly be on a part of the body with a low susceptibility to keloid and hypertrophic scar. Then its orientation must expose it to gentle continuous traction along its length to prevent contracture. It must be spared such traction across its width to prevent stretching. And it must not be subjected to intermittent stretching and relaxation along its length which would promote scar hypertrophy and delay maturation.

The factors which determine the best orientation to give a good scar vary in different parts of the body. Facial skin is peculiar in having muscles inserted into it, and the wrinkle lines run perpendicular to the underlying muscle fibres. During movements of facial expression the distance separating points on either side of a wrinkle line (and consequently the tension on the skin between them) is constantly changing, while points

FIG. 2—Keloids in tribal scars. The figure shows how different skin areas vary in their susceptibility to keloid. Keloids of the beard area fade as they approach the centre of the face. Those of the presternal skin fade out on the upper abdomen. Scars of the deltoid area are quite severely affected, those of the upper forearm much less so. (Reproduced by kind permission of the editor and publishers of the *British Journal of Plastic Surgery*).

along its length stay the same distance apart. So scars which follow the wrinkle lines do well, while those which cross them tend to become hypertrophic and to contract. On the limbs and digits the best lines for scars run transversely in the crease lines of joint flexures, or longitudinally in mid-lateral lines where joint movement least alters their length. On the trunk, where the effect of movement on the skin is relatively small, the best orientation follows Lange's lines of maximal skin tension. Thereby the stretching effect of skin tension across the breadth of the scar is kept to a minimum.

Scar Revision

Patients are often referred to the plastic surgeon because they have scars, usually on the face, which are red and lumpy, stepped, dirty, raised or depressed, or simply broad. Many of these problems would have been avoided if the wounds had been repaired initially with sufficient care and skill. But the typical windscreen injury with multiple facial lacerations may need two or three hours of operating time. Too often the repair is left to a junior casualty officer, pressed for time, using local anaesthesia or no anaesthetic at all, and provided with unsuitable instruments and suture materials. Or, associated major head, chest, and leg injuries are given understandable but sometimes exclusive priority. Scar revision is generally best left until all the redness and lumpiness has settled, usually six months to a year. But sometimes hypertrophy is aggravated by an unfavourable orientation, and in this case early revision with reorientation by Z-plasty may allow the scar to mature more rapidly.

Contracture of a linear scar may lead to elevation or depression below the surface of the surrounding skin according

FIG. 3—Bunched scars due to shelving and C-shaped lacerations.

to whether it is crossing a concavity or a convexity. In either case simple scar excision and repair is followed inevitably by recurrence of the same deformity. This may be prevented by breaking up the scar—for example, by Z-plasty. This is nearly always the treatment of choice for the raised scar; the transverse limb of the Z can be located inconspicuously in the crease or hollow crossed by the scar—maybe between the nose and the cheek, or between the lip and the chin. Breaking up a depressed scar over a convexity is equally effective; but the resulting zig-zag scar, albeit much improved in quality, crossing the prominence of the cheek or the chin, may attract more rather than less attention. An alternative remedy which prevents the new scar from sinking below the surface, is to preserve the old one, denuded of epithelium, and repair the skin over the top of it.

Some wound configurations lead to effects whose dependence on scar contracture is not immediately apparent. A C-shaped scar, by circumferential contracture, leads to bunching up (mushrooming) of the central unscarred skin flap. Recurrence may be prevented by any method which breaks up the curved line; the simplest is to square it off and give it angles. Similarly, a shelving laceration—such as is commonly seen on the forehead due to windscreen injury—becomes raised and stepped as the area of its base contracts. Revision must provide clean-cut skin margins for accurate and level apposition.

The success of the revision of broad scars depends on the cause. If the scar has given way because the dermis was not separately approximated at the time of primary repair, or because of early wound infection, the results of proper secondary repair are gratifying. But if the scar has slowly stretched under the unremitting tension of a child's taut facial skin, or if it is broad because it was unfavourably sited and has been subject to hypertrophy—and if the cause persists—the second scar may be only marginally better than the first. The solution to the first of these problems is to wait, or to warn the parents that a second scar revision will be needed when the puppy fat has absorbed permitting some relaxation of the facial skin. The posthypertrophy scar on the upper back or over the sternum is likely to be even worse after revision, and is best left strictly alone.

FIG. 4—Road-dirt tattooing of forehead scars before and after surgical revision.

Conclusion

Many people believe that the plastic surgeon can erase scars without trace. Regrettably, he must generally make a new scar, and this will be subject to the same influence of age, site, and orientation as the original wound. He can do no more than choose the time and technique to take best advantage of the merits, and where possible to circumvent the imperfections, of the natural healing processes.