The Relaxation of Scar Contractures by Means of the Z-, or Reversed Z-Type Incision:* Stressing the Use of Scar Infiltrated Tissues

The purpose of this paper is to call attention to a method by which flaps of scar tissue or of tissue considerably infiltrated with scar may be used in relaxing scar contractures. The utilization of such tissue for the relaxation of scar contraction is not generally understood although the Z-type incision by which it is accomplished is an old procedure.

It is a good plastic principle to remove all scar tissue before attempting any sort of reconstruction and this should be carried out whenever possible. However, there are many contracted scars where complete excision of the entire scar is impracticable on account of its extent and location. In these instances, unless skin grafting or flap shifting from a distant part is done, it is necessary to utilize scar or scar-infiltrated tissues, and often a great deal can be gained and much relief given by the proper use of such tissues.

In order to utilize flaps of scar-infiltrated tissue some manoeuvre must be carried out which will relax the contracted band and break the line of scar tension. In suitable cases, this may be accomplished by the use of the Z, or reversed Z, or staggered Z, or S, or reversed S-incision as one may choose to call it.

The transposition of the flaps thus formed is made possible because there is always shortening of the tissues in the direction of the contraction and usually excess or fullness on both sides of the contracted band.

History

A review of the literature was made by Dr. Herbert Wilgis and myself in order to determine, if possible, who first devised the Z-type incision and transposed the flaps thus made. As far as we can find, the earliest description of this incision with the transposition of the flaps thus made was by Denonvilliers in 1856, who apparently developed the procedure in steps. He used it successfully for the relief of ectropion of the outer third of the lower lid. This type of incision may have been used even before Denonvilliers, but we were unable to find an earlier report.

Szymanowski, in his book published in 1870, illustrated the use of a similar incision for the relief of a deviation of the angle of mouth, so the method was well known to him. Picchaud reported in 1896 the use of a modified Z-type incision for the restoration of the axilla and for the relief of scar contractures in other regions. He stressed the utilization of scar-infiltrated tissues and apparently made considerable use of the method. Berger and Bonset in 1904 used a Z-incision with the transposition of flaps for the restoration of an axilla which had been obliterated by scar contracture. Berry and Legg in 1912 employed the Z-incision for adjusting the vermilion border in a poorly repaired congenital cleft of the lip.
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McCurdy in 1913, in 1917, and again in 1924 wrote on the Z-plastic method and emphasized the importance of implanting in the centre of the wounds flaps of normal skin and shifting the burn scar to the ends of the field of operation. Morestin in 1914 described a method of relaxing a permanent flexion of the finger due to scar tissue by the use of a multiple Z-incision. An incision was made along the rim of the scar bridle dividing it into two leaves, then from this central incision several lateral incisions were made forming a number of flaps. The finger was straightened and the flaps were drawn into the angles formed by the incisions made on the opposite side. In this way the scar bridle was released and the scar pull broken by a very irregular closure. This procedure was well illustrated diagrammatically by Rahn in 1923.

Frank S. Matthews in 1915 illustrated a modified Z-type incision for liberating a band of scar tissue which was quite similar to that used by Piéchaud, but was devised without knowledge of Piéchaud's work. Pieri in 1919 illustrated the application of a modified Z-type incision with the transposition of scar flaps in deepening the commissures on badly mutilated hands. Davis illustrates the Z-type incision several times in his book on Plastic Surgery, published in 1919, and also in a paper on Arm-Chest Adhesions in 1924. He again demonstrated the use of this method on the face and neck in 1930 in the Section on Plastic Surgery in Dean Lewis' System of Surgery.

Steindler in 1923 illustrated his idea of Pieris operation in relaxing a scar web on the thumb by the use of a modified Z-type incision and also showed an excellent illustration of the relaxing of a web between the thumb and forefinger by a Z-incision. Bosch Arana in 1925 wrote on the use of a modified Z-incision with the transposition of flaps in the phalangization of the first metacarpal. C. N. Dowd in 1927 published an article on the use
FIG. 2A. Demonstrating the Z-type incision which we have found most generally useful with the transposition of flaps. A piece of chamois skin was placed on a frame and the central portion was stretched snugly between two thumb tacks to represent a scar bridle. Note the "scar bridle" CD which projects quite markedly. Along the centre of this bridge is the longest line of the Z; the arms of the Z, DB and AC, are marked out so that the tips of the flaps X and Y will be blunt. A portion of the skin has been dotted in order to show contrast after the flaps are transposed.

FIG. 2B. Illustrating the shrinkage of the flaps after the Z-incision has been made. The incision has been made along the Z previously marked out ACDB and the flaps X and Y lie completely separated and theoretically undercut. Note the gaps along the arms of the Z, which in a real scar are often much more marked, as naturally the scar pull would be greater than that in a piece of chamois skin.

FIG. 2C. Illustrating the transposition of the flaps and breaking of the scar pull. Note the position of the flaps after transposition. The flap X made in the dotted portion of the skin being drawn into the defect made by raising the flap Y in the undotted portion and vice versa. The tip of the flap X being sutured to the point B and the tip of the flap Y being sutured to the point A. Note the approximation of the edges of the flaps with horsehair sutures, the edge of AC of the dotted flap X being sutured to the edge BD of the undotted flap Y. The breaking of the "scar pull" and the relaxation of the bridge can be well seen. Note the increase in the distance between the thumb tacks as the relaxation obtained by the transposition of the flaps made it necessary to move them outward to the edges of the frame; also that the suture line is the staggered reverse of the original incision.

of the Z-incision in the repair of cicatricial contractures of the neck. Babcock in 1928 illustrates nicely the use of the Z-type incision in what he describes as Pieri's operation for the relief of a web between the thumb and forefinger.

It is probable that the Z-type incision has been described in other articles which we have not mentioned, but there is no question but that it was used over seventy years ago, and that it has been frequently rediscovered and described as a new procedure.

Technic

It is with those contractures which present a prominent bridle or web with which we most frequently have to deal, but the method is also very effective in dealing with the type of contracted scar whose contracted portion sinks into a groove and has a deep attachment instead of projecting as a bridle or web. This latter type of contracture is, of course, much less commonly found.

I usually choose a general anaesthetic, selected to suit the individual case, but if local anaesthesia is preferred for any reason, nerve block should be used, as infiltration of scar tissue is inadvisable on account of its precarious blood supply. The technic, which is quite simple, is as follows: Prepare the area to be relaxed by the method in which you have confidence. Mark out the proposed incision carefully with 5 per cent. brilliant green in alcohol on the contracted area, when the scar is under tension. The longest line of the Z is laid along the most prominent por-
Illustrating the use of the Z-type incision on the neck.

Figs. 3A. and 3B. Old burn scar of neck. Note the width of the bridle and the extent of the scar. In this case a Z-shaped incision was made and the flaps were transposed.

Fig. 3C. The result of this relaxation after twelve days can be seen. Note the complete relaxation of the scar bridle, the relief of tension and the satisfactory utilization of scar infiltrated flaps.

The treatment of burns and other extensive surface lesions which frequently result in contractures will not be considered except to say that every effort should be made to induce rapid healing with the part in proper position, as in this way excessive scar formation and subsequent contractures may be minimized. Some contractures may be avoided by very careful treatment of the original lesion, but my experience has been that contractures may and will occur in spite of every precaution. These contractures are found most frequently in the axilla; where the extremities join the trunk; around joints and on the neck and face.

As a general rule, it is advisable to delay operative work on contracted scars until nature, assisted by massage and passive motion, has had time to do all that she can. A few months will make a great deal of difference in the condition of the scar and of the surrounding tissues and by making haste slowly useless operations may be avoided, so that when we finally come to operate we will be able to see the scar as it eventually will be and can take steps to properly correct it.

This brings up the importance of the age of the patient with a scar contracture. During the growing period scar contracture, if not relieved, may materially interfere with the growth of the bony structure as well as of the adjacent soft parts and may cause changes and deformities, which can never be completely remedied. However, if the contracture
Illustrating the use of the Z-type incision for the relief of scar contractures of the fingers.

Fig. 4A. Shows the hand of a child with contraction of the index, middle and ring fingers following a severe rope burn. The middle finger was so badly burned that new tissue had to be supplied after straightening the finger, by means of a measured whole thickness graft. The ring and index fingers were not grafted but were relaxed by Z-type incisions.

Fig. 4B. Result five months later. Note that the result following the Z-type incisions is as satisfactory as that following the whole thickness graft. All the fingers can be extended and function is fully restored.

is relieved, say six months after healing is complete, which gives time for preliminary massage and other therapeutic measures, bone and soft part changes usually readjust themselves. In adults, on the other hand, while the question of interference with bone growth does not have to be considered, we must bear in mind the atrophy of disuse and in cases of long standing care must be taken not to cause fracture when manipulating a part, such as the arm, after relaxation. It has been my experience also that it is better not to operate on an adult until six months have elapsed after healing is complete, in order to take advantage of improved conditions made possible by massage and stretching.

In many cases the flaps available are made up entirely of scar tissue. Only occasionally do we find a bridle or web with even comparatively normal skin running up to the contracted band, and in these instances the circulation of the flaps is naturally much more satisfactory. The ideal condition, of course, would be to break the scar pull with flaps of normal tissue.

If the scar bridle is fairly thin and soft, it is split its full length into two leaves, which are utilized as part of the flaps. If on the other hand the scar bridle is thick and hard and is unpromising for use, then an elongated ellipse of tissue including this portion is excised and the edges are brought together with a few temporary sutures. The Z or reversed Z is then marked out, the incisions are made and the flaps are raised and transposed in the usual way.

The lines marking out the prospective flaps may vary considerably in shape and direction according to the pull of the contracture and the type of the surrounding tissue, and in this way many modifications of the Z-incision may occur. In planning flaps care must be taken to utilize the best available tissue and for this reason the incision may be a Z or reversed Z depending on whether there is less infiltration with scar to the right or to the left of the line of contracture and above or below a transverse mark dividing this line. In other words, if the tissue is less infiltrated with scar in the upper left quadrant and in the lower right quadrant (facing the patient), then the Z is used and vice versa. The contraction pull of the scar on the two sides of a central bridle may be quite different and consequently after the flaps have been formed and undercut, they may be drawn entirely away from...
Illustrating the use of several Z-type incisions for the relief of a long scar contracture.

Fig. 5A. Burn scar contracture of the thigh and leg. Duration, seventeen years. Note the thickened bridle in the popliteal space which has never healed. Also the extent of the scar on the thigh and leg. The patient is unable to fully extend the leg, and has the sensation of tightness and constant drawing. She tires easily and has considerable loss of function.

Fig. 5B. Result two months later. The ulcerated portion of the scar in the popliteal space was excised and the edges were drawn together with temporary sutures. Then the Z was marked out, the incisions made and the flaps transposed. Three other Z-incisions were made in different portions of the scar and good relaxation was obtained. The patient can now walk without discomfort and has entirely lost the sensation of tightness on the back of the leg and thigh. It may be necessary subsequently to relax the depressed scar on the inner side of the thigh.

Illustrating the use of several Z-type incisions for the relief of a long scar contracture. The contracture is as intended and thread on fine half-curved needles and only enough should be put in to approximate the edges. All tension on the flap should be avoided.

The tips of the flaps should be made blunt instead of pointed, as when thus made they are much less liable to slough. Even if the tips of the flaps do slough, which sometimes happens when there is much scar, we often find that sufficient relaxation has been accomplished and that soon the defect left by the sloughing tips will be filled up and the scar will become smooth again. It is advisable to have the flap as thick as may be, including some subcutaneous fat if it is present, in order to conserve the circulation. Should the tips of the flaps become bluish after a few hours of the sponge pressure, it is advantageous to apply continuous compresses saturated with normal salt or boracic-acid solution.

I have used the Z-incision for the relief of tension in fairly broad tight scars with con-
Illustrating the use of the Z-type incision for the relief of scar contractures in the axilla, cubital space and at the wrist.

Fig. 6A. Scar contracture following a burn. Note the involvement which extends from the chest to the hand. Some operative work had been done elsewhere before the patient came under my care.

Fig. 6B. Result, after two weeks, of relaxation at the wrist and in the cubital space.

Fig. 6C. The same arm after two years. During the interval further relaxation had been done on the axilla. Note the improvement in extension at the elbow and wrist.

Figs. 6D. and 6E. One week later the final contracture in the axilla was relaxed by a Z-incision which can be seen with the stitches in place. The wrist and cubital space were also relaxed by Z-type incisions made in scar partially relaxed by similar incisions done two years previously. Note that full extension is now possible and that an excellent axilla has been formed.

Considerable success. In the relief of congenital webbing of the neck, the Z-incision with the transposition of flaps is the method of choice. It is also most useful in deepening the commissures in incomplete syndactylism with a wide web.

When the Z-incision is used on the wrist, the flaps must necessarily be fairly short and it is better to relax at two different points rather than to attempt the formation of flaps which are too long. This may also be said of flaps about the fingers. The relaxation of a scar web, or of a congenital shortening of the web between the thumb and forefinger can
Illustrating the Z-type incision, used several times in the same area, for relaxing scar contraction.

Figs. 7A. and 7B. Extensive very thick burn scar of neck, chest and axilla. Note the extent and character of the scar.

Fig. 7C. Result after eight months of the first use of the Z-type incision on neck and axilla. Note the difference in the character of the bridle and how much thinner and less dense it is. The Z-type incision was again used on the neck and in the axilla.

often be easily relieved by a Z-incision with the transposition of flaps.

The Z-incision can be used for the relief of long contractures such as those in the axilla, and also very satisfactorily in short ones, such as we often find around the nose and ears. This gives an idea of the flexibility of the method.

In marked contractures of long standing with shortening of the underlying tissues, as much as possible should be gained at the first operation with the Z-type incision and subsequently the same procedure may be carried out in the same area after the deeper tissues have had time to stretch and soften. The character of the scar itself often changes materially, for the better, after relaxation.

The Z-type incision may also be used most
lize how much permanent relaxation can be secured by the use of scar-infiltrated tissue and this type of incision, until one is familiar with the procedure and its possibilities. The method has simplified the handling of many cases which would otherwise have had to undergo a much more extensive and serious operative procedure in order to obtain relief.

The Z-type incision has been of great use to me when dealing with contractures in all parts of the body. I have utilized it in a large series of cases and consider it one of the most generally useful manoeuvres in my armamentarium.

REFERENCES


Editorial Comment

Dr. John Staige Davis is recognized as one of the great pioneers in American plastic surgery. His preliminary training in general surgery prepared him well to develop plastic surgery in Baltimore at the Johns Hopkins Hospital. His was the first textbook of plastic surgery in this country, published in 1919 under the title Plastic Surgery: Its Principles and Practice. Throughout his lifetime he made many contributions to our specialty, one of which, describing the well-known Z-plastic technique, is reproduced here.

Although Davis considered the technique applicable to scar contracture, there are today many who would doubt the indications for its use for tissue relaxation where deficiency of skin exists. The tight web in one direction can be relaxed by a Z-plastic but only at the expense of slackness in the axis at a 90° angle to it. In this circumstance, it is considered preferable to replace the missing skin by skin grafts rather than by local tissue shifts. However, the method of Z-plasty, in addition to the uses described by Davis, has found increasing popularity and usefulness in reorienting misaligned scars and in obscuring a conspicuous linear scar by changing it to one with an irregular configuration.

Of interest in the diagram of the method is the squaring off of the apices of the flaps, a refinement not stressed in other descriptions. The sharply tapered apex of the flap is often difficult to manage but is minimized by blunting the point.

Another contribution by Davis was the popularization of the small deep graft. This graft, analogous to the Reverdin graft, was a thicker patch of skin involving almost the full thickness of the dermis. It was described many years before the revolutionary contribution by Blair and Brown of the split-thickness graft. The use of the Davis small deep
graft gave to the general surgical public a method of closing extensive raw surfaces safely and effectively. Although the cosmetic picture both of the donor site and the recipient site left much to be desired, many lives were no doubt saved, and the days of disability shortened by the popularization of this method.

John Staige Davis was a third generation of physicians in his family, and his son continues the plastic surgical tradition in Baltimore. Dr. Davis will be remembered not only for his fruitful contributions to the field of plastic surgery, but also for his able teaching to the general surgeon techniques developed by the plastic surgeon.²

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REFERENCES