METHOD OF PREPARING SKIN FOR USE IN A SKIN GRAFT

Fig 1

Fig 2

Fig 3

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Filed Jan. 15, 1964, Ser. No. 337,795

5 Claims. (Cl. 125—305)

This invention relates to skin grafts and more particularly to a method of preparing the skin from a donor area for grafting to a recipient area.

Sheet grafts, spaced patch grafts, and spray grafts are well known and have been frequently used in the past to graft skin from one area of a patient's body to another. However, these previous types of skin grafts have serious limitations and disadvantages. For example, sheet grafts using sheets of skin removed from donor areas are limited in usefulness because the recipient areas covered must be substantially the same size as the donor areas from which the sheets of skin are obtained.

Since many recipient areas are relatively large in relation to the possible donor areas from which sheets of skin may be obtained, several sheet grafts are frequently required to cover a single recipient area. This is highly undesirable from the standpoint of the patient. Thus, a sheet graft is usually only where the recipient area to be covered is relatively small and easily covered by a single sheet of skin obtained from a readily available donor area.

Moreover, sheet grafts tend to be characterized by undesirable accumulations of fluid under the skin of the covering area. These accumulations of fluid under the sheet of skin prevent the initial growing of the sheet of skin to the recipient area and as a result, a sheet graft often requires repeated draining of fluid from under the sheet of skin in order to be successful. This repeated draining of fluid is troublesome and unpleasant to the patient and when accomplished by holes made through the sheet of skin results in a loss of skin which retards healing.

Another difficulty encountered with spray grafts is that it is practically impossible to spray the skin particles over the recipient area with a uniform thickness. Moreover, the equipment necessary to obtain the skin particles for a spray graft and to apply the skin particles to a recipient area is complicated and relatively expensive to manufacture. The equipment is also relatively difficult to maintain if sterile conditions are to be achieved and to use if a graft approaching uniform thickness over the recipient area is to be obtained.

The present invention of a method of preparing a sheet of skin from a donor area for grafting to a recipient area conveniently uses skin graft apparatus including a cutting member having a plurality of spaced cutting edges, and a carrier member which encloses a sheet of skin as the spaced cutting edges of the cutting member penetrate the carrier member and the sheet of skin. The skin of the apparatus produces a plurality of rows of slits in a sheet of skin removed from a donor area as the cutting edges of the cutting member are forced through the carrier member and the sheet of skin. The slits are in parallel rows and the spaces between the slits in one row are opposite the slits in adjacent rows. The result is a mesh of skin ribbons which may be expanded to cover a recipient area two to three times as large as the donor area.

Since the piece of skin to be prepared for a skin graft is within the carrier member, only the carrier member and that portion of the cutting member penetrating the carrier member and piece of skin must be sterilized prior to use. Thus, the present invention may be practiced with apparatus which is easy to operate and maintain and which requires little care to provide a piece of skin for a skin graft under sterile conditions.

The skin graft obtained using the expandable mesh avoids the problems and difficulties of previous skin grafts. Since the expandable mesh has all parts integral with each other, the skin graft has good stability against trauma and breakdown caused by moving or bumping the recipient area. Moreover, the openings between the ribs of the mesh permit fluid tending to accumulate under the ribs to drain. This promotes the initial growth of the mesh to the recipient area by avoiding the fluid accumulations encountered with sheet grafts.

The expandable mesh provided by the present invention allows the skin to be evenly spaced over the recipient area without using a carrier sheet. This is because the ribs of the expandable mesh are evenly spaced over the recipient area as the edges of the mesh are attached to the skin edges surrounding the recipient area. Moreover, since the edges of the mesh are firmly attached to the skin edges surrounding the recipient area, a carrier sheet or other similar holding means is not needed to hold the mesh in place upon the recipient area.

The ribs of skin which form the mesh are relatively narrow in width. This produces faster healing by improving fluid drainage and causes the ribs to be elastic. The elasticity of the ribs permits them to be slightly in tension when the edges of the mesh are attached to the edges of the skin surrounding the recipient area and serves to hold the mesh in position over the whole recipient area. The elasticity of the ribs also serves to prevent the shrinkage that has normally been encountered with previous skin grafts.

A skin graft apparatus for practicing the method disclosed herein is inexpensive both to produce and maintain since it has only one moving part and requires no pumps, tubing, or motors. Moreover, the apparatus is simple to operate and does not require trained personnel to disassemble and sterilize it. In addition, the method may be practiced by a wide variety of other apparatus arrangements including simply a knife.

These and other features and advantages of the inven-
tion will be more clearly understood from the following detailed description and the accompanying drawings in which like characters of reference designate corresponding parts in all figures and in which:

FIG. 1 is a perspective view of a skin graft apparatus having a flat arrangement of the cutting member.

FIG. 2 is a cross-sectional view of the skin graft apparatus shown in FIG. 1 and shows the position of the cutting member within the carrier member as the mesh is being formed.

FIG. 3 is a partial perspective view of the carrier member.

FIG. 4 is an elevational view of a mesh prepared by the skin graft apparatus showing the mesh after expansion.

FIG. 5 is an elevational view of a mesh skin prepared by the skin graft apparatus showing the mesh before expansion.

FIG. 6 is a perspective view of a second skin graft apparatus having a roller arrangement for the cutting member.

These figures and the following detailed description disclose a specific embodiment of the present invention but the invention is not limited by the details disclosed herein since the invention may be embodied in other equivalent forms.

The present invention is most conveniently practiced by apparatus which comprises, generally, a cutting member 14 having a plurality of cutting edges 30 and a carrier member 11 for containing and positioning a piece of skin 12 for cutting by the cutting edges 30 of the cutting member 14. In the apparatus shown in FIG. 1, the cutting member 14 is formed on a base 13. The base 13 is rectangular in shape with a rack gear 19 extending along both sides of a flat surface 20. A groove 22 extends into and along each side of the base 13 below the rack gear 19.

Extending upwardly from the flat surface 20 and parallel to the rack gears 19 are a plurality of blades 34. The blades 34 form the cutting member 14 and the blades 34 are provided by a plurality of knives 29. The knives 29 are thin elongated rectangular metal strips and a plurality of blades 34 are formed in each knife 29 by a plurality of downwardly extending slots 31. The knives 29 are parallel to each other and to the rack gears 19 and are arranged so that the slots 31 of one knife 29 are opposite a cutting edge 30 and adjacent knives 29. Each blade 34 has a cutting edge 30 and all of the plurality of cutting edges 30 are in a single plane of reference substantially parallel to the flat surface 20 of the base 13.

The carrier 11 comprises a stripping sheet 36 and a pressure sheet 38 of plastic or some similar material. The stripping sheet 36 and 38 are bonded to each other by heat or other known means along three edges so as to form an envelope or jacket open along one edge. The stripping sheet 36 is relatively thin and easily penetrable by the blades 34. The pressure sheet 38 is of substantially greater thickness than the stripping sheet 36 and can be of tougher plastic than the stripping sheet 36.

A piece of skin 12 to be prepared for a skin graft is placed between the sheets 36 and 38 and the carrier member 11 containing the piece of skin 12 is placed upon the cutting edges 30 of the cutting member 14 with the stripping sheet 36 resting upon the cutting edges 30. When the carrier member 11 containing the piece of skin 12 is forced downward against the blades 34 of the cutting member 14, the blades 34 are forced through the stripping sheet 36 and the piece of skin 12 and into the pressure sheet 38. As the blades 34 are forced through the piece of skin 12, a plurality of parallel rows of slits 35 are formed in the piece of skin 12.

As the slits 35 are formed in the piece of skin 12, the carrier member 11 is removed from the cutting member 14 by withdrawing the blades 34 from the carrier member 11 and the piece of skin 12 within the carrier member 11. The stripping sheet supports the piece of skin 12 as the blades 34 are removed and it will now be understood that the carrier member 11 supports the piece of skin as it is cut by the blades 34 and that the stripping sheet 36 of the carrier member 11 serves to strip the piece of skin 12 from the knife blades 34 without damage. The blades 34 can be forced into the carrier member 11 and the carrier member 11 removed from the blades 34 by hand or some other similar means.

After the slits 35 have been formed and the carrier member 11 removed from the blades 34, the piece of skin 12 is removed from the carrier member 11 by separating the sheets 36 and 38. When removed from the carrier member 11, the piece of skin 12 as shown in FIG. 4, and it will be seen that the arrangement of blades 34 described above forms a plurality of parallel rows of slits 35 in the piece of skin 12 with each slit 35 centered lengthwise opposite the spaces between the slits 35 of adjacent rows of slits 35.

The arrangement of slits 35 described permits the piece of skin 12 to be expanded into a mesh 27, as shown in FIG. 5, by hand or other similar means and to be placed over a recipient area (not shown) substantially larger than the piece of skin 12 before expansion into the mesh 27. The mesh 27 is a mesh of skin ribbons 39 and the ends of the skin ribbons 39 are sewn to the edges of the skin surrounding the recipient area (not shown). When the ends of the skin ribbons 39 are sewn to the edges of the recipient area (not shown), the skin ribbons 39 are stretched so as to produce a slight tension within each skin ribbon 39. This stretching of the skin ribbons 39 prevents the elastic shrinkage encountered in other skin grafts and increases the size of the recipient area covered by the mesh 27.

From the foregoing description it will be understood that the cutting member 14 and carrier member 11 cooperate to provide a mesh 27 which is easily positioned on a recipient area substantially larger than the donor area from which the piece of skin 12 is removed and which remains firm in position on the recipient area while permitting fluid drainage and otherwise promoting healing. It will also be understood that only the carrier member 11 and the blades 34 need be sterile since until being placed on the recipient area, the piece of skin 12 is contained between the sheets 36 and 38 of the carrier member 11 and only the blades 34 penetrate the carrier member 11.

The pressure sheet 38 of the carrier member 11 is of sufficient thickness relative to that selected for the slots 31 for the blades 34 to only partially penetrate the pressure sheet 38 after the blades are forced through the stripping sheet 36 and the piece of skin. This insures that the blades 34 are not contaminated before the blades 34 are withdrawn from the carrier member 11 by the pressure means used to force the carrier member 11 downward against the blades 34. The pressure sheet 38 also serves to prevent the blades 34 from damaging the pressure means used to force the carrier member 11 downward against the blades 34 and to prevent the cutting edges 30 of the blades 34 from being dulled by the pressure means.

The pressure means used to force the carrier member 11 downward on the cutting member 14 may be simply the hand and it will be understood that the carrier member 11 prevents injury to the hand and prevents the hand from rendering the piece of skin 12 unstable. A similar result is obtained if means other than the hand is used as a pressure means and it has been found convenient to use a pressure roll 15 as a pressure means.

In the apparatus shown in FIG. 1, the pressure roll 15 is rotatably held between two support arms 18 and movable along the length of the base 13.

The support arms 18 are shaped in a similar manner and the lower edge of the support arms 18 are joined by a slide bar 25 which extends between the support arms 18 and under the base 13. Positioning pins 24 extend from the
support arms 18 into the grooves 22 in the base 13. The result of this arrangement is that the support arms 18 are slidably positioned on opposite sides of the base 13 with one corner of each support arm 18 extending upwardly above the flat surface 20 of the cutting member 14. The pressure roll 15 is cylindrical and has a pinion gear 21 at each end which engages one of the rack gears 19. An axle 28 extends through the pressure roller 15 and is rotatably inserted through the support arm 18. A handle 26 is integral with the axle 28 at one end and it will now be understood that as the handle 26 is turned, the pressure roller 15 and the pinion gears 21 also turn. As a result, the pressure roller 15 moves across the cutting member 14 as pinion gears 21 advance along the rack gears 19. This causes the carrier member 11 resting on the cutting member 14 to be squeezed between the pressure roller 15 and the cutting member 14 and the blades 34 to be forced into the carrier member 11.

FIG. 6 discloses a second apparatus for practicing the present invention in which the cutting member 114 is arranged on a cylindrical surface. The cutting member 114 is rotatably positioned a fixed distance from a pressure roller 115 and as the cutting member 114 is turned by a handle 126, the carrier member 11 is moved between the cutting member 114 and the pressure roller 115.

The cutting member 114 is comprised of a cylindrical drum 110 having a plurality of circular knives 129 extending outwardly therefrom. Slots 131 in the knives 129 form blades 134 and the distribution of the blades 134 around the circumference of the drum 110 is such that when a carrier member 11 is moved between the pressure roller 115 and carrier member 114, the blades 134 form a pattern of slits 35 in a piece of skin 12 identical to the pattern formed by the first embodiment of the invention.

Integral with and outwardly of each end of the drum 110 is a gear spur 122. An axle 120 extends through the drum 110 and the spur gears 122. Similarly, a spur gear 121 is integral with and outwardly of each end of the pressure roller 115 and an axle 128 extends through the pressure roller 115. The axles 128 and 120 are parallel to each other and extend between and through support arms 118 extending above a platform 150. The handle 126 is at one end of the axle 130 and it will be understood that as the handle 126 is turned, the pressure roller 115 and drum 110 rotate in opposite directions so as to move the carrier member 11 between them. The platform 150 provides a convenient surface on which to rest the carrier member 11 before and after the carrier member 11 is passed by the pressure roller 115 and drum 110.

It will now be understood that regardless of the pressure means used in an apparatus for practicing the invention, a cutting member 14 forms a plurality of slits 35 in a piece of skin 12 which permits the piece of skin 12 to be expanded into a mesh 27 and that the mesh 27 provides an improved and highly successful skin graft. The carrier member 11 provides a sterile container for the piece of skin 12 before, as, and after the slits 35 are formed and in addition serves to prevent the blades 34 from becoming unsterile or from damaging a pressure means such as a pressure 15 or 115.

Moreover, the stripping sheet 36 of the carrier member 11 provides a convenient means for removing a piece of skin 12 from the blades 34 without damage to the piece of skin 12. Since only the blades 34 engage a piece of skin 12 within a carrier member 11, only the blades 34 of the cutting member 14 need be sterile and the resulting limited degree of sterilization required by the skin graft apparatus and the ease of stripping the piece of skin 12 from the cutting member 14 make the apparatus relatively easy to use and maintain. That a skin graft apparatus suitable to practice the invention is relatively inexpensive to manufacture in any of a variety of arrangements is apparent from its simplicity once the skin graft method is understood.

It will be obvious to those skilled in the art that many variations may be made in the embodiments chosen for the purpose of illustrating the present invention without departing from the scope thereof as defined by the appended claims.

What is claimed as invention is:

1. A method of preparing a piece of skin for a skin graft, said method comprising the steps of making parallel columns of slits in the piece of skin with the slits of one column being offset from the slits of its adjacent column, and expanding the piece of skin into a mesh of skin ribbons.

2. A method of preparing a piece of skin for a skin graft, said method comprising the steps of cutting in the piece of skin a first group of slits arranged in columns and rows and a second group of slits arranged in columns parallel to the columns of the first group and in rows displaced from the rows of the first group, and expanding the piece of skin into a mesh of skin ribbons.

3. The method of claim 1 including the steps of placing said piece of skin within a carrier member prior to said making parallel columns of slits and removing said piece of skin from said carrier member prior to said expanding the piece of skin.

4. The method of claim 1 in which said piece of skin is positioned between a pressure sheet and a stripping sheet during said making parallel columns of slits.

5. The method of claim 1 in which said making parallel columns of slits includes forcing a cutting edge through said piece of skin.

6. The method of claim 1 in which said making parallel columns of slits includes simultaneously forcing a plurality of cutting edges through said piece of skin.

7. The method of claim 4 in which said making parallel columns of slits includes forcing a cutting edge through said stripping sheet and said piece of skin by pressure applied to said pressure sheet.

8. The method of claim 7 including removing said piece of skin from said cutting edge by motion of said stripping sheet relative to said cutting edge.

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