METHODOLOGY AND APPARATUS FOR EXTERNAL FIXATION OF BONE FRACTURES

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Filed: Nov. 14, 1972

Appl. No.: 306,214

U.S. Cl. ........................................ 128/92 A
Int. Cl. .................................... A61F 5/04
Field of Search .... 128/92 A, 92 R, 92 B, 92 D, 128/83

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ABSTRACT

A method and apparatus are provided for external fixation of bone fractures. The method comprises inserting at least one pin in each major fragment of bone with a portion of the pins extending above the skin surface, drawing the pins toward one another and applying a bridge to the pins to hold them in place under compression parallel to the bone being repaired. The apparatus is at least two elongated pins adapted to be inserted at one end into the bone on opposite sides of a fracture, bridge means engaging the other ends and compression means acting on the pins generally parallel to the bone.

8 Claims, 9 Drawing Figures
METHODS AND APPARATUS FOR EXTERNAL FIXATION OF BONE FRACTURES

This invention relates to methods and apparatus for the external fixation of bone fractures and particularly to a method and apparatus for using an external bridge together with metal pins which are driven into the fracture fragments either percutaneously or under direct vision.

The treatment of fractures particularly fractures of the limbs such as the arm and the leg has historically been based upon the encapsulation of the limb within a cast of plaster after the bone fragments have been moved into place by some mechanical manipulation of the broken member. This practice has many drawbacks. For example, the area around the fracture is usually contused and swells drastically out of its normal proportions. This places great pressure on the area beneath the plaster cast and consequently great pressure on the muscle and portion of the bone at the fracture. As the healing progresses the area beneath the plaster cast slowly shrinks so that some time after application of the cast the cast no longer fits or significantly supports the fracture area. Moreover, the period of time that the cast is in place is so long the wearer finds the cast to be cumbersome and uncomfortable as well as less than sanitary. I have developed a new method and apparatus for external fixation of bone fractures which eliminates the need for a plaster cast surrounding the fracture area. The method of my invention involves the use of metal pins driven into fracture fragments either percutaneously or under direct vision. The pins are held in appropriate position externally of the skin by the use of a bridge which spaces and holds the pins and the bone fragments into which they are driven in fixed position for healing. Preferably the bridge is made of a cement material which can be positioned while soft and will quickly harden in position holding the pins in the desired arrangement with respect to the fracture fragments. In a preferred practice of my invention, I form the bridge by using a flexible bladder of oblong shape filled with a cement in the plastic condition which is capable of hardening in the bladder. A particularly suitable material for this is epoxy resin. Preferably I provide flexible oblong bladders filled with a resin base into which the hardener or catalyst may be added by injection at the time of use and thoroughly mixed by hand manipulation prior to application. The bladder could be furnished with a reinforcing material such as chopped fiberglass, metal filings or any of a variety of other strengthening fillers and any reinforcing material. In addition, wires or similar reinforcing members could be contained within the bladder to add strength to the completed bridge. Preferably the pins are held in proper place during hardening of the cement by a temporary bridge which is removed after the final bridge has hardened. Preferably this is done by attaching the temporary bridge to the pins at a point between their site of exit from the skin of the limb being treated and the point of entry into the bladder. Preferably such temporary bridge has mechanism for adjusting the position of the pins relative to the bridge and thus to allow manipulation for improvement of positioning of the bone and bone fragments at the fracture, prior to final hardening of the cement.

In the foregoing general description I have set out certain objects, purposes and advantages of my invention. Other purposes, objects and advantages of this invention will be apparent from a consideration of the following description and the accompanying drawings in which:

FIG. 1 is an isometric view of an arm showing the arrangement of the apparatus of this invention for the purpose of holding a fractured radius.

FIG. 2 is a vertical section through the forearm and radius as well as the bridge holding the fractured bone in place according to FIG. 1.

FIG. 3 shows a second embodiment of the pin for use in this invention.

FIG. 4 shows a third embodiment of the pin for use in this invention.

FIG. 5 shows a fourth embodiment of the pin for use in this invention.

FIG. 6 shows a second embodiment of a bladder and pin arrangement according to this invention.

FIG. 7 shows a third embodiment of pin and bridge structure according to this invention.

FIG. 8 shows a fourth embodiment of the pin and bridge structure according to this invention.

FIG. 9 shows one form of temporary bridge which may be used during the installation of the bridge and pin structure of this invention.

Referring to the drawings I have illustrated in FIG. 1 the fixation of a fracture of the radius in the forearm of a human being. In FIG. 2 are seen two portions of the radius on opposite sides of the fracture 10, identified by the numerals 11 and 12. Pins 13, 14, 15 and 16 are driven percutaneously into the two portions of the radius 11 and 12, spaced in line from the fracture 10. A bridge 17 is fixed to the ends of the pins 13, 14, 15 and 16. The bridge is made up of an external pliable bladder 18 of polyethylene filled with fortified epoxy resin and formed to hold the pins and the key portions of the radius in fixed relation. The bridge is applied by pushing the pins 13, 14, 15 and 16 through the bladder and the resin while the resin is in the soft and unhardened condition and held in place until the cement hardens in the bladder. The bladder can be removed or left in place as desired.

In the installation of the pins and bladder I preferably provide a temporary bridge such as is shown in FIG. 9. In using this temporary bridge the pins 13, 14, 15 and 16 are driven into the bone portions. A temporary bridge made up of two portions connected by a ball and socket universal joint 20 is connected to the pins above the skin line. The two portions 21, 22 which are connected to universal joint 20 are preferably formed of spaced plates 21a, 21b, 22a, and 22b held together by clamp screws or bolts 23. The pins are clamped between these clamp plates and held in position by them during the time the bladder filled with the unhardened cement is placed over the exposed ends of the pins and hardened.

The function of the bladder 18 is simply to contain the cement while it hardens about the pin along with any desirable reinforcement material or accessory devices which might be desired to be incorporated in the system. The bladder must hold the cement in shape and contain a sufficient volume to provide a mechanically adequate and convenient bridge for the pins used in the fracture.

The pins may take a variety of shapes. They may be in the form of a straight pin with sharpened ends, one end designed to cut through soft tissue and bone so that...
it may be readily implanted. The other end is simply sharpened sufficiently to permit skewering of the pin on the bladders. The pin end may be threaded for more secure engagement of the pin in the bone and it may be provided with some mechanism for applied tension between two or more pins on opposite sides of the fracture. Typical of such pins are those shown in FIGS. 3, 4, and 5. In FIG. 3 I have shown a pin 30 having a side flange 31 with an opening 32 to which a spring or other device for imparting tension may be applied. In FIG. 4 I have shown a pin 35 with an eyelet 35a intermediate its ends to receive a spring or other tensioning device. In FIG. 5 I have shown a pin 50 having a crimp 51 or bend intermediate its ends to form a placement device for a spring or other tensioning device.

In FIG. 6 I have shown a form of truss structure where extreme strength is required. In the structure shown in FIG. 6 I have illustrated straight pins 45 and bent pins 46 entering the soft tissue and the bone ends 47, 48 to provide the extra strength necessary in some bone fractures. Trussing could be provided in a transverse plane or other planes as desired. It will be obvious from the drawings that extreme rigidity in the longitudinal axis as shown would interfere with the application of compression forces at the fracture site. However, this can be overcome by using the structure shown in FIG. 7. In FIG. 7 I have illustrated truss arrangements in which a hinge 60 is provided in the bridge 61 and 62. This may be done by applying two end to end bladders 61 and 62 with a hinge connection 60 to harden into place or the hinge 60 may be inserted in the bridge after the bridge is in place and hardened. In the structure shown in FIG. 7 I have shown two bridge segments 61 and 62 connected by a hinge 60. Each bridge segment is provided with a straight pin 64 and two bent pins 65, 66. Each of the bent pins 65 adjacent to the break 67 are connected by a spring 68 to exert compression on the bone. The arrangement which is shown in FIG. 7 is particularly desirable in order to create compression perpendicularly to a plane closer to that of a fracture so as to avoid any tendency toward telescoping, such as might occur in an oblique break, e.g., certain spiral fractures.

In FIG. 8 I have shown a structure in which two bridges on opposite sides of the fracture are used. Here the two bone sections 71 and 72 to be connected are implanted with pins 73, 74, 75 and 76 which pass through the bone section 71 and 72 and through the soft tissue 77 on each side of the bone. A bladder 78 is fixed on the ends projecting from one side and a bladder 79 from the ends projecting on the other side. The fluid cement in the bladders is solidified to hold the pins in place. As shown in the drawings the pins may be threaded intermediate their ends at the portion engaging the bone. They may also be threaded at the extreme ends to engage the solidified resin.

A sterile dressing, not illustrated, would be desirable over the pin entry sites and a rubber band could be applied to the pin above the dressing to help keep them in place. Alternatively, specialized dressings for the pin sites might be found useful. These might take the form of waterproof sterile bushings of soft material which could be impregnated with anti-bacterial ointment. For example, such bushings might be of soft rubber or plastic or they may be of some sponge-like material impregnated with ointment or any other variety of other devices.

It is obvious from the foregoing description of my invention that the practice as set out therein has a variety of advantages over the prior art practices. For example, fixation of the bones is completely unaffected by soft tissue swelling. Soft tissue swelling cannot cause circulatory deficit through pressure exerted by the fixation device as it can in the case where the fixation device is a plaster cast. There is no joint immobilization whatever required after the cement is fully hardened and compression is applied. Bending, torsional and tensile stress to the fractured bone should, however, be minimized as one would expect. Deformity resulting from loss of reduction would not be obscured by the fixation device as it is in the case of a plaster cast and such deformities could be promptly corrected before they become a part of the healed bone structure. Finally topical therapy indicated on the injured extremity can be carried out with little impediment from the fixation device. This can be very helpful in cases where significant soft tissue injury has occurred along with the bone fracture.

While I have illustrated and described certain preferred embodiments of my invention in the foregoing specification, it will be understood that this invention may be otherwise practiced within the scope of the following claims.

1. A method of external fixation of bone fractures comprising the steps of inserting at least one threaded pin into each major fragment of bone with a portion of the threaded pin extending beyond the soft tissue surrounding the fracture, reducing the fracture by drawing the threaded pins into proper position under compression generally transverse to the fracture line, applying a compliant bridge to the threaded pins at the portions exposed from the soft tissue while under compression, said compliant bridge permitting relative adjustment of the pins in one bone fragment with respect to those in another bone fragment and fixing the compliant bridge in rigid position on the pins to hold the threaded pins in place under compression during healing of the bone fractures said compliant bridge having rigidifying means permitting deformation of the bridge while the pins are placed therein and causing said bridge to become rigid while said compression acts on said pins.

2. A method of external fixation of bone fractures comprising the steps of inserting at least one threaded pin into each major fragment of bone with a portion of the pin extending beyond the soft tissue surrounding the fracture, reducing the fracture by drawing the pins into proper position under compression generally transverse to the fracture line, applying a bridge to the pins at the portions exposed from the soft tissue to hold the pins in place under compression during healing of the bone fractures, said bridge comprising a bladed filler with soft cement which is applied to the pin ends and hardened.

3. A method as claimed in claim 2 wherein the cement is epoxy resin.

4. A method as claimed in claim 1 wherein pressure is applied to the pins transverse to their length between the bridge and the bone to urge the pins together.

5. An apparatus for fixation of fractured bones comprising at least two elongated high strength threaded metal pins adapted to be inserted at one end into a fractured bone on opposite sides of the fracture, compliant bridge means adapted to engage said pins at the other
5 end outside the patient's body and spaced from the bone, compression means acting on the pins generally parallel to the bridge and bone to urge the bone ends together within the compliant bridge means and means causing the compliant bridge to become rigid while said compression means acts on said pins.

6. An apparatus for fixation of fractured bones comprising at least two elongated high strength metal pins adapted to be inserted at one end into a fractured bone on opposite sides of the fracture, bridge means adapted to engage said pins at the other end outside the patient's body and spaced from the bone and compression means acting on the pins generally parallel to the bridge and bone to urge the bone ends together, said bridge comprising a bladder filled with a hardenable cement adapted to be placed over the said other ends of the pin and hardened in situ.

7. An apparatus as claimed in claim 5 wherein the bridge is hinged intermediate its ends.

8. An apparatus as claimed in claim 5 wherein the compression means is an elastomer band.

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