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(54) Title: BONE FRACTURE FIXATION SYSTEM WITH SUBCHONDRAL AND ARTICULAR SURFACE SUPPORT

(57) Abstract: A volar plate includes a head portion with two sets of pegs. The first set of the pegs is substantially linearly and the axes of the pegs are preferably oblique relative to each other, and are preferably angled relative to each other in two dimensions. The second set of pegs is provided relatively distal of the first set through a buttress of the head portion of the plate. The second set of pegs is preferably angled relative to the plate such that the pegs are oriented substantially perpendicular to the body of the plate and extend between the pegs of the first set. The first set of pegs provides support for subchondral bone fragments, while the second set of pegs provides support behind the articular bone surface.



WO 2004/087005 A2

## BONE FRACTURE FIXATION SYSTEM WITH SUBCHONDRAL AND ARTICULAR SURFACE SUPPORT

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates broadly to surgical implants. More particularly, this invention relates to a bone fracture fixation system having support pegs.

#### 2. State of the Art

Fracture to the metaphyseal portion of a long bone can be difficult to treat. Improper treatment can result in deformity and long-term discomfort.

By way of example, a Colles' fracture is a fracture resulting from compressive forces being placed on the distal radius, and which causes backward displacement of the distal fragment and radial deviation of the hand at the wrist. Often, a Colles' fracture will result in multiple bone fragments which are movable and out of alignment relative to each other. If not properly treated, such fractures result in permanent wrist deformity. It is therefore important to align the fracture and fixate the bones relative to each other so that proper healing may occur.

Alignment and fixation of a metaphyseal fracture are typically performed by one of several methods: casting, external fixation, interosseous wiring, and plating. Casting is non-invasive, but may not be able to maintain alignment of the fracture where many bone fragments exist. Therefore, as an alternative, external fixators may be used. External fixators utilize a method known as ligamentotaxis, which provides distraction forces across the joint and permits the fracture to be aligned based upon the tension placed on the surrounding ligaments. However, while external fixators can maintain the position of the wrist bones, it may nevertheless be difficult in certain fractures to first provide the bones in proper alignment. In addition, external fixators are often not suitable for fractures resulting in multiple bone fragments. Interosseous wiring is an invasive procedure whereby screws are positioned into the various fragments and the screws are then wired together as bracing. This

is a difficult and time-consuming procedure. Moreover, unless the bracing is quite complex, the fracture may not be properly stabilized. Plating utilizes a stabilizing metal plate typically against the dorsal side of the bones, and a set of parallel pins extending from the plate into holes drilled in the bone fragments to provide stabilized fixation of the fragments. However, the currently available plate systems fail to provide desirable alignment and stabilization. In particular, with a distal radius fracture, there is a need for alignment and stabilization of both the subchondral bone and the articular surfaces which is not met by current plates.

### SUMMARY OF THE INVENTION

It is therefore an object of the invention to provide an improved volar fixation system for distal radius fractures.

It is another object of the invention to provide a volar fixation system that desirably aligns and stabilizes multiple bone fragments in a fracture to permit proper healing.

It is an additional object of the invention to provide a volar plate system which provides support for articular and subchondral surfaces.

In accord with these objects, which will be discussed in detail below, a volar fixation system is provided which generally includes a T-shaped plate intended to be positioned against the volar side of the radial bone, a plurality of bone screws for securing the plate along a non-fractured portion of the radial bone, and a plurality of bone pegs sized to extend from the plate and into bone fragments at the metaphysis of a radius bone.

The plate is generally T-shaped, defining an elongate body, a head portion angled up relative to the body, a first side which is intended to contact the bone, and a second side opposite the first side. The body portion includes a plurality of countersunk screw holes for the extension of the bone screws therethrough. The head portion includes a plurality of threaded peg holes for receiving the pegs therethrough. According to the invention, the peg holes are arranged into first and second sets. The first set of the peg holes is substantially linearly arranged and also preferably arranged such that the holes are positioned increasingly

distal in a medial to lateral direction along the second side. Axes through the first set of holes are preferably oblique relative to each other, and are preferably angled relative to each other in two dimensions such that pegs inserted therethrough are similarly obliquely angled relative to each other. The second set of peg holes is provided relatively distal of the first set. The holes of the second set are also substantially linearly arranged, and the holes define axes that are preferably substantially parallel. More preferably, the second set of peg holes are angled relative to the plate such that pegs positioned within the holes are oriented substantially perpendicular to the body of the plate and extend between the pegs of the first set. Pegs in the first set of peg holes provide support for the dorsal aspect of the subchondral bone fragments, while pegs in the second set of peg holes provide support for the volar aspect of the subchondral bone, behind the articular bone surface.

Additional objects and advantages of the invention will become apparent to those skilled in the art upon reference to the detailed description taken in conjunction with the provided figures.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a volar fixation system according to the invention;

Fig. 2 is a side elevation view of a volar plate and pegs of the volar fixation system of the invention;

Fig. 3 is a distal end view of a volar plate and pegs of the volar fixation system of the invention; and

Fig. 4 is a bottom view of a volar plate and pegs of the volar fixation system of the invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Turning now to Figs. 1 through 4, a fracture fixation system 100 according to the invention is shown. The system 100 is particularly adapted for aligning and stabilizing multiple bone fragments in a Colles' fracture.

According the first embodiment, the system 100 generally includes a substantially rigid T-shaped plate 102, commonly called a volar plate, bone screws 130, and pegs 140, 142. The plate 102 is intended to be positioned against the volar side of a fractured radius bone. The T-shaped plate 102 defines a head portion 116, and an elongate body portion 118 preferably angled relative to the head portion. The angle between the head portion 116 and the body portion 118 is preferably approximately  $23^\circ$  and bent at a radius of preferably approximately 0.7 to 0.8 inch. A distal buttress 121 of the head portion 116 (i.e., the portion of the head portion distal a first set of peg holes 134, discussed below) is preferably angled proximally toward the medial side at an angle  $\alpha$ , e.g.  $5^\circ$ , relative to a line that is perpendicular to the body portion 118 (Fig. 4). In addition, an upper surface 122 of the buttress 121 is preferably angled relative to the remainder of the head portion 116 such that that upper surface 122 is substantially parallel to the body portion 118 (Fig. 2). The lower surface 123 of the head portion 116 is preferably planar. The plate 102 has a thickness of preferably approximately 0.1 inch, and is preferably made from a titanium alloy, such as Ti-6Al-4V.

The body portion 118 includes four preferably countersunk screw holes 124, 126, 127, 128 for the extension of bone screws 130 therethrough (Fig. 2). One of the screw holes, 128, is preferably generally oval in shape permitting longitudinal movement relative to the shaft of a bone screw.

The head portion 116 includes a first set 132 of threaded peg holes 134 (for placement of pegs 140 therein) and a second set 136 of threaded peg holes 138 (for placement of pegs 142 therein). The peg holes 134 of the first set are arranged along a line or slight curve. The first set of peg holes 134 are also preferably arranged such that the holes are positioned in an increasingly distal manner in the medial to lateral direction. The peg holes 134 of the first set

are preferably located approximately 0.25 inch apart. Axes through the first set of peg holes (indicated by the pegs 140 extending therethrough) are preferably oblique relative to each other, and are preferably angled relative to each other in two dimensions.

The second set 136 of peg holes 138 is provided relatively distal of the first set 132 and is most preferably located in the buttress 121. The peg holes 138 of the second set are preferably substantially linearly arranged and are preferably substantially parallel to the arrangement of peg holes 134. Each of the peg holes 138 preferably defines an axis perpendicular to the upper surface 122 of the buttress 121 and also substantially perpendicular to the body portion 116 of the plate 102. Pegs 142, placed within the peg holes 138, are preferably angled relative to pegs 140 inserted through peg holes 134, and may extend between pegs 140 in an interleaved manner. In addition, pegs 142 (and axes through peg holes 134) preferably project distally peg holes 138 and pegs 140 (and axes through pegs holes 138). Alternatively, pegs 140 through peg holes 134 and pegs 142 through peg holes 138 may be oriented substantially parallel or in other relative configurations.

The pegs 140 and 142 include a threaded head, e.g., 144, and a shaft, e.g., 146, which is preferably non-threaded. Exemplar pegs are described in more detail in U.S. Pat. No. 6,364,882, which is hereby incorporated by reference herein in its entirety.

In use, a relatively small incision is made over the fracture, and the pronator quadratus is reflected from its radial insertion exposing the entire distal radius ulnarly to the distal radioulnar joint. The plate 102 is brought against the bone and aligned with the fracture such that the first set 132 of peg holes 134 is situated substantially over the bone fragment or fragments. A first screw hole is drilled by the surgeon through hole 128 and into the radius bone. A first bone screw 130 is then inserted through the hole 128 in the plate 102 and secured to the bone. Prior to fully tightening the bone screw 130 against the plate, the plate may be longitudinally adjusted relative to the screw. Once the proper position is established, the first screw can be tightened, and additional screws 130 may be inserted through the other screw holes 124, 126, 127 in a like manner.

The fractured bones are adjusted under the plate 102 into their desired positions for healing. The surgeon then drills through peg holes 134, 138 into the bone for the pegs 140, 142. Pegs 140 are then inserted through the peg holes 134 and into the holes drilled into the fragments, and the heads of the pegs are threadably engaged in the volar plate. Similarly, pegs 142 are inserted through peg holes 138 and holes drilled behind the articular surface, and fixed to the plate, to provide support thereat. The first set of pegs 140 defines projections which support central and/or dorsal aspects of the subchondral bone, which is particularly desired in dorsally unstable fractures of the distal radius. The second set of pegs 142 defines projections which provide support at the volar aspect behind the articular surface of the bone surface. The sets 132, 136 of pegs preferably laterally overlap to provide tangential cradling of the subchondral bone. Preferably, at least three pegs are provided in each set 132, 136 to provide a preferred degree of subchondral support. The fracture fixation system thereby defines a framework which substantially tangentially supports the bone fragments in their proper orientation. In accord with an alternate less preferred embodiment, suitable support may also be provided where the pegs 140 and 142 are parallel to each other or in another relative orientation.

While fixed single-angle pegs have been disclosed for use with the plate (i.e., the pegs may be fixed in respective threaded peg holes only coaxial with an axis defined by the respective peg holes), it is appreciated that an articulating peg system, such as that disclosed in U.S. Pat. No. 6,440,135 or co-owned and co-pending U.S. Serial No. 10/159,612, both of which are hereby incorporated by reference herein in their entireties, may also be used. In such articulating peg systems, the peg holes and pegs are structurally adapted such that individual pegs may be fixed at any angle within a range of angles may also be used for either or both sets 132, 136 of peg holes and associated pegs. In addition, while less preferable, one or both sets of the pegs may be replaced by preferably blunt tines which are integrated into the plate such that the plate and tines are unitary in construct. Similarly, other elongate projections may be coupled to the plate define the desired support.

There have been described and illustrated herein an embodiment of a volar fixation system and a method of aligning and stabilizing a Colles' fracture. While a particular embodiment of the invention have been described, it is not intended that the invention be

limited thereto, as it is intended that the invention be as broad in scope as the art will allow and that the specification be read likewise. Thus, while particular materials for the elements of the system have been disclosed, it will be appreciated that other materials may be used as well. In addition, while a particular number of screw holes in the volar plate and bone screws have been described, it will be understood another number of screw holes and screws may be provided. Further, fewer screws than the number of screw holes may be used to secure to the volar plate to the radius bone. Also, fewer or more peg holes and bone pegs may be used, preferably such that at least two pegs angled in two dimensions relative to each other are provided. In addition, while a particular preferred angle between the head portion and body portion has been disclosed, other angles can also be used. It will therefore be appreciated by those skilled in the art that yet other modifications could be made to the provided invention without deviating from its spirit and scope as claimed.



What is claimed is:

1. A fixation plate, comprising:

a substantially rigid plate defining first and second sets of threaded peg holes adapted to individually receive fixation pegs therethrough, said second set of peg holes defining axes that extend between and non-parallel to axes of said first set of peg holes.

2. A fixation plate according to claim 1, wherein:

said rigid plate includes a proximal elongate body portion and a distal head portion at one end of the body portion, and said first and second sets of peg holes are provided in said head portion.

3. A fixation plate according to claim 2, wherein:

said head portion is angled relative to the body portion.

4. A fixation plate according to claim 3, wherein:

said head portion includes a distal buttress portion having an upper surface which is substantially parallel to said body portion, and said second set of peg holes are in said buttress portion.

5. A fixation plate according to claim 4, wherein:

said second set of peg holes define axes which are substantially perpendicular to said body portion.

6. A fixation plate according to claim 1, wherein:

in said first set of peg holes, at least two of said peg holes are oblique relative to each other.

7. A fixation plate according to claim 6, wherein:

in said first set of peg holes, at least two of said peg holes are oblique in two dimensions relative to each other.

8. A fixation plate according to claim 7, wherein:  
in said first set of peg holes, each of said pegs is oblique in two dimensions relative to the others.
9. A fixation plate according to claim 6, wherein  
said second set of peg holes define parallel axes.
10. A fixation plate according to claim 2, wherein:  
said second set of peg holes is offset distally relative to said first set of peg holes.
11. A fixation plate according to claim 10, wherein:  
said first set of peg holes defines axes which project distally of said second set of peg holes.
12. A fixation plate according to claim 1, wherein:  
said plate is a substantially T-shaped plate sized for fixation of volar wrist fractures.
13. A fixation plate according to claim 2, wherein:  
said body portions includes at least one screw hole.
14. A fixation plate, comprising:  
a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of the body portion, said head portion being angled upward relative to said body portion and said head portion defining first and second longitudinally displaced sets of threaded peg holes adapted to individually receive fixation pegs therethrough, said second set of peg holes being located distal said first set of peg holes.
15. A fixation plate according to claim 14, wherein:  
said first set of peg holes laterally overlaps said second set of peg holes.

16. A fixation plate according to claim 15, wherein:

said head portion includes a distal buttress portion having an upper surface which is substantially parallel to said body portion, and said second set of peg holes are in said buttress portion.

17. A fixation plate according to claim 16, wherein:

said second set of peg holes define axes which are substantially perpendicular to said body portion.

18. A fixation plate according to claim 14, wherein:

in said first set of peg holes, at least two of said peg holes are oblique relative to each other.

19. A fixation plate according to claim 18, wherein:

in said first set of peg holes, at least two of said peg holes are oblique in two dimensions relative to each other.

20. A fixation plate according to claim 19, wherein:

in said first set of peg holes, each of said pegs is oblique in two dimensions relative to the others.

21. A fixation plate according to claim 14, wherein

said second set of peg holes define parallel axes.

22. A fixation plate according to claim 14, wherein:

said first set of peg holes define axes which project distally of said second set of peg holes.

23. A fixation plate, comprising:

a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of the body portion, said head portion defining first and second longitudinally displaced sets of threaded peg holes adapted to individually receive fixation pegs therethrough, said second set of peg holes defining axes which are substantially parallel to each other, and said first set of threaded peg holes including at least two peg holes having axes which are oblique relative to each other.

24. A fixation plate according to claim 23, wherein:

said head portion is angled relative to the body portion and includes a distal buttress portion having an upper surface which is substantially parallel to said body portion, wherein said second set of peg holes are in said buttress portion.

25. A fixation plate according to claim 23, wherein:

said axes through said second set of peg holes are substantially perpendicular to said body portion.

26. A fixation plate, comprising:

a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of the body portion, said head portion defining a first set of substantially linearly arranged threaded peg holes, and a relatively distal second set of substantially linearly arranged threaded peg holes, each of said first and second sets of substantially linearly arranged threaded peg holes including at least three peg holes.

27. A fixation plate according to claim 26, wherein:

said head portion is angled relative to the body portion and includes a distal buttress portion having an upper surface which is substantially parallel to said body portion, wherein said second set of peg holes are in said buttress portion.

28. A fixation plate according to claim 27, wherein:

said axes through said second set of peg holes are substantially perpendicular to said body portion.

29. A fracture fixation system, comprising:

- a) a substantially rigid plate;
- b) a first set of elongate projections coupled to said plate; and
- c) a second set of elongate projections coupled to said plate,

wherein said second set of projections defines axes that extend between and non-parallel to axes of said first set of projections.

30. A fracture fixation system according to claim 29, wherein

said plate includes a first set of threaded peg holes, and said first set of projections are fixed-angle pegs threaded into said first set of threaded peg holes.

31. A fracture fixation system according to claim 30, wherein

said plate includes a second set of threaded peg holes, and said second set of projections are fixed-angle pegs threaded into said second set of threaded peg holes.

32. A fracture fixation system according to claim 29, wherein:

said plate includes a proximal elongate body portion and a distal head portion at one end of the body portion, and said first and second sets of projections are provided at said head portion.

33. A fracture fixation system according to claim 32, wherein:

said head portion is angled relative to the body portion.

34. A fracture fixation system according to claim 32, wherein:

said head portion includes a distal buttress portion having an upper surface and a lower surface, said upper surface being substantially parallel to said body portion, and said second set of projections extending from said lower surface.

35. A fracture fixation system according to claim 34, wherein:

said second set of projections are substantially perpendicular to said body portion.

36. A fracture fixation system according to claim 29, wherein:

at least two of said projections of said first set of projections are oblique relative to each other.

37. A fracture fixation system according to claim 36, wherein:

at least two of said projections of said first set of projections are oblique in two dimensions relative to each other.

38. A fracture fixation system according to claim 37, wherein:

each of said projections of said first set of projections is oblique relative to the others.

39. A fracture fixation system according to claim 36, wherein

said projections of said second set of projections are parallel to each other.

40. A fracture fixation system according to claim 29, wherein:

said second set of projections extends from a location distal relative from a location from which said first set of projections extends.

41. A fracture fixation system according to claim 40, wherein:

said first set of projections projects distally of said second set of projections.

42. A fracture fixation system according to claim 29, wherein:

said plate is a substantially T-shaped plate sized for fixation of volar wrist fractures.

43. A fracture fixation system, comprising:

a) a substantially rigid plate having a proximal elongate body portion and a distal head portion angled upward relative to said body portion;

b) a first set of at least three substantially linearly arranged elongate projections coupled to said head portion; and

c) a second set of at least two substantially linearly arranged elongate projections coupled to said head portion, said second set of projections extending from a location distal from which said first set of projections extends.

44. A fracture fixation system according to claim 43, wherein  
said plate includes a first set of threaded peg holes, and said first set of projections are fixed-angle pegs threaded into said first set of threaded peg holes.
45. A fracture fixation system according to claim 43, wherein  
said plate includes a second set of threaded peg holes, and said second set of projections are fixed-angle pegs threaded into said second set of threaded peg holes.
46. A fracture fixation system according to claim 43, wherein:  
axes through said first set of projections project distally of axes through said second set of projections.
47. A fracture fixation system according to claim 43, wherein:  
said first and second sets of projections are coupled to said plate by at least one of a threaded coupling thereto and a unitary construction with said plate.
48. A fracture fixation system, comprising:
- a) a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of said body portion;
  - b) a first set of at least three substantially linearly arranged elongate projections coupled to said head portion; and
  - c) a second set of at least two substantially linearly arranged elongate projections coupled to said head portion, said second set of projections extending from a location distal from which said first set of projections extends,
- wherein said first and second sets of projections are laterally overlapping.

49. A fracture fixation system, comprising:

- a) a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of the body portion;
- b) a first set of elongate projections extending from said head portion, said first set of projections defining axes which are oblique relative to each other; and
- c) a second set of elongate projections extending from said head portion, said first set of projections defining axes which are substantially parallel.

50. A fracture fixation system according to claim 49, wherein:

said first set includes at least three projections and said second set includes at least two projections.

51. A fracture fixation system according to claim 49, wherein:

said second set of projections extends from a location distal from which said first set of projections extends.

52. A fracture fixation system according to claim 49, wherein:

at least one said first and second set of projections is defined by pegs threadably fixed to said plate.

53. A fracture fixation system, comprising:

- a) a substantially rigid plate having a proximal elongate body portion and a distal head portion at one end of the body portion, said plate sized and shaped for placement on a volar side of a distal radius bone;
- b) a first means for supporting a central and/or dorsal aspects of subchondral bone of the distal radius bone; and
- c) a second means for supporting a volar aspect of subchondral bone of the distal radius bone.



54. A fracture fixation system according to claim 53, wherein:

said first and second means extend from said plate, and said second means extends from a location relatively distal a location from which said first means extends.

55. A fracture fixation system according to claim 53, wherein:

each of first and second means comprises a plurality of elongate projections extending from said plate.

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