A tool comprises a first body shaped to detachably receive a bone implant having a first portion with a first flat surface adapted to be attached to a bone and a second portion with a second flat surface oriented at a pre-determined angle relative to the first flat surface, the bone implant having at least one fastener hole penetrating each of the first and second portions. A second body has a surface or member. The second body is adjustably connected to the first body to selectably position the surface or member relative to the bone implant.
Fig. 13

1304
POSITION IMPLANT ON CALCANEOUS
1306
INSERT POSTERIOR SCREWS
1308
CUT BONE
1312
ATTACH INSERTER
1314
PLACE TEMP FIXATION PIN

1316
ROTATE SHAFT TILL DESIRED OFFSET
1318
DRILL GUIDE/DRILL OPEN HOLE
1320
REMOVE DRILL GUIDE AND PLACE SCREW
1322
DRILL THROUGH DRILL-THROUGH THUMB SCREW
1324
REMOVE INSERTER
1326
PLACE FINAL SCREW
Fig. 14

1404
POSITION IMPLANT ON CALCANEUS
1406
POSITION IMPLANT, MARK LINE ACROSS BONE
1408
CUT BONE
1412
ATTACH INERTER
1414
PLACE TEMP FIXATION PIN
1416
ROTATE SHAFT TILL DESIRED OFFSET

1418
DRILL GUIDE/DRILL OPEN HOLE
1420
REMOVE DRILL GUIDE AND PLACE SCREW
1422
DRILL THROUGH DRILL-THROUGH THUMB SCREW
1424
REMOVE INERTER
1426
PLACE FINAL SCREW
IMPLANT FOR OSTEOTOMY, TOOL FOR INSERTING THE IMPLANT, AND METHOD OF INSERTING THE IMPLANT USING THE TOOL

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/695,149, filed Aug. 30, 2012, the entirety of which is incorporated by reference herein.

FIELD

[0002] This disclosure relates to an implant for an osteotomy, and tools for inserting an implant.

BACKGROUND

[0003] A calcaneal osteotomy is a form of surgery for correction of severe hind foot misalignment. During the procedure, the heel bone is cut and the tuberosity is moved medially toward the inside or laterally towards the outside, depending on the direction of the misalignment to be corrected. For example, if the patient has flat feet, the heel may be offset medially to shift the hind foot toward the inside to improve the weight distribution on the foot. On the other hand, if the patient has a high arched foot the calcaneal osteotomy may be performed to shift the hind foot laterally, to improve stability and reduce risk of sprain.

[0004] This procedure has often been performed by driving screws through the tuberosity into the anterior calcaneus. Some of the primary challenges associated with this approach are determining the amount of intra-operative offset that is achieved, the ability for fluoroscopy for targeting and placing the screws, and screw head prominence.

[0005] Implants have been developed for insertion during calcaneal osteotomy. For example, the assignee of this patent application, Wright Medical Technologies, has developed the DARCO® DPS plate, which provides support. This plate includes an anterior plate, a posterior plate, and an offset segment connecting the anterior and posterior plates. The DARCO® DPS plate is available with different amounts of offset between the anterior and posterior plates.

SUMMARY

[0006] In some embodiments, a tool comprises a first body shaped to detachably receive a bone implant having a first portion with a first flat surface adapted to be attached to a bone and a second portion with a second flat surface oriented at a pre-determined angle relative to the first flat surface, the bone implant having at least one fastener hole penetrating each of the first and second portions. A second body has a surface and member, and is adjustable connected to the first body to selectively position the surface or member relative to the bone implant.

[0007] In some embodiments, an apparatus comprises a bone implant having a first portion with a first flat surface adapted to be attached to a bone and a second portion with a second flat surface oriented at a pre-determined angle relative to the first flat surface. The bone implant has at least one fastener hole penetrating each of the first and second portions. A cut guide is attachable to the bone implant using at least one of the fastener holes. The cut guide has a guide surface that is coplanar with the second flat surface when the cut guide is attached to the bone implant.

[0008] In some other embodiments, a method is provided that comprises: (a) fastening a bone implant to a bone, such that a first surface of the bone implant contacts a first portion of the bone; (b) connecting a tool to the bone implant, the tool having a movable contact member configured to engage a second portion of the bone which has been severed from the first portion of the bone; (c) adjusting the movable contact member until the second portion of the bone has a predetermined offset relative to the first surface of the bone implant; and (d) drilling a hole in the second portion of the bone for fastening the bone implant thereto, the drilling being performed using a drill guide in the tool.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is an isometric view of a tool for inserting a calcaneal implant.

[0010] FIG. 2 is an exploded view of the tool of FIG. 1.

[0011] FIG. 3 is a bottom isometric view of the tool of FIG. 1.

[0012] FIG. 4 is an isometric view of the tool of FIG. 1, with implant attached.

[0013] FIGS. 5 and 6 show adjustment of the offset in the tool of FIG. 1.

[0014] FIG. 7 shows the tool of FIG. 1 after screw insertion, prior to removal of the tool.

[0015] FIGS. 8A and 8B are rear and front isometric views of a cut guide.

[0016] FIG. 8C is an exploded view of the cut guide illustrated in FIGS. 8A and 8B.

[0017] FIG. 9 is a front isometric view of the cut guide, with implant attached, in position on the bone.

[0018] FIG. 10 shows the implant of FIG. 7, after removal of the insertion tool.

[0019] FIG. 11 is a side cross-sectional view showing a detail of the tool of FIG. 7, before removal of the tool.

[0020] FIG. 12 is a flow chart of a method for performing a calcaneal osteotomy, using the cut guide and insertion tool.

[0021] FIG. 13 is a flow chart of a method for performing a calcaneal osteotomy, using the insertion tool.

[0022] FIG. 14 is a flow chart of a method for performing a calcaneal osteotomy, using the insertion tool.

DETAILED DESCRIPTION

[0023] This description of the exemplary embodiments is intended to be read in connection with the accompanying drawings, which are to be considered part of the entire written description. In the description, relative terms such as “lower,” “upper,” “horizontal,” “vertical,” “above,” “below,” “up,” “down,” “top” and “bottom” as well as derivative thereof (e.g., “horizontally,” “downwardly,” “upwardly,” etc.) should be construed to refer to the orientation as then described or as shown in the drawing under discussion. These relative terms are for convenience of description and do not require that the apparatus be constructed or operated in a particular orientation. Terms concerning attachments, coupling and the like, such as “connected” and “interconnected,” refer to a relationship wherein structures are secured or attached to one another either directly or indirectly through intervening structures, as well as both movable or rigid attachments or relationships, unless expressly described otherwise.

[0024] This disclosure provides an implant 150 (FIG. 10), an insertion tool 100 (FIGS. 1-7) for positioning the implant 150 and drilling aligned holes, and optionally, a cut guide 200.
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(FIGS. 8-9) for making an aligned cut through the bone 170 during a calcaneal osteotomy. The implant 150 is suitable for shifting the tuberosity 171 of the calcaneus 170, either medially or laterally, relative to the anterior calcaneus 172, and provides rigid fixation during the bone healing process.

In some embodiments, the implant 150 has a “door stop” or “L” bracket configuration, as best seen in FIG. 10. The implant has a bottom surface 151 adapted to engage the lateral or medial surface of the tuberosity 171. The implant also has an anterior surface 152 (FIG. 6) which abuts the cut surface of the anterior calcaneus, as shown in FIG. 10. In some embodiments, the anterior surface 152 is normal to the bottom surface 151. As shown in FIG. 10, the anterior holes 153 in the implant 150 are oriented at an angle $\theta_1$ with respect to the posterior holes. The angle $\theta_1$ can be in a range from 30 to 60 degrees. In some embodiments, the angle $\theta_1$ is about 45 degrees. In some embodiments, the posterior holes in the implant are angled about 10 (e.g., from 7 to 13) degrees away from the cut made in the calcaneus. This, when used with a drill guide, forces screw placement posteriorly to optimize bony purchase.

The anterior hole 153 is oriented at an obtuse angle $\theta_2$, relative to the bottom surface 151, for receiving a fasterener 162. In some embodiments, the implant 150 is a plate having four holes 153; the posterior holes accept two (2) screws 161 inserted into the tuberosity 171, and the anterior holes accept two screws 162 placed into the cut surface 173 of the anterior calcaneus 172. Other embodiments (not shown) include one hole 153 for receiving one screw 161 inserted into the tuberosity and one hole for receiving one screw 162 inserted into the anterior calcaneus.

The plate 150 is positioned below the distal (anterior) portion 172 of the calcaneus 170 and therefore is not felt by the patient. Seating the implant 150 below the surface of the anterior calcaneus 172 also allows the surgeon to tamp down the edge or shelf created by the osteotomy, and smooth the transition. The configuration of the implant 150 does not dictate a specific offset amount between the tuberosity and the anterior calcaneus. One size of implant 150 as described herein can be used to provide a variety of offsets. Although the configuration of the implant 150 does not dictate the offset increments, in some embodiments, the inserter instrument sized to install the implant 150 may provide for discrete offset increments (e.g., 1 mm increments). In other embodiments, the inserter tool permits continuous control of the offset throughout a range (e.g., 6 mm to 12 mm).

(FIGS. 1-7) show an embodiment of an insertion tool 100, which can be used during the calcaneal osteotomy. The insertion tool 100 has a first (core) body 110 shaped to detachably receive a bone implant 150. The anterior and bottom surfaces of the first (core) body 110 abut the top surface of the implant 150 during insertion. A second body (track groove body) 120 comprises a shelf 121 extending outward in a direction perpendicular to a surface of the core body 110 and parallel to a bottom surface 151 of the implant 150. The shelf 121 has a surface or member, such as the stop 122 (FIGS. 2 and 3). The surface or the stop member 122 is adapted to provide a stable point of contact with the bone 170 regardless of the exact shape of the bone. Because a bone is not perfectly flat, member 122 is configured to provide two points of fixation against the bone. This allows the tool 100 to seat stably without rocking. This also provides a self-centering capability when applying the screws 162.

The second (track groove) body 120 is adjustable connected to the core body 110 to selectively position the surface or member 122 relative to the bone implant 150. For example, as shown in FIGS. 2 and 3, the core body 110 has a track 112 on its anterior side, and the track/groove body 120 has a groove 123 on its posterior surface configured to receive and slide along the track. FIGS. 2 and 3 show one example, but a variety of track and groove configurations may be used in alternative embodiments.

As shown in FIG. 7, the shelf 121 of track/groove body 120 has a slot or hole 123, through which a temporary fixation pin 160 is optionally placed during implant insertion. The fixation pin 160 has a thread 163 for insertion into the anterior calcaneus 172. The fixation pin 160 has a flange 164, head or ridge, for engaging the top surface of the shelf 121, and fixing the track/groove body against the anterior calcaneus 172. When the thread 163 of the fixation pin 160 engages the bone, adjustment of the position of the track/groove body relative to the core body 110 causes relative movement between the tuberosity 171 and the anterior calcaneus 172. Thus, the insertion tool can be used to smoothly and precisely move the anterior calcaneus 172 relative to the tuberosity 171 during the osteotomy.

A third (drill-through thumb screw) body 130 extends through the first (core) body 110. The third body 130 is detachably connectable to the bone implant 150 for retaining the bone implant against the core body 110, as shown in FIGS. 4-6. In some embodiments, the drill-through thumb screw 130 has a drill guide 131 configured for inserting a drill bit 139 (FIG. 5) through the drill guide 131 and through a hole 153 in the bone implant 150. For example, in some embodiments, drill-through thumb screw 130 has a male thread 132 which is the same size as the anterior hole 153 of the implant 150. Thus, the drill-through thumb screw 130 simultaneously connects the insertion tool 100 to the implant 150 and provides the drill guide 131 for drilling a properly aligned hole into the cut surface 173 of the anterior calcaneus 172, into which an anterior screw 162 is to be inserted. Although FIG. 2 shows thread 132 as a straight thread, in other embodiments, thread 132 may be tapered.

The drill-through thumb screw 130 also has a ridge 133 for retaining the drill-through thumb screw 130 in the core body 110. During assembly of the tool 100, the drill-through thumb screw 130 is inserted into the core body 110, and two of the dowel pins 111 are inserted to retain the drill-through thumb screw 130. The drill-through thumb screw 130 of FIGS. 1-7 has a rounded cylindrical outer surface for easy gripping, but the configuration of the outer surface can be configured differently for convenience. For example, the outer surface can have a square or hexagonal cross-section, or other suitable grip configuration.

The tool 100 further comprises a shaft 140 rotatably connected to the first (core) body 110. The shaft 110 has a male threaded portion 141 (FIGS. 5 and 6). The second (track/groove) body 120 has a female threaded opening for receiving the threaded portion 141 of the shaft 140, such that rotation of the shaft 140 advances the second (track/groove) body 120 relative to the bone implant 150, as shown in FIG. 5, or retracts the track/groove body 120 relative to the bone implant 150, as shown in FIG. 6. This permits the surgeon to vary the offset between the member 122 and the bottom surface 151 of the implant 150, in a range from D1 (FIG. 5) to D2 (FIG. 6).

During insertion, the stop 122 of track/groove body 120 abuts the cortex of the anterior calcaneus 172; and the bottom
surface 151 of the implant 150 abuts the tuberosity 171 of the calcaneus. Thus, the offset distance between the tuberosity 171 and the anterior calcaneus 172 is directly controlled by rotating the shaft 140. This offset distance is equal to the vertical component of the distance between the member 122 of the groove/track body 120 and the bottom surface 151 of the implant 150. In some embodiments, the range of offsets is from D1−6 mm to D2−12 mm. The surgeon selects the appropriate offset for the individual patient, and rotates the shaft 140 to achieve the selected offset. In some embodiments, the shaft 140 has an enlarged portion 142 positioned adjacent the threaded portion 141, so as to limit a range of travel of the groove/track body 120 relative to the bone implant 150. For example, in some embodiments the stop 142 limits the maximum offset to 12 mm. This can prevent the surgeon from inadvertently offsetting the anterior calcaneus 172 beyond 12 mm relative to the tuberosity at any time during the osteotomy. In other embodiments (not shown), the track/ groove body 120 is advanced using a ratchet, detents or other mechanism.

In some embodiments, the shaft 140 has an end distal from the core body 110, with a connector 144 for connecting the shaft 140 to a tool handle (not shown). For example, the connector 144 may be an “AO QUICK CONNECT” connector. In some embodiments, the shaft 140 has a prescribed thread 141 to facilitate selection of a desired offset by the surgeon. For example, in some embodiments, the thread 141 provides one mm advance/retraction of the groove/track body 120 per full turn of the shaft. The handle facilitates turning of the shaft 140, and clear identification of when the shaft 140 has turned through a complete 360 degree rotation. In other embodiments, the shaft 140 has a groove 145. During assembly of the tool 100, the shaft 140 is inserted through the threaded hole in the groove/track body 120 and into the core body 110. One of the pins 111 is then inserted into the core body 110 to retain the shaft in place.

FIG. 11 is a side cross sectional view showing the tool 100 and implant 150 in place prior to removal of the tool 100. The implant has a bottom surface 151 abutting a lateral or medial surface of the tuberosity 171 and an anterior surface 152 abutting the cut surface of the anterior calcaneus 172. The anterior surface 152 is normal to the bottom surface 151, and is oriented at the same angle as the cut face 173 of the anterior calcaneus 172, which it abuts. The thread 132 of the drill-through thumb screw 130 fits into the anterior hole 153 of the implant 150, and is oriented at an angle of 45 degrees relative to the vertical surface. In this position, the drill-through thumb screw 130 provides the drill guide 131 for drilling one of the holes into the bone, into which one of the anterior screws 162 is inserted. In some embodiments, the core body 110, groove/track body 120, drill-through thumb screw 130 and shaft are all made of grade 530 stainless steel, and the dowel pins 111 are made of grade 818 stainless steel. Other suitably hard and strong alloys can be used.

FIGS. 8A, 8B, 8C and 9 show a cut guide 200, which can optionally be used to cut the bone 170 in alignment with the implant 150. The cut guide 200 is detachably connectable to the anterior hole 153 in the bone implant 150. The cut guide 200 has a planar saw guide surface 201 defining a cutting plane through the bone 170, when the bone implant 150 is fastened to the bone and the cut guide. The cut guide 200 comprises the planar saw guide surface 201, a mounting member 202, a set screw 204 and optionally, a handle 205. The cut guide 200 may be formed from a single piece of material, or a plurality of components. A “C” clip 207 (FIG. 8B) holds the set screw 204 in mounting member 202 so that the screw is retained in the cut guide 200. The set screw 204 is used to attach the cut guide 200 to the implant plate 150. The combination of the cut guide 200 and implant plate 150 can be used to guide the cutting for the calcaneal osteotomy. The cut guide 200 is adapted for use during installation of a bone implant 150 of a type described above, having a first (posterior) portion with a first flat surface 151 adapted to be attached to a bone 172 and a second (anterior) portion with a second flat surface 152 oriented at a pre-determined angle (e.g., 90 degrees) relative to the first flat surface 151.

The planar saw guide surface 201 of the cut guide 200 is coplanar with, or parallel to the plane containing the front surface 152 of the implant 150, when the cut guide 200 is attached to the implant. In some embodiments, the planar saw guide surface 201 of the cut guide 200 has a built in 0.127 to 0.381 mm offset from the front surface 152 of the implant 150 (when the cut guide is attached to the implant 150). The cut guide 200 is configured to form a cut from about 0.127 to 0.381 mm anterior of the front surface 152 of the implant 150, so that the anterior surface 152 of the installed implant 150 is about 0.127 to 0.381 mm away from the cut surface of the tuberosity. Subsequently, when the implant plate 150 is fastened to the anterior calcaneus 172 and the fasteners 162 are tightened, there is a 0.127 to 0.381 mm compression of the calcaneus against the tuberosity. In other embodiments, the planar saw guide surface 201 is coplanar with the second flat surface 152 of the bone implant 150, when the cut guide 200 is attached to the implant. The bone implant 150 has at least one fastener hole 153 penetrating each of the first and second portions. In some embodiments the implant has one anterior hole 153 and one posterior hole. In other embodiments, the implant 150 has two anterior holes 153 and two posterior holes. The cut guide 200 is attachable to the bone implant 150 using at least one of the same fastener holes 153 through which the anterior screws 162 (which fasten the implant 150 to the cut surface 173 of the anterior calcaneus 172).

The cut guide 200 has a mounting member 202 with a mounting hole for attaching the cut guide to the bone implant 150. The mounting hole receives the screw 204. The mounting hole is oriented at a predetermined angle relative to the guide surface, matching the orientation of the anterior hole(s) 153 of the implant 150. The predetermined angle relative to the second flat surface can be from about 30 degrees to about 60 degrees. In one embodiment, the predetermined angle is 45 degrees, matching the orientation of the anterior holes 153 in the implant 150. The cut guide 200 has a handle 205 comprising a shaft with a distal end fixed to cut guide 200 by dowel 203. In some embodiments, the distal end has a connector 206 for connecting the shaft to a tool handle (not shown). In other embodiments, the handle shaft contains a AO quick connection so an additional handle can be placed onto the shaft if desired.

FIG. 12 is a flow chart of a method of installing a bone implant. At step 1202, a cut guide 200 is attached to the bone implant 150. The cut guide 200 has a guide surface 201 that is coplanar with or parallel to the plane containing the second surface 152 of the implant 150 when the cut guide is attached to the bone implant. The step of attaching the cut guide 200 includes inserting a fastener 204 through a first hole in the cut guide 200 and a second (anterior) hole 153 in a second portion of the bone implant 150. The second portion of the bone implant has a second surface 152 thereon, with a
second (anterior) hole 153, where the anterior screw 162 is to be inserted through the second (anterior) hole.

[0041] At step 1204, the implant 150 with attached cut guide 200 is positioned on the calcaneus 170. At step 1206, the bone implant 150 is fastened to the bone 170, such that a first surface 151 of the bone implant 150 contacts a first portion 171 of the bone 170. In some embodiments, the implant 150 has two posterior holes, and this fastening step includes inserting two posterior screws 161 through the posterior hole(s) 153 in the implant and into the first portion 171 of the bone 170. In other embodiments, the implant has one posterior hole, and this step inserts one screw into that posterior hole. At step 1208, the bone is cut along a plane containing the guide surface 201 of the cut guide 200. At step 1210, the screw 204 is removed and the cut guide 200 is removed from the implant 150. The implant 150 remains attached to the tiberosity.

[0042] At step 1212, an insertion tool 100 is connected to the bone implant 150. The tool 100 has a track/groove body 120 with a movable contact member 122 configured to engage a second portion 172 of the bone 170 which has been severed from the first portion 171 of the bone. In some embodiments, the connection between the tool 100 and the implant 150 is made by inserting the threaded male end 132 of the drill-through thumb screw 130 into female threads of one of the anterior holes 153 of the implant 150. At step 1214, a (temporary) insertion pin 160 is optionally inserted through an opening 123 in the shelf 121 of the track/groove body 120 having the movable contact member 122, so that the threaded end 163 of the pin engages the bone 170 through the opening 123. In some embodiments, the pin 160 has a flange 164, and the pin 160 is inserted until the flange abuts the shelf 121.

[0043] At step 1216, the shaft 140 of the insertion tool is rotated, so as to adjust the movable contact member 122 until the second portion 172 of the bone 170 has a predetermined offset relative to the first surface 151 of the bone implant 150. In some embodiments, a shaft 140 having a fixed displacement relative to the bone implant 150 is rotated. The groove/track body 120 having the movable contact member 122 includes a female thread engaging the male thread 141 of the shaft 140. Rotating the shaft 140 adjusts the displacement of the movable contact member 122 relative to the bone implant 150. With the fixation pin 160 screwed into the bone, the rotation of shaft 140 and advancement/retraction of the track/groove body 120 changes the offset of the anterior calcaneus 172 relative to the tiberosity 171. At step 1218, in embodiments having two anterior holes 153, a drill guide (not shown) which is not engaged by the tool from the tool 100 is inserted in the open hole 153 of the implant 150 not covered by the tool 100. A hole is drilled in the second portion 172 of the bone 170 for fastening the bone implant 150 thereto. At step 1220, the drill guide is removed from the open hole and one of the anterior screws 162 is inserted through the anterior hole 153 and into the anterior calcaneus 172. In some embodiments, if compression is desired, non-locking screws are used. In other embodiments, locking screws are used. Also, in embodiments where the implant has only a single anterior hole 153 and a single posterior hole 153, steps 1218 and 1220 are skipped. At step 1222, the remaining anterior hole is drilled into the anterior calcaneus, through the drill guide 131 of the drill-through thumb screw 130. In some embodiments, instead of performing step 1222 while the tool 100 is attached, the tool 100 is removed, and steps 1218 and 1220 are repeated to form the remaining anterior screw hole.

[0044] At step 1224, drill-through thumb screw 130 containing the drill guide 131 is rotated, until threads 132 of the threaded body 130 disengage from the threads of the second (anterior) portion of the bone implant 150. The insertion tool 100 is removed. At step 1226, the final anterior fastener (e.g., a screw) 162 is inserted through the anterior hole 153 and into the anterior calcaneus 172. The screw 162 is inserted into the drilled hole in the second portion of the bone, so that the bone implant is fastened in a corner between a perimeter of the first portion of the bone and a cut face of the second portion of the bone.

[0045] FIG. 13 is a flow chart of a variation of the method, which is performed free-hand, without the cut guide 200. At step 1304, the implant 150 (without cut guide 200) is positioned on the calcaneus 170. At step 1306, the bone implant 150 is fastened to the bone 170, such that a first surface 151 of the bone implant 150 contacts a first portion 171 of the bone 170. In some embodiments, the implant 150 has two posterior holes, and this fastening step includes inserting two posterior screws 161 through the posterior hole(s) 153 in the implant and into the first portion 171 of the bone 170. In other embodiments, the implant has one posterior hole, and this step inserts one screw into that posterior hole. At step 1308, the bone is cut along the implant that was positioned in step 1306. At step 1312, an insertion tool 100 is connected to the bone implant 150. In some embodiments, the connection between the tool 100 and the implant 150 is made by inserting the threaded male end 132 of the drill-through thumb screw 130 into female threads of one of the anterior holes 153 of the implant 150. At step 1314, a (temporary) insertion pin 160 is optionally inserted through an opening 123 in the shelf 121 of the track/groove body 120 having the movable contact member 122, so that the threaded end 163 of the pin engages the bone 170 through the opening 123. In some embodiments, the pin 160 has a flange 164, and the pin 160 is inserted until the flange abuts the shelf 121.

[0046] At step 1316, the shaft 140 of the insertion tool is rotated, so as to adjust the movable contact member 122, so that the threaded end 163 of the pin engages the bone 170 through the opening 123. In some embodiments, the pin 160 has a flange 164, and the pin 160 is inserted until the flange abuts the shelf 121. At step 1318, the shaft 140 of the insertion tool is rotated, so as to adjust the movable contact member 122 until the second portion 172 of the bone 170 has a predetermined offset relative to the first surface 151 of the bone implant 150. At step 1318, in embodiments having two anterior holes 153, a drill guide (not shown) which is not engaged by the tool from the tool 100 is inserted in the open hole 153 of the implant 150 not covered by the tool 100. A hole is drilled in the second portion 172 of the bone 170 for fastening the bone implant 150 thereto. At step 1320, the drill guide is removed from the open hole and one of the anterior screws 162 is inserted through the anterior hole 153 and into the anterior calcaneus 172. In some embodiments, if compression is desired, non-locking screws are used. In other embodiments, locking screws are used. Also, in embodiments where the implant has only a single anterior hole 153 and a single posterior hole 153, steps 1318 and 1320 are skipped.

[0047] At step 1322, an anterior hole 153 is drilled into the anterior calcaneus, through the drill guide 131 of the drill-through thumb screw 130. At step 1324, drill-through thumb screw 130 containing the drill guide 131 is rotated, until threads 132 of the threaded body 130 disengage from the threads of the second (anterior) portion of the bone implant 150. The insertion tool 100 is removed. At step 1326, the final anterior screw 162 is inserted through the anterior hole 153 and into the anterior calcaneus 172.

[0048] FIG. 14 is a flow chart of another variation of the method, which is performed free-hand, without the cut guide
At step 1404, the implant 150 (without cut guide 200) is positioned on the calcaneus 170.

At step 1406, the implant 150 is positioned, such that a first surface 151 of the bone implant 150 contacts a first portion 171 of the bone 170, and the implant is used to make a line across the bone using a skin marker. At step 1408, the bone is cut, following the line made at step 1406. At step 1412, an insertion tool 100 is connected to the bone implant 150. In some embodiments, the connection between the tool 100 and the implant 150 is made by inserting the threaded male end 132 of the drill-through thumb screw 130 into female threads of one of the anterior holes 153 of the implant 150. At step 1414, a (temporary) insertion pin 160 is optionally inserted through an opening 123 in the shelf 121 of the track/groove body 120 having the movable contact member 122, so that the threaded end 163 of the pin engages the bone 170 through the opening 123. In some embodiments, the pin 160 has a flange 164, and the pin 160 is inserted until the flange abuts the shelf 121. At step 1416, the shaft 140 of the insertion tool is rotated, so as to adjust the movable contact member 122 until the second portion 172 of the bone 170 has a predetermined offset relative to the first surface 151 of the bone implant 150. At step 1418, in embodiments having two anterior holes 153, a drill guide (not shown) which is not engaged by the tool 100 is inserted in the open hole 153 of the implant 150 not covered by the tool 100. A hole is drilled in the second portion 172 of the bone 170 for fastening the bone implant 150 thereto. At step 1420, the drill guide is removed from the open hole and one of the anterior screws 162 is inserted through the anterior hole 153 and into the anterior calcaneus 172. Steps 1418 and 1420 are then repeated for placement of the open posterior screw 161 after the anterior screw 162 is placed into the anterior calcaneus 172, as indicated by the dashed arrow in FIG. 14.

In embodiments where the implant has only a single anterior hole 153 and a single posterior hole 153, steps 1418 and 1420 are skipped. At step 1422, an anterior hole 153 is drilled into the anterior calcaneus, through the drill guide 131 of the drill-through thumb screw 130. At step 1424, drill-through thumb screw 130 containing the drill guide 131 is rotated, until threads 132 of the threaded body 130 disengage from the threads of the second (anterior) portion of the bone implant 150. The insertion tool 100 is removed. At step 1426, the final anterior screws 162 are inserted through the anterior hole 153 and into the anterior calcaneus 172, the drill guide is used to drill and the final posterior screw is placed.

The insertion tool 100 can be used in other ways. For example, the surgeon can preset the position of the groove/track body 200 to provide a desired offset between the anterior calcaneus 172 and the tuberosity 171. Then the surgeon can move the bone portions 171, 172 into position on the tool 100. When the bone portions 171, 172 abut the tool, they have been moved into the desired spatial relationship.

Although a particular example is described above in which the implant is used for a calcaneal osteotomy, one of ordinary skill in the art can readily apply the teachings herein to implants and insertion tools for osteotomies related to other bones besides the calcaneus.

Although the subject matter has been described in terms of exemplary embodiments, it is not limited thereto. Rather, the appended claims should be construed broadly, to include other variants and embodiments, which may be made by those skilled in the art.

What is claimed is:

1. A tool, comprising:
a first body shaped to detachably receive a bone implant having a first portion with a first flat surface adapted to be attached to a bone and a second portion with a second flat surface oriented at a predetermined angle relative to the first flat surface, the bone implant having at least one fastener hole penetrating each of the first and second portions; and
a second body having a surface or member, the second body adjustably connected to the first body to selectively position the surface or member relative to the bone implant.

2. The tool of claim 1, further comprising:
a third body extending through the first body, the third body detachably connectable to the bone implant for retaining the bone implant against the first body.

3. The tool of claim 2, wherein:
the third body has a drill guide configured for inserting a drill bit through the drill guide and through a hole in the bone implant.

4. The tool of claim 3, wherein:
the bone implant has a bottom surface for abutting a bone, and the hole is oriented at an obtuse angle relative to the bottom surface for receiving a fastener.

5. The tool of claim 3, wherein:
the tool further comprises a cut guide detachably connectable to the bone implant, the cut guide having a planar surface defining a cutting plane through a bone, when the bone implant is fastened to the bone and the cut guide; and
the third body has a threaded end for engaging the hole in the bone implant when the bone implant is not fastened to the cut guide.

6. The tool of claim 5, wherein the cut guide has a handle with a distal end, the distal end having a connector for connecting the shaft to a tool handle.

7. The tool of claim 1, further comprising a shaft rotatably connected to the first body, the shaft having a threaded portion, the second body having a threaded opening for receiving the threaded portion of the shaft, such that rotation of the shaft advances or retracts the second body relative to the bone implant.

8. The tool of claim 7, wherein the shaft has an enlarged portion positioned adjacent the threaded portion, so as to limit a range of travel of the second body relative to the bone implant.

9. The tool of claim 7, wherein the shaft has an end distal from the first body, with a connector for connecting the shaft to a tool handle.

10. The tool of claim 1, wherein the member of the second body comprises a shelf extending outward in a direction perpendicular to a surface of the first body and parallel to a bottom surface of the implant, the shelf having a ridge on a bottom surface thereof.

11. The tool of claim 1, further comprising:
a third body extending through the first body, the third body detachably connectable to the bone implant for retaining the bone implant against the first body, the third body having a drill guide configured for inserting a drill bit through the drill guide and through a hole in the bone implant, the bone implant having a bottom surface for abutting a bone, wherein the hole is oriented at an obtuse angle relative to the bottom surface for receiving a fas-
tener, the third body having a threaded end for engaging the hole in the bone implant; and a shaft rotatably connected to the first body, the shaft having a threaded portion, the second body having a threaded opening for receiving the threaded portion of the shaft, such that rotation of the shaft advances or retracts the second body relative to the bone implant, wherein the shaft has an enlarged port that is adjacent the threaded portion, so as to limit a range of travel of the second body relative to the bone implant.

12. Apparatus comprising:
a bone implant having a first portion with a first flat surface adapted to be attached to a bone and a second portion with a second flat surface oriented at a pre-determined angle relative to the first flat surface, the bone implant having at least one fastener hole penetrating each of the first and second portions; and a cut guide attachable to the bone implant using at least one of the fastener holes, the cut guide having a guide surface that is coplanar with the second flat surface when the cut guide is attached to the bone implant.

13. The apparatus of claim 12, wherein the fastener hole of the second portion of the bone implant is oriented at a predetermined angle relative to the second flat surface of about 30 degrees to about 60 degrees, and the cut guide has a mounting member with a mounting hole for attaching the cut guide to the bone implant, the mounting hole being oriented at the predetermined angle relative to the guide surface.

14. A method, comprising:
(a) fastening a bone implant to a bone, such that a first surface of the bone implant contacts a first portion of the bone;
(b) connecting a tool to the bone implant, the tool having a movable contact member configured to engage a second portion of the bone which has been severed from the first portion of the bone;
(c) adjusting the movable contact member until the second portion of the bone has a predetermined offset relative to the first surface of the bone implant; and
(d) drilling a hole in the second portion of the bone for fastening the bone implant thereto, the drilling being performed using a drill guide in the tool.

15. The method of claim 14, wherein step (b) includes rotating a threaded body containing the drill guide, until threads of the threaded body engage threads of the second portion of the bone implant.

16. The method of claim 14, further comprising attaching the movable contact member to the second portion of the bone temporarily with a fastener.

17. The method of claim 14, wherein step (c) includes rotating a shaft having a fixed displacement relative to the bone implant, the movable contact member having a female thread engaging a male thread of the shaft, whereby rotating the shaft adjusts displacement of the movable contact member relative to the bone implant.

18. The method of claim 14, wherein the bone implant has a second surface oriented at a predetermined angle relative to the first surface, the method further comprising, before step (b):
attaching a cut guide to the bone implant, the cut guide having a guide surface that is coplanar with the second surface when the cut guide is attached to the bone implant; and
cutting the bone along a plane containing the guide surface.

19. The method of claim 18, wherein the step of attaching the cut guide includes inserting a fastener through a first hole in the cut guide and a second hole in a second portion of the bone implant, the second portion of the bone implant having the second surface thereon, wherein the hole-drilled in step (d) is drilled through the second hole.

20. The method of claim 14, further comprising:
removing a portion of the tool having the drill guide therein from an opening in the tool; and
inserting a fastener through a hole in the bone implant, into the drilled hole in the second portion of the bone, so that the bone implant is fastened in a corner between a perimeter of the first portion of the bone and a cut face of the second portion of the bone.

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