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BONE FIXATION DEVICE

Abstract

There is disclosed a bone fixation device that can include a cage having an optional mesh portion. The bone fixation device can be configured to couple a leg portion to a foot portion of a user's body. In at least one embodiment, the device includes at least one cage having a plurality of struts forming cells. There can be an optional mesh portion having a pre-set porosity that can be either constant or variable in density. In at least one embodiment there can be a cage portion which is substantially spherical shaped. Alternatively, the device can be substantially egg shaped. In at least one embodiment there can be a central post hole for receiving a post. In another embodiment at least one plate or shaft can connect to the cage.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. patent application Ser. No. 18/474,343 filed on Sep. 26, 2023, which is a continuation of U.S. patent application Ser. No. 17/313,206 filed on May 6, 2021, and issued as U.S. Pat. No. 11,766,337 on Sep. 6, 2023, which is a continuation of U.S. patent application Ser. No. 16/268,074 filed on Feb. 5, 2019, and issued as U.S. Pat. No. 11,147,679 on Oct. 19, 2021, which claims priority from U.S. Provisional Application No. 62/626,525 filed on Feb. 5, 2018, the entire disclosures of which are hereby expressly incorporated herein by reference.

BACKGROUND OF THE INVENTION
[0002] At least one embodiment relates to a bone fixation device which can in at least one embodiment be used to fix an ankle. In at least one embodiment, the bone fixation device is configured to be placed between a tibia portion of a person's leg and their foot portion. The bone fixation device can be used to fix or secure the leg portion of the person's body to a foot portion of the person's body using a structure which is configured to promote bone growth and healing in the joint region. Thus, there is a need for a bone fixation device which is used to fix a lower portion of a person's leg to a foot portion of the person's leg to heal a person's body in an ankle region.
SUMMARY OF THE INVENTION
[0003] There is disclosed a bone fixation device that can include a cage having an optional mesh portion. The bone fixation device can be configured to couple a leg portion to a foot portion of a user's body. In at least one embodiment, the device includes at least one cage having a plurality of struts forming cells. There can be an optional mesh portion having a pre-set porosity that can be either constant or variable in density. In at least one embodiment there can be a cage portion which is substantially spherical shaped. Alternatively, the device can be substantially egg shaped. In at least one embodiment there can be a central post hole for receiving a post. In another embodiment at least one plate or shaft can connect to the cage.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0004] Other objects and features of the present invention will become apparent from the following detailed description considered in connection with the accompanying drawings which disclose at

least one embodiment of the present invention. It should be understood, however, that the drawings are designed for the purpose of illustration only and not as a definition of the limits of the invention.

[0005] In the drawings, wherein similar reference characters denote similar elements throughout the several views:

[0006] FIG. **1** is a side view of a first embodiment of a bone fixation device;

[0007] FIG. **2**A is a perspective view of the embodiment shown in FIG. **1**;

[0008] FIG. **2**B is a top view of the embodiment shown in FIG. **1**;

[0009] FIG. **3** shows a side view with this embodiment placed inside of an ankle joint;

[0010] FIG. **4** is a side perspective view of another embodiment of the device placed inside of an ankle and including a post;

[0011] FIG. **5** is a side view of another embodiment;

[0012] FIG. **6** is a top perspective view of another embodiment;

[0013] FIG. **7** is a side-top perspective view of the second embodiment;

[0014] FIG. **8** is a top-side perspective view of the second embodiment;

[0015] FIG. **9** is a another side-top perspective view of the second embodiment;

[0016] FIG. **10** is an end view of a foot with the second embodiment disposed in the ankle joint;

[0017] FIG. **11** is a plan view of a third embodiment;

[0018] FIG. **12** is a side view of the third embodiment;

[0019] FIG. **13** is a side view of the third embodiment;

[0020] FIG. **14** is a top plan view of a fourth embodiment;

[0021] FIG. **15** is a side view of either a third or fourth embodiment disposed in an ankle region;

[0022] FIG. **16** is another view of the third or fourth embodiment disposed in a person's ankle;

[0023] FIG. **17** is a view of a fifth embodiment coupled to a bone;

[0024] FIG. **18** is another view of the fifth embodiment coupled to a bone;

[0025] FIG. **19** is a side view of the fifth embodiment;

[0026] FIG. **20** is a top perspective view of the fifth embodiment

[0027] FIG. **21** is a side view of the fifth embodiment;

[0028] FIG. **22** is a side view of a sixth embodiment;

[0029] FIG. **23** is a side view of a seventh embodiment;

[0030] FIG. **24** is a side view of the seventh embodiment having fasteners;

[0031] FIG. **25** is another side view of the seventh embodiment;

[0032] FIG. **26** is a view of the seventh embodiment coupled to a bone;

[0033] FIG. **27** is a side view of an eighth embodiment;

[0034] FIG. **28** is a side view of the eighth embodiment coupled to a foot;

[0035] FIG. **29** is another side view of the eighth embodiment coupled to the foot;

[0036] FIG. **30** is a view of another embodiment of an outer shell or cage;

[0037] FIG. **31** is a view of the outer shell or cage with a mesh screen disposed inside;

[0038] FIG. **32** is a cross-sectional view of the mesh screen taken along a vertical plane

[0039] FIG. **33** is another cross-sectional view of the implant of FIG. **31** taken along another vertical plane;

[0040] FIG. **34** is a cross-sectional view of another slice of the implant; and

[0041] FIG. **35** is a top view of the implant taken along a horizontal plane.

DETAILED DESCRIPTION

[0042] Referring to the drawings, FIG. **1** shows a side view of a first embodiment of a bone fixation device **10** which includes an outer shell/cage which comprises a plurality of struts **14**. Struts **14** are configured to form a plurality of cells **16**. Each of these cells can be shaped in a substantially hexagonal manner, however any suitable shape for each cell may be used. Each of the cells then joins another adjacent cell such that there are a plurality of cells forming an overall cage or shell having a honeycomb pattern. The cage **12** can be formed in any suitable shape but in this

embodiment it is substantially spherical.
[0043] Disposed inside of the cage **12** is a mesh **18**, which can be a mesh screen. The mesh screen can extend beyond the confines of the cage to mesh with adjacent bone. For example, the mesh screen can extend out beyond the cage by a pre-set margin such as 3 mm (millimeters) or at least 1 mm in one embodiment or at least 2 mm in another embodiment, to form an interactive surface radially outside of the surface of the struts of the cage **12**. In at least one embodiment the mesh screen extends radially outside of the struts by no more than 5 mm. This radial extension is shown by way of example by arrow **18***a* extending out beyond the extension of the cage (See FIG. **2**B, See also FIG. **9**). In addition, the cage has an edge **19** which forms a rim (See FIG. **2**C as well) which opens up into a post hole or central core **25**. The bone fixation device can be formed as a two-piece device having a shell and a separate mesh screen or it can be formed as one piece and printed in a single printing process. Coupled to the cage **12** are a plurality of screw channels **20** and **22**. Each of the screw channels **20** and **22** are configured as a hollow cylinder having a hollow core such as hollow core or hole **23** (See FIG. **2**A) which is configured to receive a screw or other type of fastener.
[0044] FIG. **2**B is a top view of the embodiment shown in FIG. **1**, in this view of the bone fixation device **10** is shown having a post hole or central hollow core **25** which is configured to allow a post to fit therein. The hollow core is formed to have a hollow core within the mesh portion as well. The mesh portion can have a varying lattice structure of varying density which is suitable to allow for selected bone growth rates. In addition, the mesh or lattice or mesh **18** is configured to receive bone growth material such as a gel or other type of bone growth material to aid in the growth in bone in the lattice.
[0045] FIG. **3** shows a side view with this embodiment of the device **10** placed inside of an ankle joint. This ankle joint includes a leg portion **28** and a foot portion **29**, forming an ankle joint. This view shows cage **12** along with screw channel **22**.
[0046] FIG. **4** is a side perspective view of the embodiment of the bone fixation device **10** having a post **30** disposed therein. With this design, post **30** comprises a shaft extending through the post hole or central core **25** (See FIG. **2**B). Post **30** is configured to stabilize a tibia or leg portion of a person's leg.
[0047] FIG. **5** is a side view of another embodiment which is a bone fixation device **40** which includes a cage **42** having a plurality of struts **44**, wherein a plurality of struts, such as six struts form a six-sided cell **46** which can be hexagonal in shape. There is also a plate **47** which extends out from cage **42** via an extension section **49**. A mesh screen **48** is disposed in and around cage **42** and can be of a pre-set standard density or of a varying density as well. Thus, the density of the mesh screen can be that of a more dense structure in the middle with lower density at the exterior surfaces, a constant density throughout or a more dense structure on in the exterior surfaces with a less dense structure in the center. Alternatively, the density profile can vary from a more dense section towards a center hole (moving radially inwardly) such as center hole **55** to less dense on the outer edges (a radially outward region). Conversely the density profile can be that it is less dense on the outer edges both at the radially outward region and at the center region (adjacent to the center hole) towards a more dense profile towards a center region of the body between the radially outward region and the center hole. Alternatively, the density profile can be such that it is most dense towards the radially outward region and least dense at the center hole **55**. These same density profiles can apply with any of the embodiments disclosed herein.
[0048] FIG. **6** is a top perspective view of the second embodiment wherein this shows the device **40** having an extension section **49** extending to plate **47**. The cage **42** also has a central post hole **55** configured to receive a post inserted therein. With this design as well the mesh screen is configured to extend radially beyond the surface of a cage such as cage **42** to provide additional surface interaction with a surrounding bone.
[0049] FIG. **7** is a side-top perspective view of the device **40** showing plate **47** extending from cage

42. Plate **47** is configured to be an irregular shaped plate with a rounded exterior plate surface. In at least one embodiment this plate shape is at least substantially semi-spherical in shape.

[0050] FIG. **8** is a top-side perspective view of the device embedded inside of a leg section **28** and a foot section **29** with plate **47** extending from cage **42** and bracing against foot **29**.

[0051] FIG. **9** is another side-top perspective view of the device **40** which shows another view of the extension section **49**, with plate **47** being shown a substantially rounded in a dome like or semi-spherical shape. A screw channel **50** is also shown having a screw hole. There is shown also struts **44** of cage **42** with the struts forming cells **46**. An upper rim **51** is formed to provide for a central post hole **55** (see FIG. **6**). As shown, the mesh screen or lattice **48** extends beyond the frame or struts **44** of cage **42**.

[0052] FIG. **10** is an end view of a foot with the device **40** disposed in the ankle joint which is formed by the leg section **28** and the foot section **29**. There is also shown a screw channel **50** as well as a fastener such as a screw **51** inserted therein. While the device **40** or device **10** can be fastened to an adjacent bone using known fasteners, other types of fasteners can be inserted into a bone so that the cage **12** or **42** is secured or friction fit into the bone and then this allows the device to be adhered to a bone such as a tibia, a foot, a toe or any other end or terminating bone structure. Thus, this design allows for one of many different types of fixation such as a friction fit (FIG. **22**), a screw for fixation (FIG. **3**, **4**, or **8**), or a plate for fixation (See FIG. **27**).

[0053] FIG. **11** is a plan view of a third embodiment which shows a bone fixation device **60** having a body section **61** having a cage **62**. There is also a screw channel **64** coupled to body section **61** as well. Coupled to body section **61** is at least one elongated shaft **68**. Coupled to the elongated shaft **68** is at least one T section **69**. T section **69** extends substantially perpendicular to elongated section **68**. T-section and elongated shaft form a handle for allowing for the trial insertion of the bone fixation device **10** or **40** into the patient's leg.

[0054] FIG. **12** is a side view of device **60** which shows a body section **61** having a plurality of struts **63** forming cells **65**. A second screw channel **66** is also coupled to body section **61**. Each of these screw channels are configured to receive a fastener such as a screw such that the body section can be fastened to an adjacent structure such as a bone.

[0055] FIG. **13** shows another view of this embodiment or device **60** showing body section **61**, screw channels **64** and **66** along with elongated sections **68** and T section **69**.

[0056] FIG. **14** shows a top view of device **60** which shows body section **61**, screw channel **64**, elongated shaft **68** and T section **69**. A central post hole **67** is also shown which allows a post to be inserted therein.

[0057] FIG. **15** shows this embodiment inserted into an ankle region wherein it is disposed between a leg portion **28** and a foot portion **29**. Elongated shaft **68** is shown extending out from this ankle section to T section **69**.

[0058] FIG. **16** is another view of the third or fourth embodiment showing device **60** disposed in a person's ankle with extension section or elongated shaft **68** extending out to T section **69** which extends over a person's foot **29** and out in front of a person's leg **28**.

[0059] FIG. **17** is a view of a fifth embodiment of a bone fixation device **80** coupled to a bone such as a leg bone **28**. This embodiment includes a body section **81** which can have any shape but in at least one embodiment has a substantially cylindrical shape with a substantially spherical end cap. This body section **81** having a plurality of screw holes **82** disposed therein. There is an extending portion **85** which also includes a plurality of screw holes **86** as well. Body section is formed to fit over the end of a leg portion such as a tibia bone of a leg.

[0060] FIG. **18** is another view of the bone fixation device **80** coupled to a bone such as a tibia bone. In this embodiment, drill guide **90** is configured to guide screws or drill holes other fasteners as they are drilled into bone to fix the an implant to the bone. As shown in this view guide fixation device **80** includes drill holes **82** and **83** as well. Thus, the drill guide **90** is configured to guide a user in inserting screws into the drill holes **82** and **83** respectively.

[0061] FIG. **19** is a side view of the fifth embodiment showing bone fixation device **80** having drill guide **90** which has a plurality of drill holes **92** disposed therein. In addition, as shown in this view there is a drill hole **82** which is visible as well. For example, drill holes **92** can be configured to line up with drill holes **82** so that guide **90** forms a guide for inserting fasteners such as screws to couple fixation device **80** to a person's leg.
[0062] FIG. **20** is a top perspective view of a cut guide **94** which has a proximal end labeled “P” and a distal end labeled “D” with a plurality of drill holes **96** disposed therein. There is also a slot **95** disposed adjacent to the distal end. The cut guide provides a guide for a doctor or surgeon to cut a person's bone. This cut guide **94**, the drill guide **90** and an associated bone fixation device such as bone fixation device **80** can be assembled in a kit such as a surgical kit for performing a coupling of the bone fixation device to a person's bone.
[0063] FIG. **21** is a side view of the device **80** which shows a body section **81**, drill holes **82**, and **83** as well as an elongated section **85** having at least one drill hole **86**. The elongated section **85** extends along longitudinal axis **87** to create an elongated body of the device **80**. The device is configured to form an end cap on then end of a person's bone. This end cap can have a substantially spherical surface signifying the end structure of a bone.
[0064] FIG. **22** is a side view of the device **80** which includes two elongated sections **85** and **89** which extend substantially along longitudinal axis **87**. Each of these elongated sections has drill holes to allow the device to be secured to a user's bone. While elongated section **85** can be screwed into the bone, elongated section **89** can be inserted into a bone so that it is friction fit into the bone and then this allows the device to be adhered to a bone such as a tibia, a toe or any other end or terminating bone structure. In at least one embodiment, the elongated member inserts into a center of the bone. It can be pushed into the center of the bone canal like a hip stem. The other elongated plate **85** sits on top of the bone. Screws or other fasteners are inserted through the holes **86** through the bone and then into the matched holes on elongated section **89**. The drill guide **90** shown in FIG. **19** allows for drilling in fasteners into holes **92** so that the fasteners match the holes **86** on elongated section **85** with the holes on elongated section **89** to fasten the device to an adjacent bone. Thus, this design allows for one of many different types of fixation such as a friction fit (FIG. **22**), a screw for fixation (FIG. **3**, **4**, or **8**), or a plate for fixation (See FIG. **27**).
[0065] FIG. **23** is a side perspective view of another embodiment which includes a cage device **100** having a body section **101**. A plurality of holes **102** are formed in body section **101**. In addition, there are a plurality of elongated sections **104** and **108**, wherein each of these elongated sections has holes such as holes **106**. The body section **101** includes a plurality of struts **105** which each form cells **107**. The cells can be of any suitable shape but in this case can be hexagonal in shape. Body section **101** is substantially rounded and in this case is substantially pear shaped. A plurality of protruding sections including protruding section **110** and protruding section **112** extend out laterally from body section **101** in a substantially transverse manner. Each of these protruding sections **110** and **112** has a respective hole **111** and **113**. Each of holes **111** and **113** is configured to receive a fastener such as a screw.
[0066] FIG. **24** shows a view of the device **100** including a plurality of fasteners **115**. There is shown extending sections **104** and **108** each configured to receive fasteners such as fasteners **115**, while body section **101** has holes **102** as well as protruding fastening sections **110** and **112** configured to receive fasteners extending in a manner substantially parallel to the longitudinal extension of the body section **101**. Fastening sections **110** and **112** extend out laterally from the body section **101**.
[0067] A plurality of screw channels **114** and **116** are shown disposed in the body section **101** as well.
[0068] FIG. **25** shows another view of the embodiment **100** which shows body section **101** with a protruding fastening section **112** extending out therefrom. Elongated sections **104** and **108** are shown extending out therefrom as well. Disposed in body section **101** are holes **102** as well.

[0069] FIG. **26** shows a view of the device **100** having body section **101** coupled to a person's bone such as a tibia **119**. Elongated sections **104** and **108** are shown having fasteners **115** coupled thereto.
[0070] FIG. **27** is a side view of another embodiment **130** which shows a plate **131** having a plurality of screw holes **132**. Plate **131** extends along a substantially elongated axis **136** and bends towards a partially transverse axis **134** via a curved or flared extension **135**. The angle of bend can be between 5 degrees to 60 degrees of bend off of a longitudinal axis **136**. Coupled to the plate **131** is a cage **140**. Cage **140** has a plurality of holes **142**, a plurality of struts **144**, and a plurality of cells **146**. There is also a screw channel **147** coupled to cage **140** as well. This embodiment **130** can be a single printed piece or formed from two pieces wherein cage **140** is coupled together with plate **131** with a connection screw.
[0071] FIG. **28** shows a view of the device **130** having plate **131**, screw channel **142** receiving a fastener **143**, as well as a plurality of additional fasteners **148** for securing the bone fixation device **130** to an adjacent bone such as a tibia **28**. There is also shown cage **140** for fixing the device to both the tibia **28** and to a person's foot **29**.
[0072] FIG. **29** shows a side view of the device **130** secured to a person's body with plate **131** being secured to tibia **28** and also to a person's foot **29**. A plurality of fasteners **147** is shown as well as flared extension **135** extending out from tibia **28** and towards the user's foot **29**. Screw channel **142** is shown receiving fastener **143** as well.
[0073] FIG. **30** shows another embodiment which shows a cage **210** having struts **214**, including laterally extending struts **212** and **213**. In addition there are a plurality of screw channels **221** and **222** having openings **220** which are formed to receive fasteners or screws. These screw channels are disposed inside of the cage **210** rather than being positioned radially outside of the cage **210** as shown in FIG. **1**.
[0074] FIG. **31** shows the embodiment of the cage shown in FIG. **30** with mesh **218** disposed inside of cage **210** having struts **214**. Mesh **218** is configured to extend radially outside of struts **214** of cage **210** so that they form interaction points with an adjacent bone. Each of these struts join at different join points **215** to form patterned cells such as cells **216**.
[0075] FIG. **32** shows a cross sectional view of the cage **210** which shows mesh **218**, as well as struts **214**. This view also shows a section of a screw or fastener channel **221** having hole **220** disposed therein. Mesh **218** is shown sectioned off, while struts **214** are also shown.
[0076] FIG. **33** shows another cross sectional view of the cage **210** which shows mesh **218**, as well as struts **214**. This view also shows a section of a screw or fastener channel **222** having hole **220** disposed therein. Mesh **218** is shown sectioned off, while struts **214** are also shown.
[0077] FIG. **34** shows a side tangential cross-sectional view which shows screw openings or hole **220** formed in channels **221** and **222**. Struts **214** are also shown along with mesh screen **218** as well.
[0078] FIG. **35** shows a top cross-sectional view of the embodiment showing screen **218** along with channels **221** and **222** having screw holes **220** disposed therein. The shape of this design is substantially similar to that of the design of FIG. **1** with the exception of the channels **221** and **222** being disposed inside of the cage rather than being disposed external from the cage. In addition, from this view it is shown that at least portions **218** a of the mesh screen **218** extend radially outside of or beyond associated struts such as struts **214**.
[0079] With the above designs there results an ankle fusion cage that can be manufactured with 3D Printing technology. The device can have a variable honey comb lattice structure with selectively smaller pore size on the bone surfaces. While a variable honeycomb structure is proposed alternative embodiments can be of any suitable shape with either a pre-set pore size of a variable pore size. As shown above, the cage and the plates have various locations for screws to go through and to fasten into the bone segments. In these embodiments, the lattice always sits above the surface of the structural frame so it is in contact with the bone. The structure allows for an

intramedullary nail to go through the device. Because the device can be printed it can be customized per patient based upon an initial CT scan of the patient.
[0080] Using this type of process, a doctor can take an initial image of a region of the body such as a finger joint, an ankle, a knee or a site of a fracture. Based upon the patient's weight, whether they are a smoker, their bone density, diet, age, etc., the doctor or medical professional can create a specialized temporary trial that can be originally printed to fit the patient's needs. This printing can be customized to fit the surface morphology of the bone in the fracture site as well.
[0081] With the fastening of the device to a user, instead of a fastener going through it due to a lack of bone, an anterior plate can be secured using a connection screw to the structure.
[0082] Another option is to have a polished portion extending from the cage to slide against adjacent sections. The polished portion can be formed from the body section such as body section **81** or plate section **47**.
[0083] The cage such as any one of cage **12** and/or **42**, or **61** is of a design that incorporates a spherical interface with bone segments it comes in contact with. Thus, the top and/or the bottom of the cage will have a general spherical shape that transitions to a somewhat cylindrical body. This is due to using existing acetabular reamers that are available in most hospitals as part of total hip systems.
[0084] Accordingly, while at least one embodiment of the present invention have been shown and described, it is to be understood that many changes and modifications may be made thereunto without departing from the spirit and scope of the invention as defined in the appended claims.

Claims

1. A kit for a bone fixation device comprising: a bone fixation device comprising: a body section having a longitudinal axis and comprising an end cap portion that defines a first longitudinal end of the device and a body portion extending longitudinally from the end cap portion that comprises an internal cavity that is open at a longitudinal end of the body portion, wherein the end cap portion caps off the internal cavity at the first longitudinal end of the device; at least one fastening portion extending longitudinally from a portion of the longitudinal end of the body portion in a direction extending away from the end cap portion and defining a second longitudinal end of the device, said at least one fastening portion being longitudinally-elongated and comprising a plurality of longitudinally-spaced screw holes; and a mesh disposed within the internal cavity on internal surfaces of the body portion, wherein the body section is configured to fit over a portion of a bone such that the end cap portion forms an end structure for the bone; and at least one drill guide configured to be coupled to the bone fixation device configured to guide fasteners into at least one of the plurality of longitudinally-spaced screw holes and the bone.
2. The kit as in claim 1, further comprising a cut guide configured to facilitate cutting of the bone, wherein the cut guide comprises a proximal end, a distal end with a plurality of drill holes, and a cut slot disposed adjacent to the distal end.
3. The kit as in claim 1, wherein the body portion is substantially cylindrical.
4. The kit as in claim 1, wherein the longitudinal axis intersects the end cap portion.
5. The kit as in claim 1, wherein the longitudinal end of the body portion defines a longitudinal end of the body section.
6. The kit as in claim 1, wherein the body portion comprises a plurality of longitudinally-spaced fastening holes.
7. The kit as in claim 6, wherein the plurality of longitudinally-spaced fastening holes of the body portion comprises a plurality of substantially longitudinally-aligned first fastening holes.
8. The kit as in claim 1, wherein the end cap portion of the body section comprises a substantially spherical outer end surface.
9. The kit as in claim 1, wherein the body section is configured to fit over an end portion of a leg

bone or an end portion of a toe bone.

10. The kit as in claim 1, wherein the at least one fastening portion comprises a first fastening portion, the first fastening portion comprising a plurality of substantially longitudinally-aligned, longitudinally-spaced screw holes of the plurality of longitudinally-spaced screw holes.

11. The kit as in claim 10, wherein the body portion comprises a plurality of substantially longitudinally-aligned, longitudinally-spaced first fastening holes that are substantially longitudinally-aligned with the plurality of substantially longitudinally-aligned, longitudinally-spaced screw holes of the first fastening portion.

12. The kit as in claim 11, wherein the body portion comprises a plurality of substantially longitudinally-aligned, longitudinally-spaced second fastening holes, the first fastening holes and the second fastening holes being disposed in circumferentially-spaced portions of the body portion.

13. The kit as in claim 11, wherein the first fastening portion comprises an inner bone engagement surface configured to engage an outer surface of the bone when the body section is fit over the portion of the bone.

14. The kit as in claim 13, wherein the mesh is further disposed on the inner bone engagement surface.

15. The kit as in claim 1, wherein the at least one fastening portion comprises a first fastening portion that comprises an inner bone engagement surface configured to engage an outer surface of the bone when the body section is fit over the portion of the bone.

16. The kit as in claim 15, wherein the first fastening portion is configured as a bone plate portion.

17. The kit as in claim 15, wherein the inner bone engagement surface is substantially aligned with a portion of the inner surfaces of the body portion.

18. The kit as in claim 15, wherein the mesh is further disposed on the inner bone engagement surface.

19. The kit as in claim 15, wherein the at least one fastening portion comprises a second fastening portion that is configured to extend into an interior of the bone when the body section is fit over the portion of the bone.

20. The kit as in claim 1, wherein the at least one fastening portion comprises a first fastening portion that is configured to extend into an interior of the bone when the body section is fit over the portion of the bone, and wherein the first fastening portion comprises a plurality of the plurality of longitudinally-spaced screw holes, and the mesh is further disposed on at least a portion of the first fastening portion.