{PTL 1}

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{PTL 2}

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{Summary}

{0007}

When the bone plate is fixed to the tibia with screws, the artificial bone inserted into the dilated section needs to be reliably held without dropping. For a long time period of about one to two years after high tibial osteotomy, the patient stands upright, walks, and engages in more energetic activities in some cases with the bone plate fixed to the tibia. If the fixability of the bone plate to the tibia is hampered, there is risk of damaging tissue around the bone plate and screws, leading to a bone fracture or a decrease in the therapeutic effect. For this reason, the fixability of the bone plate to the tibia is important.

{0008}

In the bone plate system in Patent Literature 1, in order to ensure the fixability of the bone plate to the tibia while still preventing the inserted artificial bone from dropping, screw holes are threaded so as to be tilted relative to the plate thickness direction of a bone plate 1 so that screws are tightened in a direction tilted relative to the thickness

direction of the bone plate. Once the bone plate is tightened and fixed to the tibia as described above, the bone plate easily bulges towards the outer side, as shown in Fig. 7, and this bone plate that has bulged towards the outer side readily interferes with the skin, causing pain.

{0009}

Because the body section of the bone plate in Patent Literature 2 is in a flat plate shape, this bone plate has poor fixability to the tibia. In the bone plate system in Patent Literature 2, the axial directions of the screws can be changed when the bone plate is to be fixed to the epiphyseal region. However, determining, each time, an optimal insertion angle of an optimal screw by taking into account the fixability of the bone plate not only involves complicated procedures but also poses problems such as a screw, if inserted at an incorrect angle, breaking through the cancellous bone, thus leading to a crush fracture and damage to important tissue.

{0010}

The present bone plate and a bone plate system have been conceived in light of the above-described circumstances, and a bone plate and a bone plate system having an optimized structure to enhance the fixability and stability of the bone plate to the tibia may be provided.

{0010a}

Aspects of the invention are defined in the independent claims. Some optional features of the invention are defined in the dependent claims.

{0011}

One example disclosed herein is a bone plate including: a band-shaped body section that is fixed, along a longitudinal direction of a tibia, to an obliquely anterior inner side surface of the tibia at a position lower than a notch formed in an inner side surface of the tibia; a transverse section that is fixed, along a direction intersecting the longitudinal direction of the tibia, to the inner side surface of the tibia at a position higher than the notch; a joining section for joining the body section and the transverse section; and a plurality of screw holes that are arranged in the transverse section, the body section, and the joining section in a manner spaced apart from one another and that pass therethrough in a plate thickness direction, wherein the plurality of screw holes include a first screw hole provided in the joining section and a second screw hole provided in the body section, the body section, the joining section, and the transverse section have a curved surface shape that continues in such a manner as to twist about an axial line along the longitudinal direction of the tibia, a first plane on which an axial line of the first screw hole is disposed and a second plane on

which an axial line of the second screw hole is disposed are substantially parallel to each other, the angles between a straight line connecting a longitudinal-direction upper-end portion and lower-end portion in the bone plate and the first plane and the second plane are predetermined angles, and the axial line of the first screw hole and the axial line of the second screw hole are disposed at twisted positions.

{0012}

According to this aspect, the first plane having the axial line of the screw tightened into first screw hole and the second plane including the axial line of the screw tightened into the second screw hole are substantially parallel, and the axial line of the screw tightened into the first screw hole and the axial line of the screw tightened into the second screw hole are at positions twisted relative to each other.

{0013}

The screw inserted into the first screw hole provided in the joining section is inserted so as to be substantially parallel to the bone cutting surface directly above the bone cutting surface at the site of osteotomy. Also, the screw inserted into the second screw hole provided in the body section is inserted so as to be substantially parallel to the screw inserted into the first screw hole directly below the site of osteotomy.

At this time, the leading end of the screw inserted into the body section disposed directly below the site of osteotomy is tightened in a direction which is not parallel to the

straight line for specifying an arrangement direction of the plurality of fourth screw holes and the axial directions of the fourth screw holes.

By doing so, the leading end of the screw inserted into the first screw hole provided in the joining section is inserted in a tilted manner so as to approach the leading ends of the screws inserted into the four screw holes provided in the transverse section, and hence the bone plate can be more firmly screwed and fixed to the tibia.

{0018}

In the above-described aspect, the axial line of the first screw hole, the axial line of the second screw hole, axial lines of the third screw holes, and the axial lines of the fourth screw holes may be arranged so as to be substantially orthogonal to the plate thickness direction of the bone plate. With this structure, the screws can be firmly tightened to the bone plate having an appropriate thickness, and the fixability of the bone plate to the tibia can be further enhanced.

{0019}

In the above-described aspect, the curved surface shape maybe twisted by 18.7° ± 10° about an axial line parallel to a longitudinal axis of the body section.

With this structure, the bone plate can be disposed so as to closely fit to the side surface of the tibia.

readily free from load) for the tibia provided with the bone plate can be suppressed, thereby making it possible to further promote bone reproduction in the dilated section into which the artificial bone is inserted.

{0025}

Another example disclosed herein is a bone plate system including: any one of the above-described bone plats; and a plurality of screws that are tightened into the plurality of screw holes in the bone plate to fix the bone plate to the tibia.

{0026}

According to the above-described aspect, the screw tightened into the first screw hole and the screw tightened into the second screw hole are disposed on planes substantially parallel to each other such that the axial line of the first screw and the axial line of the second screw are at twisted positions, and hence the leading end of the screw tightened into the second screw hole is tightened in a direction gradually away from the osteotomy surface at the site of osteotomy, and a wide correction angle can be ensured without causing the screw to break through the osteotomy surface.

{0027}

By tightening the screws in this manner, the screws can be tightened while avoiding portions with low bone density and

screws do no break through the articular surface or interfere with the artificial bone and a bone defect part.

{0034}

The above-described aspect may include: a first block containing the transverse section, the joining section, and a first screw group composed of a plurality of screws tightened into the first screw hole and the fourth screw holes; and a second block containing the body section and a second screw group composed of a plurality of screws tightened into the second screw hole and the third screw hole, wherein the bone plate system may have elasticity that, when a vertical load is relatively applied from the first block to the second block at a position 30 to 50 mm away from the transverse section of the bone plate in the longitudinal axis direction, allows flexure with which the first block is displaced by 0.15 mm ± 0.1 mm/kgf relative to the second block in a direction of the vertical load.

By adjusting the amount of flexure of the bone plate system in this manner, stress shielding (a phenomenon in which a bone is readily free from load) for the tibia provided with the bone plate can be suppressed, thereby making it possible to further promote bone reproduction in the dilated section into which the artificial bone is inserted.

{Advantageous Effects}

{0035}

The present bone plate and a bone plate system may afford an advantage in that a bone plate and a bone plate system optimized to enhance the fixability of the bone plate to a tibia for a long time period can be provided.

{Brief Description of Drawings}

{0036}

{Fig. 1A}

Fig. 1A is an overall view showing a bone plate system.

{Fig. 1B}

Fig. 1B is an overall view showing the positional relationship between the bone plate in Fig. 1A and screws inserted into screw holes provided in the bone plate.

{Fig. 1C}

Fig. 1C is a plan view showing the positional relationship between the bone plate in Fig. 1A and screws inserted into screw holes provided in the bone plate.

{Fig. 2A}

Fig. 2A is a front view showing a bone plate used in the bone plate system in Fig. 1A.

{Fig. 2B}

Fig. 2B is a side view showing the bone plate in Fig. 2A.

{Fig. 2C}

{0037}

A bone plate 1 and a bone plate system 2 will now be described with reference to the drawings.

As shown in Fig. 1A, the bone plate system 2 according to this embodiment includes: the bone plate 1; a plurality of screws 3 for fixing this bone plate 1 to a high side surface of a tibia X; and an artificial bone 4 inserted into a notch formed from the inner side surface side towards the outer side of the tibia X.

{0038}

The bone plate 1 according to this embodiment is an elongated band-shaped member that is fixed to a high inner side surface of the tibia X after osteotomy for high tibial osteotomy of gonarthrosis and has a subtlely curved shape in conformance to a typical surface shape of the tibia X so as to run along the curved surface shape of the side surface thereof at a position changing from the diaphyseal region towards the epiphyseal region of the tibia X.

{0039}

As shown in Figs. 2A, 2B, and 2C, this bone plate 1 includes: an elongated band-shaped body section 1a; a transverse section 1b extending in a direction intersecting the longitudinal direction of this body section 1a; and a joining section 1c for linking the body section 1a and the

{0049}

Because the screws are threaded so that the axial lines D of the screw holes 6, the axial line A of the screw hole 7, and the axial line B of a screw hole 5a are each substantially orthogonal to the plate thickness direction of the bone plate 1, the screws 3 can be firmly tightened to the tibia X through the bone plate 1 with an appropriate thickness, thereby further enhancing the fixability of the bone plate 1 to the tibia X.

{0050}

As shown in Fig. 4A, the joining section 1c is formed to bend with a bending angle of 175° ± 10° relative to the transverse section 1b. For this reason, as shown in Fig. 4B, the axial line A of the screw 3b inserted into the screw hole 7 in the joining section 1c is inserted upwardly by an amount equivalent to a bending angle of 175° ± 10 relative to the axial lines D of the screws 3a inserted into the screw holes 6 in the transverse section 1b.

With this structure, the fittability of the bone plate 1 to the tibia X can be enhanced while still preventing the leading end of the screw 3b inserted into the joining section 1c from interfering with the leading ends of the screws 3a inserted into the transverse section 1b.

{0051}

By forming the bone plate 1 according to this embodiment

{CLAIMS}

{Claim 1}

A bone plate comprising:

a band-shaped body section arranged for fixing, along a longitudinal direction of a tibia, to an obliquely anterior inner side surface of the tibia at a position lower than a notch formed in an inner side surface of the tibia;

a transverse section arranged for fixing, along a direction intersecting the longitudinal direction of the tibia, to the inner side surface of the tibia at a position higher than the notch;

a joining section for joining the body section and the transverse section; and

a plurality of screw holes that are arranged in the transverse section, the body section, and the joining section in a manner spaced apart from one another and that pass therethrough in a plate thickness direction,

wherein the plurality of screw holes include a first screw hole provided in the joining section and a second screw hole provided in the body section,

the body section, the joining section, and the transverse section have a curved surface shape that continues in such a manner as to twist about an axial line along the longitudinal direction of the tibia,

a first plane on which an axial line of the first screw

mm inclusive and is desirably 95 mm to 105 mm inclusive, and the distance between the first screw hole and the second screw hole is 24 mm to 34 mm inclusive and is desirably 24 mm to 30 mm inclusive.

{Claim 8}

A bone plate system comprising:

the bone plate according to one of claims 1 to 7; and

arranged for a plurality of screws to be tightened into the plurality of screw holes in the bone plate to fix the bone plate to the tibia.

{Claim 9}

The bone plate system according to claim 8,

wherein the plate thickness of the bone plate is 3 ± 1 mm, and

arranged for the amount of flexure of the bone plate and the plurality of screws when a vertical load in the longitudinal axis is applied to the plurality of screws at a position 30 to 50 mm away from the transverse section of the bone plate in the longitudinal axis direction in a state where the bone plate is tightened with the plurality of screws is 0.15 mm ± 0.1 mm/kgf.

{Claim 10}

The bone plate system according to claim 8 or 9, wherein the bone plate and the screws are formed of a highly biocompatible material and are preferably formed of a

titanium-based alloy, a cobalt-chromium alloy, or a stainless steel.

{Claim 11}

The bone plate system according to one of claims 8 to 10,

wherein the screws are hollow screws each having a through-hole that is arranged to allow a guide pin to pass therethrough,

each of the screws has a crest diameter of φ5.0 mm to 5.8 mm inclusive and a root diameter of φ4.5 mm to 5.3 mm inclusive, and

the hollow axis diameter of the above-described hollow screw is φ1.8 mm to 2.8 mm inclusive.

{Claim 12}

The bone plate system according to one of claims 8 to 11, wherein the angles between the straight line connecting the longitudinal-direction upper-end portion and lower-end portion in the bone plate and the first plane and the second plane are 80° to 95° inclusive and are preferably 84° to 91° inclusive, and the angle relative to the fourth plane is 74° to 80° inclusive and is preferably 75° to 79° inclusive.

{Claim 13}

The bone plate system according to claim 8 comprising:

a first block for containing the transverse section, the joining section, and for a first screw group composed of a plurality of screws to be tightened into the first screw hole

and the fourth screw holes; and

a second block for containing the body section and for a a second screw group composed of a plurality of screws to be tightened into the second screw hole and the third screw hole,

wherein the bone plate system has elasticity that, when a vertical load is relatively applied from the first block to the second block at a position 30 to 50 mm away from the transverse section of the bone plate in the longitudinal axis direction, allows flexure with which the first block is displaced by 0.15 mm ± 0.1 mm/kgf relative to the second block in a direction of the vertical load.