



5 Apparatus for the osteosynthesis of bone fragments,
 in particular for the fixation of bone fractures

DESCRIPTION

10 The invention relates to an apparatus for the osteosynthesis of
bone fragments, in particular for the fixation of bone
fractures, according to the precharacterizing clause of Claim
1. In addition, the present invention relates to instrumentaria
according to the precharacterizing clauses of Claims 12 and 14.

15 The primary aim in the treatment of fractures is to restore the
function of the injured limb. To avoid misalignments and to
prevent fracture diseases (stiffened joints and damage to the
soft parts as a result of circulatory disorders) it is
desirable to stabilize the broken bone by firm osteosynthesis
to such an extent that prolonged external fixation by plaster
20 casts or the like is unnecessary and active movement therapy of
the injured limb can be begun immediately. Similarly, in
reconstructive surgery on the skeleton emphasis is placed on an
early active functional treatment as well as on reliable
ossification. Additional important desiderata are a shorter
25 stay in the hospital, the soonest possible restoration of the
load-bearing capacity of the bone and, in particular, a
reduction of the time needed for the operation. The above-
mentioned aim has been substantially achieved by the apparatus
according to DE 42 00 757 A1, which was originated by the
30 inventor of the present invention and has been successfully
employed in practice. However, experience has shown that it
would be favorable to make the retaining strap more flexible,
in order to achieve a better fit between the retaining strap
and the surface of the bone, such that the entire surface of
35 the retaining strap is in contact with the bone over the full
length of the encircling section.

This aim is achieved in accordance with the invention by the
characteristics disclosed in Claim 1. Because the receiving

element is so disposed as to be rotatable about an axis approximately perpendicular to the flat surface of the retaining strap, the retaining strap can be made to fit more closely to conically shaped sections of bone, in such a way that all along the section wrapped around the bone, practically its full surface is in contact with the bone.

The retaining strap wraps like a collar around the bone or the bone fracture to be fixed. This arrangement largely avoids a linear contact between retaining strap and bone. The apparatus in accordance with the invention has a correspondingly gentle and tolerable action on the bone.

To facilitate the operation, it is advantageous to provide the bone-facing surface of the end section of the retaining strap, at which the receiving element is disposed, with at least one spike or thorn that can penetrate bone, in order to prevent the retaining strap from slipping when it is wrapped around the bone and tightened. Additional spikes or thorns can be provided for this purpose on the surface of the retaining strap that faces the bone, but preferably only on the half of the strap that bears the above-mentioned receiving element.

The construction of the apparatus in accordance with the invention is particularly simple when the receiving element is formed by a piece of retaining strap that is bent into a flat sleeve, the open cross section of which corresponds approximately to the cross section of the retaining strap, so that the other end section of the strap can be passed through the flat sleeve with clearance.

Another constructionally simple embodiment relevant in this regard is characterized by the form of the swivel pin about which the receiving element rotates, namely that the swivel pin protrudes from the bone-facing surface of the end section of the retaining strap that bears the receiving element, this protruding part of the pin having the shape of a spike or thorn to engage the bone. The swivel pin of the receiving element thus has a dual function.

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In order to increase the rotational stability between receiving element and the associated end section of the retaining strap after the latter has been tightened and fixed, on the side of the rotatably disposed receiving element that faces the retaining strap and/or on the side of the retaining strap that faces the receiving element radial serrations are disposed in a star pattern centered on the swivel pin or the bores that receive the swivel pin.

As an alternative to the preceding embodiment, the receiving element can be constructed in a funnel shape, with an expanded opening toward the free end of the associated end section of the retaining strap and/or in the opposite direction. In this case a swivel mounting of the receiving element on the associated end section of the retaining strap is in some circumstances unnecessary. This latter embodiment can also be combined with the first-mentioned, so that the retaining strap can be fitted more closely to the surface of the bone. Preferably the receiving element is also formed as a flat sleeve in this embodiment.

To further increase the flexibility of the retaining strap, the features according to Claim 7 and/or 8 can additionally be provided. These specify that the retaining element should be tiltable relative to the swivel pin within predetermined limits (about 5° to 25°); that is, within the given limits its mounting should be universally rotatable. For this purpose the swivel pin is preferably made flexible or the receiving element is mounted on the pin with somewhat greater clearance.

For the fixation of loose bone fragments, a movable bone-thorn according to Claims 9 to 11 is helpful. This also prevents undesired slippage of the retaining strap when it is wrapped around the bone and tightened. The instruments according to Claims 12 to 14 facilitate the manipulation or application of the apparatus in accordance with the invention.

In the following, exemplary embodiments of the apparatus in accordance with the invention are described in greater detail with reference to the attached schematic drawing, wherein:

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Fig. 1 shows in perspective a retaining-strap apparatus in accordance with the invention;

Fig. 2 shows the retaining-strap apparatus according to Fig. 1 to illustrate the swivelability of the receiving element for the section of the retaining strap at the end away from the bone;

Fig. 3 is a front view of the section of the retaining strap at the end near the bone, with the receiving element of the retaining strap in the direction of Arrow III in Fig. 1;

Fig. 4 is a view from below of the receiving element of the retaining strap to illustrate the rotation-stabilizing radial serrations;

Fig. 5 is a plan view of an alternative embodiment of a retaining-strap receiving element;

Figs. 6 and 7 are perspective views of preferred bone-thorns;

Fig. 8 shows a bone-thorn that can be slid along the retaining strap, in a cross-sectional view of the retaining strap;

Fig. 9 shows a pair of forceps to position the movable bone-thorn and press it into the bone; and

Fig. 10 is a view of a bone drill.

The apparatus for the osteosynthesis of bone fragments, in particular for the fixation of bone fractures, according to

Figures 1-4 comprises a retaining means that is wrapped around the fracture or the bone in the region of the site to be treated, in the form of a flat, ribbonlike retaining strap 10, at one end of which, namely the end section 11 near the bone, a receiving element 12 is disposed, through which can be passed the other end of the retaining strap 10, namely the end section 13 away from the bone. After the retaining strap has been



tightened around the bone, the part of the end section 13 that has been passed through the receiving element 12 is bent up and back, so that the end sections 11 and 13 will remain in the positions to which they have been adjusted relative to one another. In this way the end section 13 of the retaining strap 10 is fixed to the receiving element 12. This fixation is not illustrated as such in the figures.

As can be seen in Figures 2 and 3, the receiving element 12 is so disposed that it can rotate about an axis 14 perpendicular to the flat surface of the retaining strap 10 (see especially Fig. 2). This arrangement enables the retaining strap to be fitted more closely to the surface of a bone, in particular to an approximately conically shaped bone surface.

For fixation of the end section 11 of the retaining strap 10, namely the end near the bone, on the surface of this end section 11 that faces the bone there is disposed at least one spike or thorn 15 that penetrates the bone. According to Fig. 3, the swivel pin 14 of the receiving element 12 protrudes beyond the bone-facing surface of the end section 11 of the retaining strap 10 associated with the receiving element 12, this protruding section of the swivel pin 14 having the shape of a spike or bone-thorn 15. The swivel pin 14 thereby has a dual function. It serves simultaneously as an axle about which the receiving element 12 swivels and as a means of fixing the end section 11 of the retaining strap 10 to the bone. The retaining strap 10 is thus prevented from slipping while it is being wrapped around the bone and tightened.

As Fig. 1 shows, on the surface of the retaining strap 10 that faces the bone an additional spike or bone-thorn 16 is disposed. It is situated in the half of the retaining strap 10 that is associated with the receiving element 12.

The receiving element 12 in the embodiment illustrated is formed by a piece of retaining strap bent into a flat sleeve 17, the open, approximately rectangular cross section of which corresponds to the cross section of the retaining strap 10, in such a way that the other end of the retaining strap, the end



section 13 away from the bone, can be passed through the flat sleeve 17 with clearance. This embodiment is particularly simple to manufacture. In particular, in this embodiment the swivel pin 14 can be simply fixed in position. The flat sleeve 17 is divided by a longitudinal slot 18 on its upper surface. To fix the swivel pin 14, the two upper halves of the flat sleeve 17 are bent outward slightly. After the swivel pin 14 has been fixed, these two halves are bent back again, so that the flat sleeve has the shape shown in Figures 1 to 3. The swivel pin 14 is formed by a rivet, in which the head toward the bone has the form of a pointed cone and forms the spike or bone-thorn 15 mentioned above. The rotatability of the described receiving element 12 or the flat sleeve 17 relative to the end section 11 of the retaining strap 10 is indicated in Fig. 3 by the double arrow 18. In this regard see also Fig. 2.

According to Fig. 4, on the surface of the rotatably mounted receiving element 12 that faces the retaining strap 10 or the end section 11 thereof radial serrations 20 are disposed in a star pattern centered on the swivel pin 14 or the bore 19 that receives the swivel pin 14. In the same way, complementary radial serrations can also be provided on the surface of the retaining strap or its end section 11 that faces the receiving element 12. By this means, after fixation of the retaining strap rotational stability between the receiving element and the associated end section 11 of the retaining strap 10 is ensured.

The retaining strap and the receiving element 12 are preferably made of a titanium alloy compatible with human tissue.

Fig. 5 illustrates an alternative solution in which the receiving element 12 again has the form of a flat sleeve 17 but is funnel-shaped, with a wider opening toward the free end of the associated retaining-strap end section 11. In this embodiment it is not absolutely necessary for the receiving element 12 to be rotatably disposed as in the embodiment according to Figures 1 to 3. If it is thus disposed, however, the retaining strap will have greater flexibility and can be more closely fitted to various surface configurations of the



bone to be treated. The flat sleeve 17 can also be funnel-shaped in the opposite direction. A double funnel, with widened openings at both ends, is also conceivable.

For a further increase in flexibility of the apparatus, the receiving element can be tiltable with respect to the swivel pin, within predetermined limits; that is, its mounting can function as a universal joint within given limits. The range of tilt amounts to about 5° to 25° relative to the swivel pin, on all sides. As a concrete means of achieving this aim, the swivel pin can be made flexible or the receiving element can be mounted on the swivel pin with somewhat greater clearance.

In Figures 6 and 7 two different kinds of bone-thorns are illustrated. The thorn according to Fig. 6 has the shape of a pointed cone and the thorn according to Fig. 7 is a more compressed pointed cone. The last-mentioned embodiment is characterized by a V-shaped cutting edge that facilitates penetration into the bone.

Figure 1 illustrates still another bone-thorn 21, which is mounted on a U-shaped slide 22' so that its position along the retaining strap 10 can be adjusted. This adjustability is indicated by the double arrow 33 in Fig. 1. The slide 22' is kept on the retaining strap 10 by its two edges that are bent at successive right angles, so that they enclose the two long edges of the retaining strap 10.

Instead of the U-shaped slide 22' illustrated in Fig. 1, a flat sleeve 22 slidable along the retaining strap 10 can be provided; such a sleeve is illustrated in Fig. 8. The provision of a bone-thorn 21 that can be slid along the retaining strap 10 allows the thorn to be positioned according to individual requirements. In particular, loose bone fragments can be fixed with this slidable bone-thorn. Furthermore, suitable placement of the bone-thorn 21 can prevent slippage of the retaining strap along the bone while the strap is being wrapped around the bone and tightened. For this purpose, the slidable bone-thorn 21 is preferably positioned on the side of the bone

opposite the site of access through the muscle incision, as illustrated in Fig. 9.

The sliding sleeve 22 and the slide 22' are preferably made from a piece of retaining strap, and in any event from the same material as the retaining strap.

At sites on the bone that are accessible through the incision, it is recommended that a hole be drilled in advance to receive a bone-thorn 15, 16 or 21. A bone-thorn drill according to Fig. 10 can be used for this purpose; it consists of a shaft 30, at one end of which there is a cross bar 31 or the like and at the other end, a drill-bit 32 in the shape of a pointed cone. The configuration of the drill-bit 32 is like that of a wood drill. The cross bar 31 serves as a handle to transmit the torque for drilling.

To position the slidable bone-thorn 21 on the side of the bone opposite the site of access through the muscle incision, it is preferable to use special forceps as illustrated schematically in Fig. 9. This pair of forceps 23 is shaped like water-pump pliers, in which one jaw 24 is approximately semicircular in shape so that its free end 26 can be passed around the bone to the position opposite the site of access. This free end 26 is provided with a holding device 28 to engage the bone-thorn that is slidable along the retaining strap 10 wrapped around the bone. The holding device 28 takes the concrete form of a projection 29 that extends inward, away from the free end 26 of the forceps jaw 24, so that the slidable bone-thorn 21 or its slide 22' or sliding sleeve 22 can be set onto it, in such a way that when the forceps jaws 24 and 25 are pressed together, the pressure is exerted only on the bone-thorn 21, the bone-facing side of the thorn slide 22' or of the sliding sleeve 22, and the associated section of the retaining strap 10. With this arrangement, the forceps 23 do not compress the sliding sleeve or the thorn slide. The handles of the forceps are indicated by the reference numeral 27.

All the characteristics disclosed in the application documents are claimed as essential to the invention, to the extent that



they are new with respect to the state of the art singly or in
combination.

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Apparatus for the osteosynthesis of bone fragments,
in particular for the fixation of bone fractures

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CLAIMS

1. Apparatus for the osteosynthesis of bone fragments, in particular for the fixation of bone fractures, with a retaining means that wraps around the fracture or the bone in the region of the site to be treated, wherein the retaining means is a retaining strap (10) in the form of a flat strip of the nature of a hose- or pipe-clamp, at one end of which, namely the end section (11) near the bone, there is provided a receiving element (12) through which the other end of the retaining strap (10), namely the end section (13) away from the bone, can be passed so that it can then be fixed at the receiving element (12), holding the strap wrapped around the bone in place under tension, characterized in that the receiving element (12) is mounted so that it can be rotated about an axis (14) approximately perpendicular to the flat surface of the retaining strap (10).
2. Apparatus according to Claim 1, characterized in that at least one spike or thorn (15) that penetrates the bone is provided at the end of the retaining strap (10) near the bone, on the surface of the end section (11) that faces the bone.
3. Apparatus according to Claim 1 or 2, characterized in that the receiving element (12) is formed by a piece of retaining strap bent into a flat sleeve (17), the open, approximately rectangular cross section of which corresponds to the cross section of the retaining strap (10), so that the other end section (13), the end of the strap away from the bone, can be passed through the flat sleeve (17) with clearance.





4. Apparatus according to one of the Claims 1 to 3,
characterized in that the swivel pin (14) of the receiving
element (12) protrudes from the surface of the retaining
strap (10) that faces the bone at the end section (11)
5 associated with the receiving element (12), this protruding
part of the swivel pin (14) having the form of a spike or
thorn (15).
- 10 5. Apparatus according to one of the Claims 1 to 4,
characterized in that radial serrations (20) are provided
on the side of the rotatably mounted receiving element (12)
that faces the retaining strap (10) and/or on the surface
of the retaining strap (10) that faces the receiving
element (12), arranged in a star pattern centered on the
swivel pin (14) or the bore (19) that receives it.
- 15 6. Apparatus according to the precharacterizing clause of
Claim 1,
characterized in that the receiving element (12) has a
funnel-shaped opening toward the free end of the associated
retaining-strap end section (11) and/or in the opposite
20 direction.
- 25 7. Apparatus according to one of the Claims 1 to 5,
characterized in that the receiving element (12) can be
tilted in all directions relative to the swivel pin (14)
within predetermined limits (about 5° to 25°); that is,
within given limits its mounting functions as a universal
joint.
- 30 8. Apparatus according to Claim 7,
characterized in that the swivel pin (14) of the receiving
element (12) is of flexible construction and/or the
receiving element (12) is held on the swivel pin (14) with
somewhat greater clearance.
9. Apparatus, in particular according to one or more of the
Claims 1 to 8,





characterized in that at least one bone-spike or -thorn (21) is provided that can be displaced along the retaining strap (10).

10. Apparatus according to Claim 9,

5 characterized in that the displaceable bone-thorn (21) is disposed on the bone-facing surface of a sliding sleeve, in particular a flat sleeve (22), that can be shifted along the retaining strap (10).

11. Apparatus according to Claim 10,

10 characterized in that the displaceable bone-thorn (21) is disposed on the bone-facing surface of an approximately U-shaped slide (22') that can be shifted along the retaining strap (10).

12. Forceps for positioning a bone-thorn (21) and pressing it

15 into a bone according to Claims 9 to 11,
characterized in that the forceps (23) have a form similar to that of water-pump pliers, wherein one jaw (24) is approximately semicircular in shape, so that the free end (26) thereof can be passed around the bone and positioned
20 on the back side thereof, opposite the access site, and at the free end (26) there is disposed a holding device (28) for the bone-thorn (21) that can be displaced along a retaining strap (10) wrapped around the bone.

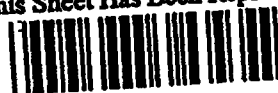
13. Forceps according to Claim 12,

25 characterized in that the holding device (28) for the displaceable bone-thorn (21) comprises a projection (29) pointing away from the free end (26) of the forceps jaw (24), onto which the displaceable bone-thorn (21) or its slide (22') or sliding sleeve (22) can be placed so that
30 when the jaws (24, 25) of the forceps are closed, pressure is exerted only on the bone-thorn (21), the side of the thorn-slide (22') or the sliding sleeve (22) facing the bone, and the associated section of the retaining strap (10).



14. Apparatus to produce a bore for a bone-thorn, comprising a shaft (30) that bears at one end a cross bar (31) or the like and at the other end a drill-bit (32) in the shape of a pointed cone.

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