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[54] **SURGICAL DEVICE**

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[58] **Field of Search** ..... 128/92 BB, 92 B, 128/92 BA, 92 BC, 92 R, 92 C, 92 CA, 92 D

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[57] **ABSTRACT**

A surgical device for joining broken bone segments includes a rail member configurated to abut against one segment of the bone and has an aperture therein. A holder member has an aperture therein and is configurated to slide along the rail member and has a longitudinal slot through which fixing screws can pass and engage with the rail member for fixing the members against relative movement with respect to one another. An elongated connecting means passes through the apertures of the rail member and of the holder member. Each of the apertures define a pivot point in which the elongated member is pivotally mounted and forms an angle with the bone which is a function of the relative positions of the two members. One end of the elongated member is anchored to the holder member and another end is fixed to another segment of the bone, the elongated member being arranged to pull the last-mentioned segment towards said holder member while abutting against said rail member.

9 Claims, 2 Drawing Figures

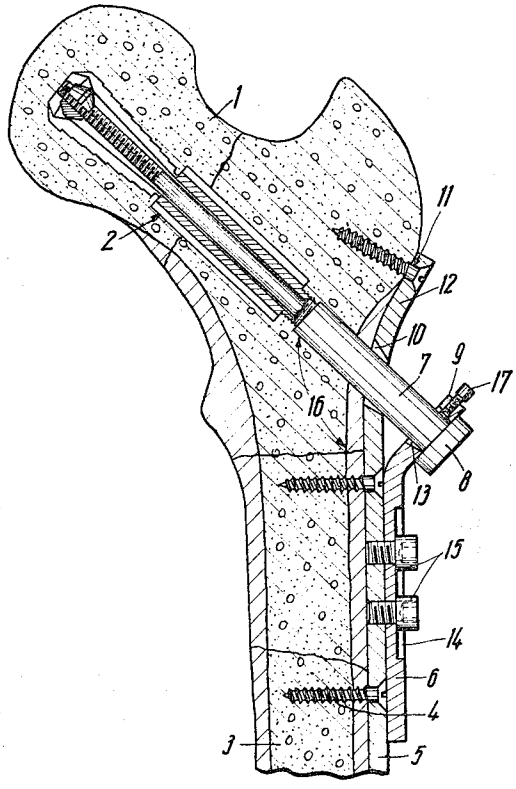

Fig. 1

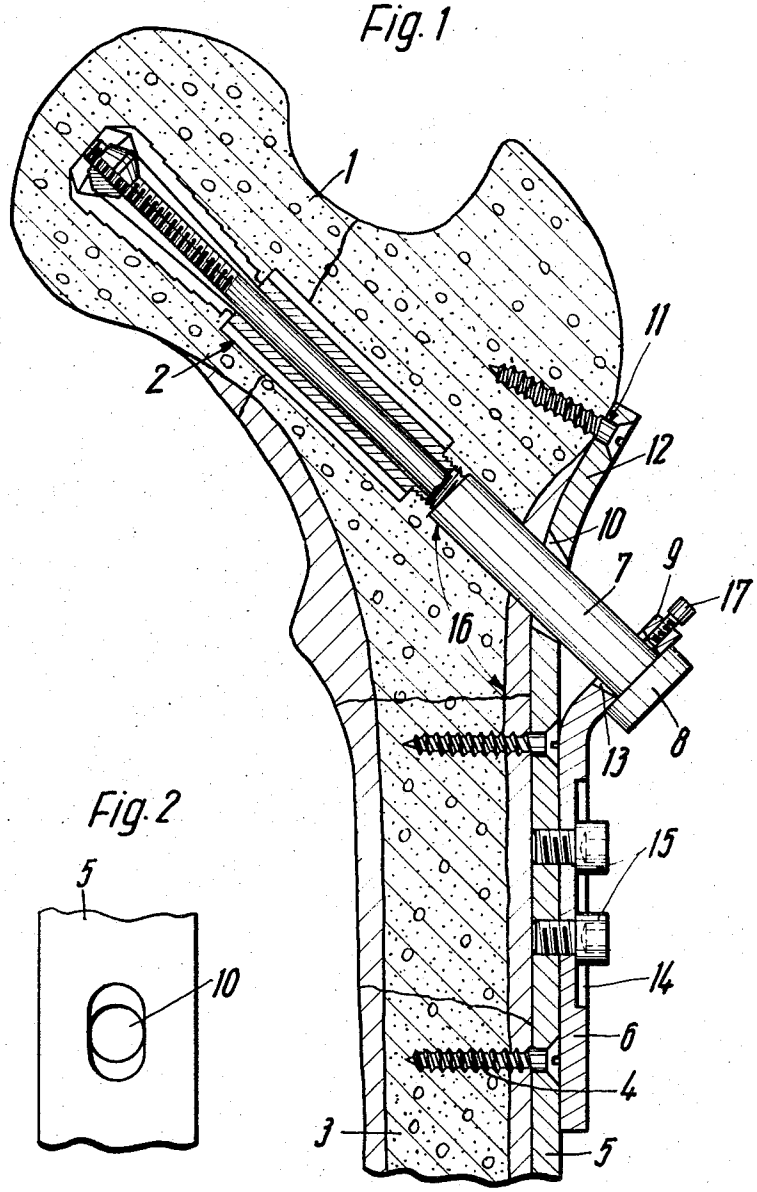

Fig. 2

SURGICAL DEVICE

BACKGROUND OF THE INVENTION

The present invention concerns a surgical device, particularly for joining a broken bone, and more especially for joining a bone broken in the region of the neck of the femur head.

In multiple bone fractures, in which in particular the neck of the femur head and the femur are affected, it is necessary for rapid healing of the fracture that the bone fragments be drawn together and held in this position. In the case of the femur, this is effected by means of a rail fastened to the bone fragments by screws. Since during the application of the rail no forces come into action which may cause gaps between the bone fragments at the line of fracture, this rail ensures rapid healing and support of the broken bone.

In order to obtain also in the case of a fracture of the neck of the femur head a rapid formation of callus, at the surface or line of the fracture, the fragments must be in contact at the surface of fracture. This can be achieved only by driving into the bone a connection element which can subsequently be anchored in the rear bone fragment. The bone fragments can then be drawn together by means of a capping sleeve that can be screwed onto a part of the connection element which is allowed to protrude from the bone. In the case of simple fractures of the neck of the femur head, in which the connection element could be driven in at the specific angle between the neck of the femur head and the femur, this kind of connection has proved very suitable.

Depending upon the course of the fracture, however, the connection element must in many cases be driven into the neck of the femur head a a different angle. The angular range between the femur and the connection element to be driven into the neck of the femur head, which can be considered for this purpose varies approximately from 120° to 140°. In these cases, there is no contact face available for engagement by the capping sleeve, it being understood that such contact face should extend perpendicular to the longitudinal axis of the connection element and should support the capping sleeve during the drawing-together of the bone fragments. The joining of the bone fragments thus becomes very difficult, or even impossible. Moreover, it is necessary in multiple fractures, due to the high loads on the femur, to provide a rigid connection between the rail fastened to the femur and the connection element secured in the neck of the femur head.

A rail is known, one end of which has the shape of a circular arc. This rail is fixed to the femur in the manner described above. The arc, forming one piece with the rail, contains a longitudinal groove, in which a nail that is to be driven into the neck of the femur head can be moved. Depending upon the position of the nail along the arc, a specific angle of the nail in relation to the femur is obtained. The nail is fixed in this position by a support plate which may be placed onto that end of the nail which protrudes from the bone, and which serves as back support for the rail which is to be fastened to the nail by a screw. The rail is then immovably clamped between the support plate and the head of the screw.

The known rail cannot, however, be used in association with a connection element of the type described above, since a support plate cannot be fixed to the end

of the connection element protruding from the bone, because a capping sleeve for drawing together the bone fragments must be screwed onto the end of the connection element.

The known rail does not permit the fastening of a connection element of the kind described to the rail at an angle of between 120° and 140°, so that a unit of connection element and rail could be formed which will take up the high forces arising from the application of a load to the femur.

Moreover, the support plate required by the known device, which, due to its large surface, cannot penetrate into the bone and therefore lies upon the bone, prevents a contact between the rail and the femur. Only the rear part of the known rail, and the support plate are in contact with the bone when the known device has been fixed. The femur thus lacks lateral support, which is required to prevent displacement of the bone fragments at the line of fracture in the femur.

SUMMARY OF THE INVENTION

It is a general object of the invention to overcome the disadvantages of the prior art.

More particularly, it is an object of the invention to provide an improved surgical device which avoids such disadvantages.

Another object is to provide such an improved device which makes it possible to obtain a rigid connection between the fragments of the femur which are held together by a rail constituting a part of the device.

According to the invention this is achieved by providing the rail with an aperture which serves at the same time as seat and as pivot point for the connection element, the connection element being pivotable about this pivot point by means of a holder which can be moved along the rail and fixed at the rail and which also contains an aperture for taking up the connection element.

After the connection element has been inserted and anchored at an angle to the femur which depends on the position and the course of the fracture line, as a rule at between 120° and 140°, the rail and the holder, which can be moved along the rail and fixed at the rail, are together pushed over the protruding end of the connection element. The capping sleeve required for joining the bone fragments is then pushed through the apertures in the holder and in the rail and is screwed onto the protruding end of the connection element. Only now is the rail screwed to the femur with the aid of fixing screws. By moving the holder along the rail, the already anchored fixing element is clamped by means of the correspondingly matched apertures in the holder and in the rail, and fixed in this position by tightening the holder to the rail. The fragments of the neck of the femur head are now drawn together by means of the capping sleeve. The head of the capping sleeve is supported either by a washer or directly by the correspondingly shaped holder.

The connection element may be any expansion belt which permits anchoring by means of expansion (i.e. spreading apart), and which utilizes a capping sleeve or nut by means of which the bone fragments can be drawn together.

The pivoting range of 120° to 140° made possible by this solution suffices in nearly all cases for driving in the connection element according to the course of the fracture and for producing a rigid connection with the rail,

and at the same time providing contact between the rail and the femur. This rigid connection between the connection element and the rail which is fixed to the femur, provides the condition for rapid healing and for the possibility of immediately subjecting the femur to a load.

The lateral support by the rail, which is in contact with the femur over its entire length, prevents a displacement of the bone fragments at the positions of fracture and thus a wrong growing-together of the femur.

Compared to the prior art, the construction according to the invention has the further advantage that when a load is applied to the femur, the clamping effect obtained in the connection between the connection element and the rail, is reinforced.

According to a further concept of the invention, the aperture in the rail and in the holder may be widened from the contact side with the bone in accordance with the pivoting angle of the connection element. This construction makes it possible to select narrower drill hole tolerances for the seating of the connection element in the rail and in the holder. The widening is, however, required only in the longitudinal direction of the drill hole, so that proper lateral support for the connection element remains assured.

According to a further advantageous concept of the invention, that part of the holder which contains the aperture for taking up the connection element, may be bent in such a way that it is positioned approximately perpendicular to the longitudinal axis of the connection element. This produces a rectangular contact face for the head of the capping sleeve to be screwed onto the connection element, which contact face could otherwise be obtained only by means of a bearing plate. Also, the holder may be attached to the rail by means of one or several fixing screws, which are guided in a longitudinal aperture extending parallel to its lateral edge. In this construction, the holder can be moved along the rail and fixed to the rail in a most simple manner for the purpose of pivoting and clamping the connection element; to avoid subsequent painful pressure spots, the screw heads may be recessed in the longitudinal aperture of the holder.

According to a last development of the invention, suitable means, in particular screws, may be arranged at the holder, for clamping the connection element which has been taken up in the aperture of the holder. This construction prevents the accidental loosening of the capping sleeve which is necessary for the drawing-together and holding-together of the bone fragments.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWING:

FIG. 1 is a partial sectional view of a device according to the invention; and

FIG. 2 shows the construction of the aperture in the rail serving for taking up the connection element.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

The device according to the invention comprises a connection element 2 in form of an expansion anchor, which may be anchored in the neck of the femur head 1, a rail 5 which is fastened to the femur 3 by means of fixing screws 4, and a holder 6 which can be moved along the rail and fixed at the rail. The connection element 2 has a capping sleeve 7 or nut which may be screwed onto that end of the connection element 2 that protrudes from the bone, a head 8 of which capping sleeve is supported by a bent section 9 of the holder 6 when the bone fragments are drawn together. Although several fracture lines have been indicated it should be understood that the device could be used with a non-fractured bone, as will be explained more fully at a subsequent point.

The rail 5 is provided with an aperture 10 for taking up the connection element 2. The aperture is widened (i.e., diverges) in the longitudinal direction of the rail 5 from the contact side with the bone, according to the pivoting range of the connection element 2 (see also FIG. 2).

The rail 5 further contains apertures 11 for taking up the fixing screws 4, by means of which the rail 5 is fastened to the femur 3. An upper section 12 of the rail 5 is contoured to conform to a high degree of the outer surface of the femur 3, so that the contact face for the lateral support of the femur 3 is as large as possible.

To use the novel device, a nail (not shown) is first driven into the femur 3 for forming a hole therein. As this is done, the bone is observed on the screen of an X-ray machine to assure that the desired angle 16 between the passage formed by the nail and the rail 15, is obtained. Now, the sleeve of element 2 is placed over the protruding rear end of the nail and driven into the bone, so as to slide over and along the nail. When this is completed, the nail has no further purpose and is withdrawn. The screw which effects expansion of the sleeve is now threaded into the expansion body of the element 2 and turned as required to expand the sleeve of element 2, thereby anchoring the latter in the femur 3. Now, the rail 5 is placed over the end portion of element 2 which protrudes outwardly of the bone, and is screwed to the latter by the screws 4. Capping sleeve 7 and holder 6 are then pushed onto the projecting portion of element 2 and threaded onto the same until sleeve 7 enters aperture 10. The holder 6 is then secured to rail 5 until screws 15 and its bent section 9 then acts as an abutment for the head 8 of sleeve 7, permitting the drawing-together of the bone fragments or sections in response to requisite turning of sleeve 7.

In order to pivot the connection element 2 in the aperture 10 of the rail 5, serving as pivot point, the holder 6 is moved upwards or downwards. In the holder 6 too, the aperture 13, provided for taking up the connection element 2, is widened (i.e., diverged) in accordance with the pivoting range. The movement of the holder 6 is made possible by the position of the longitudinal aperture 14. The holder 6 is fixed to the rail 5 by means of fixing screws 15 which are guided in the longitudinal aperture 14. The angle 16 between the connection element 2 and the rail 5 varies in dependence on the displacement of the two apertures 10, 13 in the rail 5 and in the holder 6. The angle 16 is selected as required by shifting of the holder 6 relative to rail 5, whereupon the

selected angle is then set by fixing the holder **6** on the rail **5** with the aid of the screws **15.**

After drawing together the bone fragments, the capping sleeve **7** is clamped by means of the fixing screws **17** at the bent section **9** of the holder **6,** and thus secured against accidental loosening.

I wish it to be expressly understood that the usefulness of my device is not limited to cases where a bone fracture has actually occurred. There are instances where my device can be employed to advantage even if no fracture exists. For instance, it is well known that the bones of older persons are much more susceptible to fracturing than those of younger persons. In such circumstances my device could be used as a preventive, i.e., it could be installed on an unfractured bone to give the same support and forstall the occurrence of a fracture. This use is intended to be encompassed in the protection of the appended claims.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of applications differing from the types described above.

While the invention has been illustrated and described an embodied in a surgical device, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended

1. A surgical device, particularly for joining segments of an elongated broken bone such as a femur bone, comprising a first member connectable to at least one segment of the bone so as to extend longitudinally of the latter, said first member having a first aperture; an adjustable second member slidably mounted on said first member and having a second aperture, each of said apertures being tapered and defining on each of said members a pivot point; fixing means for fixing said first and second members in one of a plurality of relative positions; and elongated means arranged to pass through and pivot about the pivot points of each of the respective apertures and be securely fixed at one end portion to at least another of the bone segments while having another end portion arranged to abut against said second member for holding said other bone segment to said second member, said elongated member forming an angle with the elongation of said first member, and thereby of the bone which is a function of the relative position between said first and second members.

2. A surgical device as defined in claim **1,** wherein said first member comprises a rigid rail configurated to extend along and abut against at least a part of the bone.

3. A surgical device as defined in claim **1,** wherein said first member is connected to a segment of the bone by means of screws.

4. A surgical device as defined in claim **1,** wherein each of said apertures taper in diameter in a direction away from the bone.

5. A surgical device as defined in claim **1,** wherein said first and second members each have substantially straight portions arranged for sliding movement relative to one another, and wherein said second member has a further portion including an angle with the straight portion of said second member such that said further portion is substantially normal to said elongated member.

6. A surgical device as defined in claim **1,** wherein said first and second members each have substantially straight portions arranged for slding movement relative to one another, and wherein said portion of said second member is provided with a longitudinal slot, said fixing means passing through said slot and engaging said portions of said first and second members.

7. A surgical device as defined in claim **6,** wherein said fixing means comprises screws.

8. A surgical device as defined in claim **1,** wherein said elongated means has portion positioned in said second aperture; and further comprising locking means on said second member in the region of said second aperture for engaging said portion and preventing movements of said elongated member relative to said second member.

9. A surgical device as defined in claim **1,** wherein said locking means comprises a fixing screw.

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