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SYSTEM FOR ATTACHING A PIECE OF OSTEOSYNTHESIS EQUIPMENT

The present invention belongs to the field of surgical instruments, and more particularly relates to fixation systems used in bone repair. It pertains to a system for fixation of an osteosynthesis instrument against a bone tissue, this system comprising at least one
5 fixation screw and an associated ancillary comprising a screwdriver.

Osteosynthesis groups together all of the methods that make it possible to keep two bone structures in place following a fracture, arthrodesis or osteotomy. It is for example used when the reduction (i.e., the replacement of the bone ends face-to-face) cannot be done
10 through outside maneuvers or when the two fragments are not stable. It implements various instruments making it possible to maintain the two fragments of the bone (or a bone and implant) relative to one another, such as plates, rods, nails, screws, pins, staples, etc. The aim is to consolidate the bone in the anatomical position.

Osteosynthesis using an instrument such as a plate, screwed by one or several screws, has been used in bone surgery for decades. The bone is then maintained by the plate,
15 which is fixed to the bone fragments to be joined, using several screws passing through said instrument and said bone tissue. The screws used to maintain the instrument may have different diameters and lengths based on the shape of the instrument and the implantation site.

These screws commonly include a relief in the upper part of the head, which will cooperate with a screwdriver, the tip of which has a complementary shape: flat head or Phillips screw, or hollow (for example, cooperating with a male 6-faced screwdriver). They are made
20 available to the surgeon at the time of the procedure simultaneously with a specific ancillary dedicated to placing the fixation system, generally comprising drills, a tap and a screwdriver.

Osteosynthesis using an instrument such as a plate associated with one or several screws is considered a safe way to obtain good bone consolidation, when it can be done perfectly. To that end, a certain number of conditions must be met, or at least sought, in which the quality of the screwing plays an essential role. It is crucial for the instrument to be closely
30 secured to the bone when it is implanted and over time. It is therefore mandatory for the screws to remain in place despite the vibrations or other stresses that may create play and

lead to loosening. The screws must therefore be securely moored both to the bone and the instrument.

It is also necessary to be able to orient the screw at an appropriate angle that the surgeon will choose based on the patient's bone parameters. The screws can thus be inserted
5 along an axis perpendicular to the instrument, but it is often necessary to give them a certain incline relative to a right angle, in particular to reach a bone fragment far away from the fracture site. As a result, the head of the screw may not completely nest in the cell (indentation) provided to that end in the instrument and protrudes on the surface.

The devices made up of an osteosynthesis instrument such as a plate and screws offered
10 to surgeons were, for some time, made from metal, generally titanium or stainless steel. At this time, the best metal devices are screwed and orientable devices. Each cell intended to receive a screw head is then made up of an eyelet having a certain mobility relative to the instrument. The locking is done by a second thread arranged at the lower part of the head of the screw, the first thread corresponding to the shaft of the screw engaged with the
15 bone. This second thread engages in a complementary thread arranged at the eyelet. When the eyelet is mounted to be orientable, this locking device can further be inclined in an appropriate direction, commonly in a radius of about 0 to 15° in all directions.

The metals or metal alloys used, although perfectly tolerated by the body, have two drawbacks. On the one hand, the instrument, which frequently assumes the form of a plate,
20 only rarely being removed (about 15% of cases), it will be involved over time in the kinematic operation of the organ it allowed to be put back together. However, because of its presence, mechanical stresses are not transmitted homogeneously in the affected bone. This makes the bone more fragile at the point of contact between the bone and the instrument, i.e., essentially at the screws. Secondary fractures are therefore frequent.

25 One example system for fixation of an osteosynthesis instrument against bone tissue including a screw and a screwdriver is described in document US 2006/0079903. The screwdriver in this document includes a handle, a rod, the front end of which bears a tip suitable for cooperating with the screw, and a sleeve mounted sliding on the rod, extending around part of the screw to guide its translation, and able to be blocked along the rod.

30 To resolve this problem, osteosynthesis devices comprising an instrument for example in the form of a plate and one or several polymer screws have been proposed. Biocompatible polymers such as PEEK (polyether ether ketone), implantable polyamides, UHMWPE

(ultrahigh molecular weight polyethylene) or PET (polyethylene terephthalate) can be used. They offer the advantage of a lower rigidity, which reduces the mechanical stresses imposed on the bone. More recently, an alternative has been proposed that is based on the use of resorbable polymers that have the advantage of gradually disappearing from the body, after a sufficient length of time for the bone to have regained its solidity. These for example include the polymers belonging to the PLA (polylactic acids) family, PCLs (polycaprolactones), PDSs (polydioxanones) and PGAs (polyglycol acids), as well as copolymers thereof.

Irrespective of whether they are resorbable, all of these polymers have one major drawback: they are radio-transparent. As a result, it is not possible to check their position during or after implantation using radiography techniques. A new generation of osteosynthesis devices has recently been developed by the applicant, made using a composite mixture of gradually-degrading materials comprising a polymer or copolymer compound and a mineral filler contributed by a ceramic.

One therefore now has a line of nonmetal osteosynthesis implants offering new advantages to the surgeon. However, a certain number of drawbacks remain to be overcome.

It has been seen that in metal osteosynthesis devices, the solidarity between the instrument and the or each screw is reinforced by locking. Devices made with a polymer base (including a composite polymer and ceramic mixture) cannot use this type of fixation. Indeed, the forming techniques for polymer materials do not make it possible to produce a fine thread on the surface, which, for all that, would not withstand the mechanical stresses (essentially friction) during screwing. The polymer screws known at this time include a conical or hemispherical head and are placed perpendicular to the general plane of the instrument, frequently a plate, or with a maximum angle of 5° relative to this plane. Like metal screws, they cannot be locked. This is a significant drawback of polymers as compared to metal.

To resolve this problem, a system has been designed for maintaining polymer-based osteosynthesis instruments using headless screws, also with a polymer base, these being placed using a screwdriver designed and dedicated specifically to these screws.

It appeared that it was possible to lock screws on polymer synthesis instruments by welding the surfaces in contact. Indeed, it is possible to take advantage of the nature of the materials used to section the screw after insertion at a desired depth in the bone to eliminate the rear part protruding after insertion, on the one hand, and to weld the screw and the concomitant instrument together by surface melting of the materials induced using an electric knife, on the other hand. The screw shaft is thus melted in the surface of the eyelet of the instrument that it passes through.

In so doing, one does away with the rear part of the screw by having the screw not protrude from the surface of the bone. The screw can then be inserted into the instrument in any direction with a high incline (up to 30°), without creating a bothersome asperity, while an osteosynthesis device with metal screws allows maximum inclines of only 15°. One thus unexpectedly obtains a higher performing locked and orientable device than the metal screw-instrument device.

However, such a device raises a new problem, which is at the base of the present invention. It is in fact essential to check the insertion depth of the screws in the bone tissue. This is particularly important due to the fact that, in many indications, it is recommended for the screws to pass all the way through the bone to grip the outer walls of the cortical bone at two opposite points. The cortical bone refers to the outside wall of the bones that gives them rigidity and elasticity. It is made up of a dense layer of calcified tissue that surrounds the medullary cavity filled with bone marrow. One difficulty for the surgeon then lies in the minute assessment of the sufficient insertion length for bicortical fixation, but without the screw, called bicortical screw, protruding excessively from the surface of the bone.

Typically, during an operation, the surgeon will determine the necessary screw length, in particular using a depth gauge, then choose screws with the appropriate length from a line of screws available to him and place them by screwing them all the way in until the screwing end of the screw, most often its head, is blocked in contact with the plate. Such a fixation method of the screws involves using screws provided with a head, whereas in the case of a screw intended to be sectioned, such a procedure cannot be used.

The problem at the base of the present invention is therefore, for a system for fixation of an osteosynthesis instrument against a bone tissue, the system being made up of at least a screw and a screwdriver, precisely checking the insertion depth of the screw in the bone tissue and in the osteosynthesis instrument applied against said tissue.

To that end, the present invention provides a system for fixation of an osteosynthesis instrument against a bone tissue, the system comprising at least i) a screw having a threaded shaft and a rear end, and ii) a screwdriver having a handle extended by a rod, the forward end of which carries an adapter suitable for cooperating with the rear end of the screw, in which system the screw is made from a material comprising a polymer, and said screwdriver is equipped with a guide member of the screw connected to the rod, a portion of the guide member projecting in front of the adapter of the screwdriver and extending along or around a part of the screw in order to guide it in axial translation, said guide member having a front end forming a stop of the screwdriver against the surface of said osteosynthesis instrument when a predefined screwing depth of the screw in the bone tissue is reached.

In the following description, and unless otherwise stated, the fixation system according to the invention will be described in a configuration where the screw is in place on the screwdriver, and in an orientation where its front part points toward the instrument to be fixed, while its rear part faces the operator. Its various component members will also be oriented using this convention.

The screwdriver allows the screwing of a screw to a chosen and predefined depth, generally read using a depth gauge. The screwing depth will correspond hereinafter to the depth of the hole formed in the bone, plus the thickness of the osteosynthesis instrument through which the screw passes. This screwing depth is chosen and predefined, generally by the surgeon: it corresponds to the degree of penetration of the screw to ensure robust fixation.

It is of course understood that the screwing depth of the screw relates to the screw length having progressed in the bone (increased by the thickness of the instrument), the corollary of which is that the progression of the front end of the screw is monitored to a desired level for fixation, which may be different from one time to the next. In the system according to the invention, the length of the screw is not chosen based on the degree of insertion to be reached. Additionally, the position of the rear end of the screw (arriving just above the osteosynthesis instrument to be fixed) does not command the stopping of the advancement of the screw, as is the case in other known systems, like that for example described in FR 2,932,078. On the contrary, according to the invention, the length of the screw is universal,

it is pushed in as much as desired, and after the screw is placed, the excess rear part of the screw is eliminated, by sectioning it.

The screw is easily sectioned inasmuch as it is made up of a material comprising a polymer, alone or mixed with another material, the hardness of which is significantly lower than that of traditional metal or metal alloy screws.

The system according to the invention can be used with types of assemblies other than the fixation of an osteosynthesis instrument against a bone tissue. The screw is inserted into the guide member until its rear end comes into contact with the adapter of the screwdriver. The adapter will then be able to cooperate with the rear end of the screw to impart a rotational movement to it when the user manipulates the screwdriver.

A portion of the guide member protrudes in front of the adapter of the screwdriver, such that said portion extends in front of the adapter, along or around part of the screw, to guide it in axial translation, during the screwing phase. Guiding in axial translation is done by an annular linear connection, which opposes transverse translations (radial relative to the axis of the rod). All of the other movements are free. This guiding is astutely provided by the front end of the guide member, using an annular linear connection having sufficient play to allow the translational movement to be done freely, without resistance. The practitioner can exert a force on the system without fearing a deviation of the tool or unwanted flexure of the screw.

The guide member performs a second function, since its front end will provide a stop of the screwdriver against the surface of the osteosynthesis instrument when the desired screwing depth is reached. Indeed, according to common practice, the screw and the screwdriver cooperate during the screwing, but separate once the screw is placed. Typically, the operator assesses by sight whether the screw has fully penetrated the part to be fixed and, lightening the pressure he exerts on the handle of the screwdriver, he will separate the tip thereof from the head of the screw. Originally according to the invention, the separation occurs when the front end of the guide member has come into contact with the osteosynthesis instrument, the screwdriver no longer being able to advance. The operator continuing to impart a rotational movement to the screwdriver, the screw will continue to advance, such that its rear end will gradually be freed from the adapter of the screwdriver. The screw is completely freed and its advance is stopped when its tip has

reached the depth initially selected. Even if the operator persists, the screw will not advance any further.

Thus, according to the present invention, the guide member that forms a stop against the wall of the osteosynthesis instrument is an independent element from the screw. It performs two functions by providing the guiding of the screw during screwing on the one hand, and stopping of the screw at a predefined depth, by separation of the screw and the screwdriver, on the other hand. In this way, it is possible to place a screw with a specific and chosen insertion depth, the depth being determined beforehand using means available to the practitioner (for example, using a depth gauge).

Once the screwing depth has been determined, it is possible, according to the invention, to modify the position of the stop based on said depth. It is possible to provide several positions of the guide member on the rod corresponding to different insertion depths of the screw. According to one preferred feature of the invention, the guide member is mounted sliding on the rod, means for blocking said member in at least one position along the length of the rod being provided. This position corresponds to the predefined screwing depth of the screw and conditions the portion of said member that must be made to protrude in front of the adapter. An adjustable stop is then produced by sliding the guide member on the rod to obtain a chosen extension length.

Advantageously, said guide member is in the form of a tube, the front end of which is provided with an orifice allowing an axial translation of the screw. The tube is mounted on the rod, which it partially surrounds and on which it can slide. Its front end, which serves as a stop, is pierced with an orifice allowing the screw to pass. It can be tightened again relative to the body of the tube so as only to allow the play necessary for the advance of the screw to remain while keeping it effectively in the screwing axis.

Preferably, the blocking means assumes the form of a knurled wheel having an axle passing through the guide member and being blocked on the rod. A knurled wheel is a means for removably securing the guide member on the rod suitable for adjusting the length of the guide member protruding past the adapter of the screwdriver, while being able to be manipulated easily by the practitioner through simple rotation.

Although it can be used with any type of screw, the screwdriver according to the invention is above all indicated for placing a headless screw. That is why, advantageously, the screw used in the system according to the invention is a headless screw, the rear end of the

screw not protruding laterally relative to the shaft of the screw (past the edge of the thread). The section of such a screw therefore has a diameter that is identical or at least similar to that of the shaft over its entire length.

This feature is advantageous for several reasons. First of all, the orifice of the guide member may have a diameter barely larger than that of the screw, so as to ensure effective guiding thereof. Secondly, the absence of protrusion on the screw allows it to pass fully through the orifice of the guide member. It is not only possible to position the screw on the screwdriver through the orifice of the guide member without having to disassemble it, but above all, the screwdriver and its guide member can be removed after having done the screwing. Lastly, and particularly interestingly, the screw can be screwed with a significant incline relative to the normal, without any bother to house a screw head in the eyelet of the osteosynthesis instrument to be fixed, since the bulk at the eyelet due to a protruding head is eliminated. It is possible to reduce the size of the holes provided on the osteosynthesis instrument, which increases its rigidity compared to instrument with beveled holes for a screw with a head.

According to one preferred feature of the invention, the screw is made from a polymer material, which may or may not be resorbable, or a composite polymer and ceramic mixture. The screw used in the fixation system may be made up 100% of a thermoplastic polymer such as PEEK, PEKK, implantable polyamines, UHMWPE, PETs, or PLA, the latter being bio-resorbable. It is also possible to use a screw made from a composite material combining a resorbable polymer and a resorbable ceramic. The ceramic can for example be chosen from among calcium sulfate, calcium phosphate, calcium carbonate, silicates, in particular bio-glasses, and will preferably be calcostronic hydroxyapatite or tricalcium phosphate. The interest of this composition lies on the one hand in its faster degradation speed than that of an osteosynthesis instrument made from polymer alone, and on the other hand in the fact that it is radiopaque.

These plastic and/or composite materials have the advantage of being easily sectioned. The surgeon can cut the rear part of the screw projecting past the implantation site using a simple clamp, for example, and will not be required to select a precise screw length before operating. When the desired screw length has penetrated the bone, it will be possible to section the excess rear part of the screw level with the osteosynthesis instrument, then to fuse it with the material at the eyelet, to reinforce its locking with the osteosynthesis

instrument. Thus, surgeons will be provided with screws with different useful diameters, but only one length. This limits the number of references that must be provided to the surgeon. A particularly interesting cooperation may therefore be obtained between headless screws made from a polymer or composite and the screwdriver of the fixation system. It will, however, be noted that polymer or composite materials not being as strong as the metals typically used, it is preferable for the rear end of the screw and the adapter of the screwdriver to be well suited to the stresses that they will undergo, in particular during screwing. That is why it is proposed for the screw to include, in the extension of the threaded shaft, a rear part allowing a solid, albeit temporary, association of the screw and the screwdriver. Thus, according to one particular embodiment of the invention, the screw has a non-threaded axial extension extending the threaded shaft and ending with the rear end, said rear end and the adapter adopting complementary nesting male and female shapes. This makes it possible to provide the screw with a thread only over a portion for which this thread is necessary.

This also makes it possible to give the rear part of the screw a smaller thickness than the adapter of the screwdriver, such that the latter can grip the rear of the screw to maintain it correctly, even if the polymer material tends to deform. That is why, preferably, the rear end of the screw constitutes the male form and the adapter constitutes the female form.

Still more preferably, the rear extension of the screw adopts the form of a spatula, i.e., a blade that is wider than it is thick. In this case, the adapter of the screwdriver is preferably a U-shaped mandrel able to receive the end of the rear extension of the screw. The use of a mandrel is particularly well suited to removable securing with the rear extension of the screw, but remaining firm during rotation of the screwdriver to contribute to maintaining the screw when the latter undergoes torsion. At the end of screwing, when the front end of the guide member abuts, the spatula will free itself spontaneously and easily from the U-shaped legs of the mandrel, until it is completely separated therefrom, thus freeing the entire screwdriver. It will then suffice to remove the guide member from the rear position of the screw still protruding, section the latter level with the plate, and optionally fuse it with the plate using the electric knife.

Preferably, if the adapter of the screwdriver is a U-shaped mandrel, this adapter is provided with a removable sleeve to reinforce the strength of the mandrel during screwing.

The adapter of the screwdriver can adopt various shapes, as long as the rear end of the screw is configured in a complementary manner. It may also be interchangeable, which makes it possible to keep the same screwdriver body to screw different types of screws while only changing the screwing adapter. This also makes it possible to use the same
5 screwdriver body by associating it with other tools for work other than screwing, for example drilling and/or tapping the instrument and the bone tissue.

It is convenient to be able to reflect the insertion depth of the screw, predefined as explained above, directly on an element of the screwdriver visible to the practitioner. Indeed, the exact position of the guide member relative to the rod corresponding to the
10 desired insertion depth of the screw, it is advantageous to have precise references to slide the guide member on the rod up to the desired length. That is why, advantageously, the rod of the screwdriver comprises means for viewing the adjustment of the position of the guide member relative to the rod.

To that end, it is for example possible to make the guide member from a transparent
15 material, such that the rod remains visible, the latter bearing references on its length. It is also possible to provide a window arranged in the guide member. According to one preferred embodiment, the display means comprise a graduated scale carried by the rod, and a slot formed in the guide member making it possible to see at least part of said scale. The scale may include graduations in the same unit as that used on the depth gauge. Once
20 the appropriate extension of the system is done, the guide member is fastened on the rod using the selected blocking means, for example a knurled wheel.

It will be noted that the method of associating the adapter and the rear of the screw should be taken into account, in particular if the adapter takes the form of a mandrel, the latter having a certain depth. Indeed, the guide member arriving in the abutting position, the
25 screw is still associated with the mandrel. It will advance a little more, such that its rear end will gradually be released from the hold of the mandrel, ultimately being freed therefrom. The depth of the mandrel must therefore be taken into account in the graduation of the scale, offsetting the origin accordingly, so that the screw reaches the previously measured depth before separating the adapter and the screw.

30 The screwdriver of the system according to the invention includes a handle to be grasped by the operator. The handle of the screwdriver can comprise a gripping member mounted

freely rotating. The practitioner can thus continue to rotate the tool without releasing pressure on the handle.

Owing to the fixation system associating screws and an appropriate screw driver, it is henceforth possible to place screws, advantageously made from a polymer, conveniently, solidly and reliably over time. This allows the use of osteosynthesis instruments made from polymer materials without raising the difficulties that have limited their widespread use in surgery to date. The system therefore performs better than a metal screw-osteosynthesis instrument assembly, the maximum orientations of which are limited.

The present invention will be better understood, and details thereof will appear, through the description provided below of one of its alternative embodiments, relative to the appended figures, in which:

- Figure 1 shows a same screwdriver and a screw that are part of the fixation system according to the invention. It is broken down into figures 1a, 1b and 1c, in which the guide member is more or less engaged on the rod.
- Figure 2 shows an exploded view of the system according to the invention, the parts arranged at the distance that they occupy with respect to the insertion site of the screw.
- Figure 3 is a perspective view of a screw included in the fixation system according to the present invention.

DESCRIPTION OF THE FIXATION SYSTEM

Figures 1 and 2 show a screwdriver 1 and a screw 12 intended to be screwed into a bone tissue 16 receiving an osteosynthesis instrument, in the case at hand a plate 15. The screwdriver 1 and the screw 12 are part of the system for fixing an osteosynthesis instrument according to the present invention. The screw 12 has a threaded shaft 13 intended to be inserted by screwing through the osteosynthesis plate 15 and the bone tissue 16. The threaded shaft is extended by the rear extension 14 bearing the rear end 14a.

The screwdriver 1 comprises the cylindrical handle 3 extending in the length of the screwdriver 1. The handle 3 is provided with a gripping element 2, which can assume different forms, for example a knob or T-shape. The handle 3 includes an axle 9 extending

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it at its end facing the gripping element 2 and serving for fitting of the latter. It is possible to motorize the screwdriver 1 by attaching it to motor means secured to the axle 9.

The handle 3 is extended by the cylindrical rod 5, the front end of which bears the adapter 7 forming the front of the screwdriver 1. Below, for the elements of the screwdriver 1, the term "front" will describe any element found across from the screw 12.

During its use, the rod 5 of the screwdriver 1 is partially covered by the guide member 4 of the screw 12, which will be described in more detail later. This guide member 4 has a portion that protrudes toward the front past the adapter 7.

The rod 5 includes, on part of its outer surface, display means consisting of a slot 10, allowing the scale 6 bearing graduations to appear, so that the surgeon, using the screwdriver 1, adjusts the length of the forward projection of the portion of the guide member 4 protruding past the screwdriver 1, in order to obtain a desired insertion depth for the screw 12.

The front end of the screwdriver 1 bears the adapter 7, which cooperates with the rear end 14a of the screw 12. In some embodiments, the adapter 7 can be removable so that the screwdriver 1 can be provided with different screwing shapes cooperating with different complementary shapes provided on the rear end 14a of the screw 12.

The adapter 7 has a central recess receiving the rear end 14a, this recess making it possible to temporarily secure the screw 12 with the screwdriver 1 during the screwing. In figure 2, the adapter 7 is in the form of a U-shaped mandrel receiving the rear end 14 and allowing it to be maintained when the screw 12 undergoes torsion. The adapter 7 is covered by the protective sleeve 8 surrounding it while allowing the rear end of the screw 12 to pass in the adapter 7. The sleeve 8 can be removable, or on the contrary mounted fixed, for example by welding.

The guide member 4 assumes the form of a hollow tube that partially covers, while surrounding, part of the rod 5 of the screwdriver 1, and protrudes in front of the screwdriver 1, such that it can receive part of the screw 12 inside it. The guide member 4 is provided at its front end 4a with a sufficient orifice 4b to allow the advance of the screw 12. It thus serves to guide this screw 12 in axial translation, the screw 12 penetrating its front opening 4a when the screw driver 1 is placed in the screwing position. The guide member 4 also serves as a stop for the screwdriver 1 with its front end 4a abutting against the wall of the osteosynthesis plate 15 when a predefined insertion depth of the screw 12 in the bone

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tissue 16 has been reached. Said insertion depth may not be exceeded, since the screw 12 and the screwdriver 1 are separated due to the abutment of the guide member 4 against the plate 15.

As shown in figures 1 to 3, the guide member 4 is advantageously in the form of a tube covering part of the screw 12 and the rod 5. It may slide along the screw 5 of the screwdriver 1. It includes the knurled wheel 11 having the axle 11a that is fixed radially by screwing against the rod 5 of the screwdriver 1, passing through the wall of the guide member 4. The guide member can thus be blocked in a chosen position. The slot 10 arranged on the guide member 4 allows the practitioner to see the graduations 6a of the scale 6 during the positioning, then blocking of the guide member 4 on the rod 5.

The fixation system according to the invention may comprise several types of screws, of different sizes and/or shapes. The screw presented in the present example embodiment (figure 3) of the invention is a headless screw. The screw 12 comprises the threaded shaft 13 extended by a non-threaded axial extension 14, bearing the rear end 14a not protruding laterally relative to the shaft of the screw 12. The threaded shaft 13 has a circular section, the rear extension 14 in turn having a substantially rectangular section, which gives it a spatula shape. This shape is fully indicated to cooperate with the adapter 7 in the form of a U-shaped mandrel.

It is also possible to provide a circular rear extension 14 or a circular threaded shaft 14 with no axial extension. In these two cases, the rear end 14a of the screw 12 may have at least one axially protruding part or at least one receiving housing respectively cooperating with a receiving housing or an axial protruding part provided on the adapter of the screwdriver.

USE OF THE FIXATION SYSTEM

Figures 1a, 1b and 1c show the same screwdriver, but with a different adjustment. An identical screw in all three cases has been installed on the screwdriver, pushing it in through the orifice 4b in the guide member 4, until its rear end 14a has arrived in the adapter 7. As shown, the length of the screw (denoted A, A' and A'') protruding past the front end 4a of the guide member 4 is in relation with the degree of retraction of the guide member 4 on the rod 5.

The projection length of the guide member 4 in front of the screwdriver 1 can also be precisely fixed. In practice, the depth of the hole having to receive the screw 12 is read, using a tool such as a depth gauge, and depending on this insertion depth of the screw thus predefined, the guide member 4 is slid to the corresponding position on the rod 5, identified by direct reading on the scale, and blocked in that position. The desired insertion depth of the screw 12 in the plate 15 and the tissue 16 is thus subtracted from the length of the screw 12 by the adjustment of the positioning of the guide member 4.

It is further necessary to take into account the method of associating the adapter and the rear of the screw, in particular if the adapter adopts the form of a mandrel, the latter having a certain depth. The guide member reaching the abutting position, the screw will still advance slightly, such that the rear end of the screw will gradually be released from the hold of the mandrel, to ultimately be completely freed therefrom. The depth of the mandrel must be taken into account in the graduation of the scale, offsetting the origin accordingly.

In figure 2, the exploded depiction of the system according to the example shows the correspondence between the penetration depth A_0 of the screw through the plate 15 and in the bone 16, and the position of the cursor 6a on the scale 6 at the retraction distance A of the guide member. During screwing in the bone tissue 16, the screw 12 sinks into the plate 15, then the bone tissue 16, such that the front end 4a of the guide member 4 comes closer to the wall of the plate 15. When the screw 12 has penetrated at the depth A_0 (decreased by the penetration length of the rear of the screw in the mandrel), the front end 4a of the guide member 4 abuts against the plate 15. An additional rotation of the screwdriver 1 will cause the screw to advance, while the screwdriver is now blocked, causing the gradual withdrawal, then separation of the rear end 14a of the screw and the adapter 7. A fine calibration makes it possible to account for the fact that the material of the screw will deform under the torsional force experienced, and the depth of the tabs of the mandrel. The scale 10 is therefore calibrated to correspond exactly to the predetermined depth A_0 .

To obtain effective bicortical fixation, as illustrated in figure 2, the screw 12 passes all the way through the thickness of the plate 15 and the tissue 16, but it does not protrude too far in the other side of the bone tissue. This is henceforth possible owing to the system according to the invention. What has been described above is valid for all insertion depths

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by screwing of the screw 12 in an osteosynthesis plate 15 or another instrument, and a bone tissue 16.

The screws 12 may have varied compositions, for example made up of up to 100% of at least one polymer. It is possible to use polylactic acid (PLA) such that they have an elasticity allowing them to be jammed in the osteosynthesis plate 15. In general, the screws 12 may be made from a resorbable or non-resorbable polymer, or a mixture of resorbable or non-resorbable polymers, or a composite mixture of at least one polymer and one or several ceramics.

The system is particularly suitable for the fixation of a plate, or other instrument, made from a resorbable or non-resorbable polymer, using screws also made from such materials, as set out above. Once the screw is inserted, and the screwdriver is removed, the remaining part is sectioned level with the plate, which is easily possible once the material making up the screw is of the polymer or polymer-based composite type. The pulling out force of the screw 12 forcibly engaged in the plate 15 and the bone tissue 16 is then identical to the pulling out force of a screw head. To obtain even better locking of the screw 12 in the plate 15, it is possible to heat seal the screw 12 and the plate 15, for example using an electric knife.

SYSTEM TIL FASTGØRELSE AF ET STYKKE OSTEOSYNTETISK UDSTYR

PATENTKRAV

1. System til fastgørelse af et osteosyntetisk instrument mod et knoglevæv (16),
5 hvilket system består af mindst:
 - i) En skrue (12), som har et gevindskift (13) og en bagende (14a), og
 - ii) en skruetrækker (1), som har et håndtag (3), der er forlænget med en stang (5),
hvis ende bærer en adapter (7), der er egnet til at samvirke med skruens (12) bagende
(14a), hvor nævnte skruetrækker er tilvejebragt med et føringselement (4) af skruen
10 (12), der er forbundet med stangen (5), og som har en forende (4a), hvor én del af
føringselementet (4) rager ud foran skruetrækkerens (1) adapter (7), og som forløber
langs eller omkring en del af skruen (12) for at føre den i aksial translation, og hvor
nævnte føringselement (4) er monteret på en sådan måde, at det kan glide på stangen
(5), hvor der er tilvejebragt midler til låsning af nævnte element (4) i mindst én position
15 over stangens (5) længde,
kendetegnet ved, at skruen (12) består af et materiale, der omfatter en polymer, hvor
skruen er indsat frit i translation i føringselementet, og hvor føringselementet (4) er låst
med nævnte låsemidler i én position over stangens (5) længde, der svarer til en
forudbestemt iskruningsdybde af skruen (12), hvor nævnte forende (4a) af
20 føringselementet (4) danner et anslag for skruetrækkeren (1) imod overfladen af nævnte
osteosyntetiske instrument, når en forudbestemt iskruningsdybde af skruen (12) i
knoglevævet (16) er nået, hvilket bevirker, at skruetrækkeren (1) blokeres, og at skruen
kan køre frem til anslag ved at adskille skruens (12) bagende (14a) fra adapteren (7).
2. System ifølge krav 1, kendetegnet ved, at nævnte føringselement (4) har form af
25 et rør, hvis forende (4a) er tilvejebragt med en åbning (4b), der tillader skruens (12)
aksiale translation.
3. System ifølge krav 1 eller 2, kendetegnet ved, at midlerne til låsning af
føringselementet (4) har form af et riflet hjul (11), som har en aksel (11a), der passerer
igennem føringselementet (4), og som er blokeret på stangen (5).
- 30 4. System ifølge et af kravene 1 til 3, kendetegnet ved, at skruen (12) er en
hovedløs skrue (12), og ved, at bagenden (14a) af skruen (12) er uden lateral
udragning.

5. System ifølge et af de foregående krav, kendetegnet ved, at skruen (12) er fremstillet af valgfrit resorberbart polymermateriale eller af kompositpolymer og en keramisk blanding.
6. System ifølge et af de foregående krav, kendetegnet ved, at skruen (12) har en aksial forlængelse (14) uden gevind som fortsættelse af gevindskaffet (13), og som ender ved bagenden (14a), hvor nævnte bagende (14a) og skruetrækkerens (1) adapter (7) har komplementært aktiverbare han- og hunformer.
7. System ifølge et af de foregående krav, kendetegnet ved, at skruens (12) bagende (14a) udgør hanformen, og adapteren (7) udgør hunformen.
8. System ifølge et af de foregående krav, kendetegnet ved, at skruens (12) bagforlængelse (14) har form som en spartel.
9. System ifølge et af de foregående krav, kendetegnet ved, at adapteren (7) er en U-formet dorn, som er egnet til at modtage enden (14a) af skruens (12) bagforlængelse (14).
10. System ifølge et af de foregående krav, kendetegnet ved, at adapteren (7) er tilvejebragt med en aftagelig forstærkningsskrue (8).
11. System ifølge et af kravene 1 til 10, kendetegnet ved, at skruetrækkerens (1) stang (5) omfatter midler til visualisering af justeringen af føringselementets (4) position i forhold til stangen (5).
12. System ifølge krav 11, kendetegnet ved, at det omfatter en gradueret skala (6), der bæres af stangen (5), og en rille (10), som er dannet i føringselementet (4), der gør det muligt at se i det mindste en del af nævnte skala (6).
13. System ifølge et af de foregående krav, kendetegnet ved, at skruetrækkerens (1) håndtag (3) omfatter et holdeelement (2), der er monteret frit i rotation.

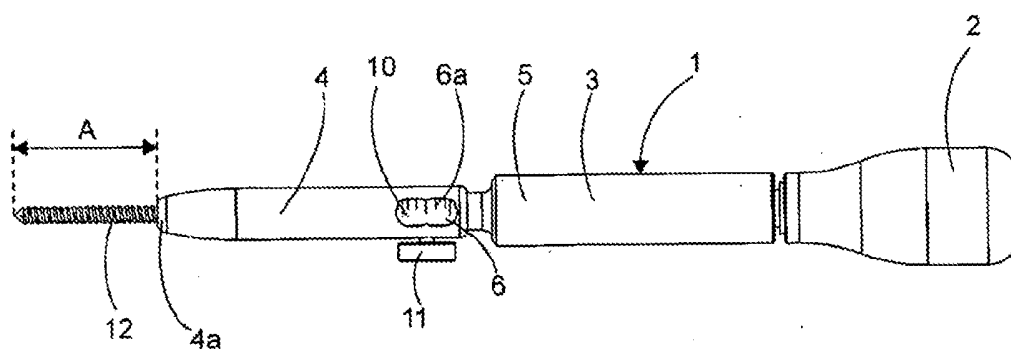


FIG. 1a

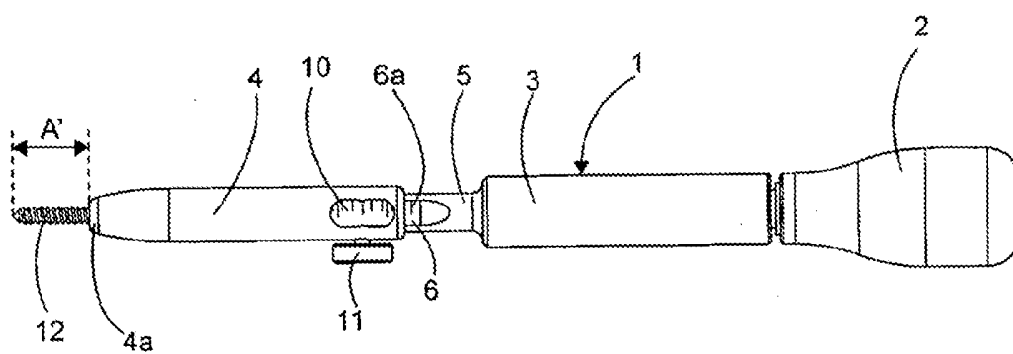


FIG. 1b

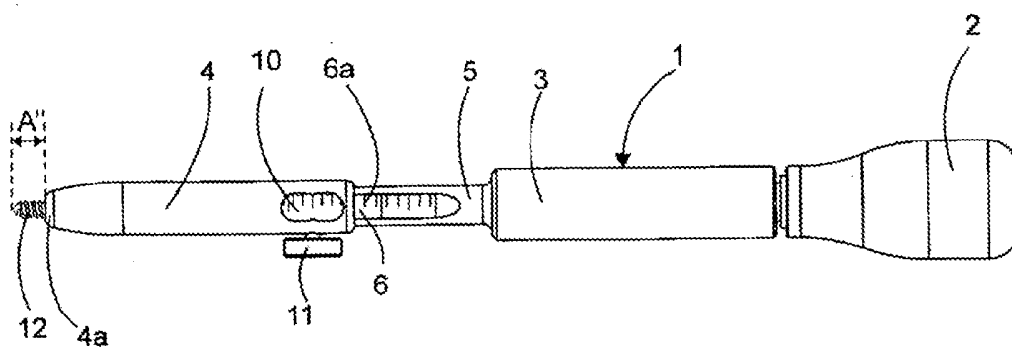


FIG. 1c

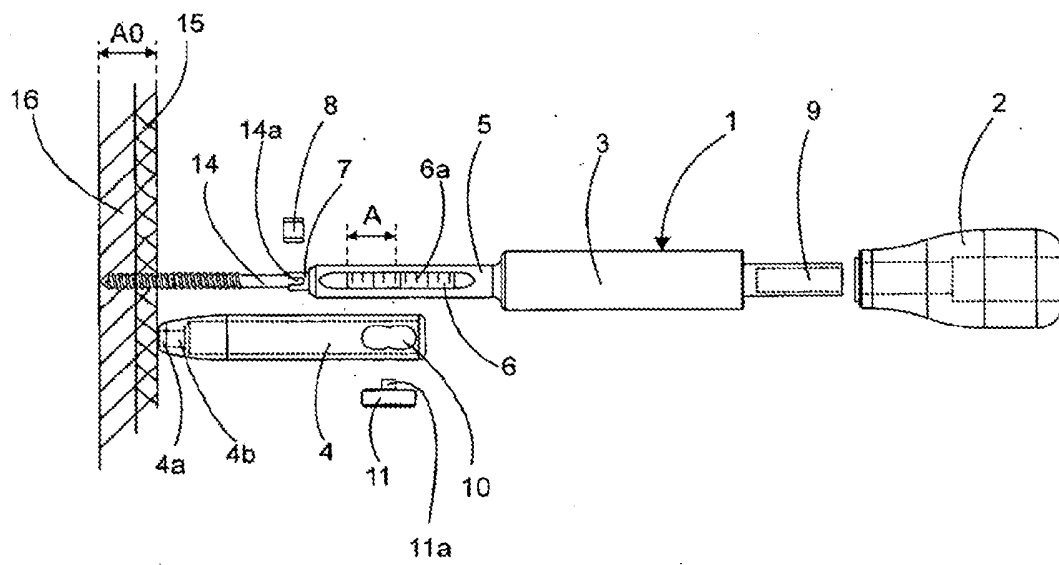


FIG.2

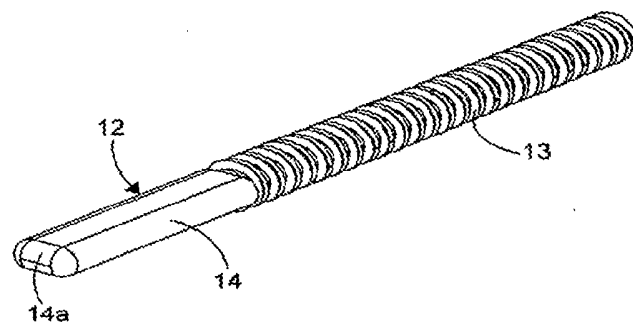


FIG.3