

SURGICAL INSTRUMENT

The present invention relates to a surgical instrument, in particular for use in dental surgery.

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Dentists performing surgeries, oral surgeons, and maxillofacial surgeons are often faced with the challenge that bone has been lost in the oral cavity as a result of bone atrophy, accidents, periodontitis, or tooth extraction.

10 When dental implants are planned in order to insert new teeth, it is important that these bone deficits be constructed before or at the same time the implant is placed, so that the dental implants once again have a new foundation and a stable support.

Autologous bone is still considered to be the gold standard in bone grafting
15 procedures. This is due to the properties of the bone, since autologous bone combines osteogenic, osteoinductive, and osteoconductive properties. This means that the bone has the potency to generate its own bone tissue and form its own vessels; in addition, it acts as a guide structure for newly generated bone. In contrast to autologous bone, bone replacement material does not have any biological potency
20 and therefore acts only osteoconductively, i.e., it also acts as a guide rail.

Various methods for working with autologous bone are already known. In the case of larger bone deficits, toothless bone areas basically lend themselves as secondary
25 intraoral extraction points, with the maxillary tuberosity, the anterior nasal spine, the palate, the region of the maxillary sinus wall in the upper jaw or the lower jaw as alternatives, since they are of a rather cortical nature, and the bone quality is considered to be very good and stable. There are various bone extraction points in the lower jaw, e.g., toothless areas, the chin, or the retromolar region.

30 The bone extraction may in this case take place using various instruments. The concept of the bone extraction is mostly similar here.

Three to four predetermined breaking points are created using either a so-called Lindemann bur or a piezosurgery device, or, alternatively, a small saw, and the block
35 is subsequently extracted using a chisel or another instrument. This is

disadvantageous in that a somewhat extensive force needs to be applied to the jaw during bone extraction. Therefore, this procedure is somewhat dreaded by the physician, also because this hammering or breaking free of the bone block from the respective region is also uncomfortable for the patient.

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Dentists are accustomed to rotary instruments and drills because of their profession. Thus, use of the so-called trephine bur or hollow bur, which is put on a handpiece and has a head that is designed as a hollow cylinder, has also become established in this way. Teeth for machining the bone are formed on the distal edge of the head.

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Trephine burs are used, for example, for implant bed preparation and have a diameter of approximately 3 mm to 4 mm. Using these burs, extremely small and narrow drilling cylinders are removed, which are only conditionally suitable for bone construction.

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In the case of the aforementioned devices, approximately three to four cuts or predetermined breaking points must be created for the bone extraction in order to obtain the necessary piece of bone. This causes great stress for the patient and requires great technical skill on the part of the surgeon. In the process, it must, in particular, be ensured that the surrounding soft tissue, e.g., the cheek or lip, is not injured by the surgical tool.

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The object of the invention is therefore to design and develop a surgical instrument in such a way that reliable bone extraction that is gentle for the patient is possible with structurally simple means.

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According to the invention, said object is achieved by the features of claim 1. The invention relates to a surgical instrument, in particular for use in dental surgery, comprising a machining device and a protector device, wherein the machining device comprises a shaft with a connection region and a hollow cylindrical head, wherein an operating area, particularly for machining and/or grinding bone is formed at a distal edge of the head, wherein the protector device surrounds the head, at least in regions, and wherein the protector device is rotatably coupled to a bearing element of the machining device extending, at least partially, within the head.

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According to the invention, it has been recognized that the underlying object can be achieved, in a surprisingly simple way, by means of the combination of a machining

device, in particular a trephine bur, and a protector device. For this purpose, the machining device has a shaft with a connection region and a hollow cylindrical head. The connection region can be used for connection to a surgical handheld device, for example a common elbow or handpiece, as is used by dentists or dental surgeons. Furthermore, the distal edge of the head is designed as an active region, in particular for machining bone. For example, the distal edge may have cutting or sawing teeth and/or a diamond tip.

In a manner further according to the invention, it has been found that the protecting device can be rotatably coupled to the head or the machining device in a particularly safe and simple manner in that the machining device has a bearing element extending, at least in regions, within the head. It is thus possible to machine bone at the extraction site with the distal edge of a machining device rotated by a medical handheld device, while the protector device remains at least substantially stationary, namely due to the pivotal connection between the protector device and machining device. Thus, the surrounding tissue is ideally protected from injuries.

In doing so, it is specifically conceivable for the bearing element to extend in the axial direction, in particular from the bottom of the head at least to the distal edge of the head. The protector device can be coupled to the free end of the bearing element. The bearing element does not necessarily have to extend up to the distal edge in the axial direction, provided the protector device projects a corresponding distance into the head in order to be rotatably coupled to the bearing element. More advantageously, the bearing element extends, in the axial direction, beyond the distal edge of the head such that the connection between the protector device and machining device is implemented outside of the head. In particular, it is conceivable for the bearing element to be formed in the shape of a pin and to engage the protector device in a corresponding region.

In a particularly advantageous manner, the protector device surrounds the head such that only a circular arc of the distal edge serves as the active region. Contrary to a preconception of a person skilled in the art, it has been recognized that a machining device with a head designed as a hollow cylinder, which has an active region for machining bone, is not only suitable for removing small drill cylinders. Instead, an appropriately designed machining device can be used to "cut away" the

required piece of bone or bone segment from the bone. The special arrangement and configuration of the protector device means that only a circular arc of the distal edge of the head can be placed into contact with the bone and thus serve as an effective active region. As a result of this design, it is possible for surgeons to “peel off” an approximately crescent-shaped bone piece from the bone that is usable for bone construction. In contrast to the instruments and tools known from the prior art, there is no need to create three to four cuts and/or predetermined breaking points. Instead, only a single predetermined breaking point – for example apical – results; a hammering-out of the bone is not necessary. The resulting block can then be extracted or luxated without applying extensive force, which is much more gentle and comfortable for the patient compared to the known devices and techniques. The protector device advantageously surrounds the head in such a way that a circular segment formed by the circular arc has a segment height of from 2.0 mm to 3.5 mm, preferably of from 2.2 mm to 2.5 mm.

It is especially conceivable for the head to have an inner diameter of from 5 mm to 10 mm, preferably of from 6 mm to 8 mm, and/or a wall thickness of from 0.2 mm to 0.6 mm, preferably of 0.4 mm. Alternatively or additionally, the head may have a depth of from 6 mm to 17 mm, in particular of from 9 mm to 14 mm, and/or the bearing element may have a length of from 10 to 19 mm, in particular of from 12 to 17 mm. In a particularly advantageous manner, the bearing element may extend 2 mm to 4 mm, in particular 3 mm, beyond the distal edge of the head in the axial direction.

In order to use the distal end of the protector device for displacing the surrounding tissue at the extraction site, the protector device may preferably be completely, but at least largely, closed at its distal end. In this case, a particular combinatorial effect is achieved with the design of the bearing element, which namely stabilizes the protector device when the outer tissue exerts pressure on the distal end of the protector device, especially in the axial direction.

In order to establish a secure connection between the protector device and the machining device, the protector device may be rotatably coupled to the shaft at its proximal end. In concrete terms, it is conceivable here for the protector device to surround the shaft in the circumferential direction.

Advantageously, the protector device can be rotatably coupled to the bearing element and/or the shaft via a sliding bearing and/or a ball bearing and/or a roller bearing. In particular, a sliding bearing is advantageous here, since this is characterized by an extremely simple and thus cost-effective design. The sliding bearing does not have to be formed as a separate element; instead, the corresponding region of the protector device or the machining device may represent the sliding bearing.

In order to prevent the processed tissue from being damaged by overheating, at least one fluid opening, for example having a diameter of approximately 0.5 mm to 0.9 mm, preferably of 0.7 mm, can be formed on the bearing element, said opening being connected to a fluid channel, for example having a diameter of approximately 0.5 mm to 1.0 mm, preferably of 0.8 mm. The fluid channel may extend from the connection region through the shaft and the bearing element to the at least one fluid opening. Thus, a cooling liquid can be introduced, for example, from the surgical handpiece, with which the surgical instrument is connected via the connection region. Since the bearing element is arranged within the hollow cylindrical head, the hollow cylindrical head and, in particular, the distal edge can ideally be exposed to cooling fluid.

In a further advantageous manner, the protector device can be made of plastic or metal. Plastic has the advantage that the protector device can be produced particularly simply and thus cost-effectively. Furthermore, a sliding bearing for connecting the protector device to the bearing element and/or the shaft can be produced in a particularly simple manner when the protector device is made of plastic. The realization of the protector device from metal offers the advantage that the protector device can be prepared again – for example in an autoclave – so that multiple use is possible.

In order to allow the surgeon a good view of the extraction site, the protector device can ideally be transparent, for example made of a transparent plastic. Alternatively or additionally, a depth marking can be formed on the outer wall of the head so that the surgeon can easily understand how deeply the head is placed into the bone to be machined. To this end for example, an especially black strip, preferably as a laser

marking, may be formed on the outer wall at regular intervals. The depth marking may be formed, in particular, in increments of 1 mm to 3 mm, preferably of 2 mm.

In a particularly refined manner, at least one opening can be formed in the side wall of the head, through which the surgeon can push the extracted bone piece out of the head, for example with tweezers. The opening can be oval, for example, wherein the longest axis can be particularly 3 mm to 5 mm, preferably 4 mm.

In a further advantageous manner, a securing element made of a material, in particular of plastic, can be formed on the shaft, the shape and/or color of which changes during preparation of the instrument, for example during autoclaving. In a particularly advantageous manner, the securing element can be arranged in or on the connection region and varied, during preparation of the instrument, in such a way that the instrument can no longer be coupled to a medical handset.

There are various options for advantageously designing and developing the teaching of the present invention. To this end, reference is made, on one hand, to the claims referring back to claim 1 and, on the other hand, to the subsequent explanation of a preferred exemplary embodiment of the invention by means of the drawing. Generally preferred embodiments and developments of the teaching are also explained in conjunction with the explanation of the preferred exemplary embodiment of the invention with reference to the drawing. The drawings show the following:

Fig. 1 shows a schematic, perspective representation of an exemplary embodiment of a surgical instrument according to the invention;

Fig. 2 shows the surgical instrument according to the invention from Fig. 1 in a schematic, lateral representation;

Fig. 3 shows the surgical instrument according to the invention from Fig. 1 in a further schematic, perspective representation;

Fig. 4 shows the surgical instrument according to the invention from Fig. 1 in a schematic, sectional representation;

Fig. 5 shows the surgical instrument according to the invention from Fig. 1 in a further schematic, sectional representation;

Fig. 6 shows the surgical instrument according to the invention from Fig. 1 in a schematic, partially sectional representation;

Fig. 7 shows the surgical instrument according to the invention from Fig. 1 in a further schematic, partially sectional representation;

Fig. 8 shows the surgical instrument according to the invention from Fig. 1 in a further schematic, partially sectional representation;

Fig. 9 shows the surgical instrument according to the invention from Fig. 1 in a schematic, perspective exploded view; and

Fig. 10 shows the surgical instrument according to the invention from Fig. 1 in a further schematic, perspective exploded view;

Figures 1 to 10 show, in various representations, an exemplary embodiment of a surgical instrument according to the invention. The surgical instrument comprises a machining device 1 which, in the exemplary embodiment shown here, is designed as a hollow bur or trephine bur. The machining device 1 comprises a shaft 2, which has a connection region 3 for coupling to a surgical handheld device, which is not shown, for example an elbow or handpiece of a dentist or dental surgeon. The machining device 1 can be set into rotation via the handheld device.

A hollow cylinder head 4 is arranged on the shaft 2. The head 4 has a distal edge 5, which is used as the active region 6 for machining and/or extracting the bone. For example, a diamond tip and/or sawing and/or cutting teeth may be formed on the distal edge 5.

A bearing element 7, which is designed as a bearing journal, extends into the head 4. In the exemplary embodiment shown, the bearing element 7 extends from the bottom 9 of the head 4 axially through the entire head 4 to beyond the distal edge 5. Specifically, the bearing element 7 is designed as an extension of the shaft 2.

Furthermore, a protector device 8 is rotatably coupled to the machining device 1. The base 10 of the protector device surrounds the shaft 2 and is rotatably coupled to both the shaft 4 and the bottom 9 of the head 4; namely, the bearing element 7 may be arranged in a recess of the distal end 11. Furthermore, the distal end 11 of the protector device 8 is closed and the protector device 8 is rotatably coupled to the bearing element 7 via the distal end 11. At this point it should be noted that the coupling between the protector device 8 and the machining device 1 can also take place via a separate bearing. It is only essential that the bone can be machined and/or extracted with the rotating head 4 of the machining device 1, while the protector device 8 essentially does not rotate and protects the surrounding tissue.

In particular, Fig. 1 clearly shows that the protector device 8 surrounds the machining device 1 such that only a circular arc of the distal edge 5 serves as the active region 6 and/or may be placed into contact with the bone to be machined. This embodiment prevents excessive penetration into the bone and protects surrounding tissue. Furthermore, it is possible for the surgeon to peel out an approximately crescent-shaped bone piece from the jaw. By coupling the distal end 11 of the protector device 8 to the bearing element 7, the distal end 11 can serve as a displacement element, with which the surrounding tissue can be displaced during engagement. In particular, Fig. 5 clearly shows that an oblique 17 is formed at the distal end 11. The oblique 17 simplifies the extraction of the bone segment from the head 4. Thus, the distal end 11 in the region of the oblique 17 is sufficiently solid reducing the diameter of the bearing element 7 at its end. It should also be noted that the corner region 18 of the distal end 11 may be rounded in order to prevent tilting of the protector device 8.

To extract the circular-segment-shaped bone piece from the head 4, openings 12 are formed in the side wall 13 of the head 4. The surgeon can thus push the loosened bone piece out of the head 4 through the opening 12 – for example with tweezers or a similar tool. Fig. 5 clearly shows that the opening 12' extends up to the bottom 9 of the head, so that the extracted bone segment can be pushed out of the head 4, in a particularly simple manner, with a separate instrument. In order to simplify this again, the edge 19 of the cylinder element 16 terminates in the axial direction with the bottom 9 of the head 4.

In order to cool the engagement point, a fluid channel 14 is formed, which extends from the connection region 3 through the shaft 4 and the bearing element 7. In

particular, Fig. 5 clearly shows that two fluid openings 15 are formed in the bearing element 7, which are in contact with the fluid channel 14 so that cooling fluid can be conveyed from the surgical handpiece to the fluid openings 15 via the connection region 3 and the fluid channel 14. The cooling liquid is sprayed from the fluid openings 15 onto the head 4 and/or the extraction site located behind it.

As can be seen in particular from Figs. 9 and 10, the protector device 8 is embodied in two parts in the exemplary embodiment shown here, namely having a base 10 and a cylinder element 16. The base 10 and the cylinder element 16 can be interconnected using positive-locking and/or friction-locking and/or bonding, for example screwed, clamped, glued, ultrasonically welded, etc. The base 10 of the protector device 8 can advantageously lie flat, at least in regions, on the bottom 9 of the head 4 in an advantageous manner.

With regard to other advantageous embodiments of the device according to the invention, to avoid repetition, reference is made to the general part of the description and also to the accompanying claims.

Finally, it is expressly pointed out that the above-described exemplary embodiments of the device according to the invention serve only to explain the claimed teaching, but do not limit it to the exemplary embodiments.

List of reference symbols

1	Machining device
2	Shaft
3	Connection region
4	Head
5	Distal edge (head)
6	Active region
7	Bearing element
8	Protector device
9	Bottom (head)
10	Base (protector device)
11	Distal end (protector device)
12, 12'	Opening (head)
13	Side wall
14	Fluid channel
15	Fluid opening
16	Cylinder element
17	Oblique
18	Corner region
19	Edge

Claims

1. A surgical instrument, in particular for use in dental surgery, with a machining
5 device (1) and a protector device (8), wherein the machining device (1) has a shaft (2)
with a connection region (3) and a hollow cylindrical head (4), wherein an active region
(6), in particular for machining and/or for grinding of bone, is formed at a distal edge (5)
of the head (4), wherein the protector device (8) of the head (4) at least partially surrounds
the head (4) and wherein the protector device (8) is rotatably coupled with a bearing
10 element (7) of the machining device (1) extending, at least in regions, inside of the head
(4).
2. The surgical instrument according to claim 1, characterized in that the bearing
element (7) extends in the axial direction, in particular from the bottom (9) of the head
15 (4), at least up to the distal edge (5) of the head (4).
3. The surgical instrument according to either claim 1 or 2, characterized in that
the bearing element (7) extends axially to beyond the distal edge (5) of the head (4).
- 20 4. The surgical instrument according to any of claims 1 to 3, characterized in that
the bearing element (7) is in the shape of a pin.
5. The surgical instrument according to any of claims 1 to 4, characterized in that
the protector device (8) surrounds the head (4) such that only a circular arc of the
25 distal edge (5) serves as the active region (6).
6. The surgical instrument according to any of claims 1 to 5, characterized in that
the protector device (8) is coupled with the bearing element (7) at its distal end (11).
- 30 7. The surgical instrument according to any of claims 1 to 6, characterized in that
the protector device (8) is closed at its distal end (11).
8. The surgical instrument according to any of claims 1 to 7, characterized in that
the protector device (8) is rotatably coupled to the shaft (2) at its proximal end.

9. The surgical instrument according to any of claims 1 to 8, characterized in that the protector device (8) is rotatably coupled to the bearing element (7) and/or the shaft (2) via a sliding bearing (17) and/or a ball bearing and/or a rolling bearing.

5 10. The surgical instrument according to any of claims 1 to 9, characterized in that at least one fluid opening (15), which is connected to a fluid channel (14), is formed on the bearing element (7), wherein the fluid channel (14) extends from the connection region (3) through the shaft (2) and the bearing element (7).

10 11. The surgical instrument according to any of claims 1 to 10, characterized in that the protector device (8) is made of plastic or metal.

12. The surgical instrument according to any of claims 1 to 11, characterized in that the protector device (8) is transparent.

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13. The surgical instrument according to any of claims 1 to 12, characterized in that at least one opening (12) is formed in the side wall (13) of the head (4).