

The invention relates to an endosseous implant comprising securing devices in the form of a head and a metal shank screwable to a base member for securing a stationary dental prosthesis which is removable under certain conditions, and also comprising a spacer sleeve provided with a centring collar and insertable into the open end of the base member and with a shoulder for abutting the top edge of the base member, and also comprising an intermediate element of resilient material such as plastics and concentrically surrounding parts of the shank.

EP-A-0 216 931 discloses an endosseous implant of this kind, in which the spacer sleeve has an upwardly and downwardly open bore and is made e.g. of plastics. The intermediate element is directly inserted into the base member and, optionally in co-operation with the spacer sleeve, which is made of resilient material, cushions the securing head or the dental prosthesis relative to the base member in all directions, i.e. both against vertical and against lateral loads. The intermediate element also provides electric insulation between the dental prosthesis and the base member, thus preventing harmful leakage currents, which may lead to corrosion and irritation of the body tissue.

The known implant has given good results on the whole, but it has been found that the intermediate element, which not only has a bearing and shock-absorbing function but also secures the shank, has a tendency to fatigue fractures particularly under tension. It has also been found that the amount of shock-absorption should if possible be adjustable, to ensure greater flexibility over a wide range of applications.

The aim of the invention is to improve the endosseous implant according to the preamble so as to eliminate or drastically reduce the risk of fatigue fractures under tension and also enable the shock-absorption to be adjustable and to increase the accuracy with which the dental prosthesis is fitted.

To this end according to the invention, in a further development of the implant in the preamble, the spacer sleeve is made of metal and is closed at its end remote from the head for securing the dental prosthesis and is screwable into the base member; the intermediate element is insertable into a widened portion at the open end of the spacer sleeve and has an annular shoulder for abutting the top edge of the spacer

sleeve; the intermediate element has an inner bore the diameter of which, in a region facing the head for securing the dental prosthesis and remote from the spacer sleeve, is greater than the outer diameter of the shank; and the shank is screwable into the spacer sleeve, when it presses an abutment surface of the dental prosthesis facing the intermediate element against an abutment shoulder of the intermediate element remote from the spacer sleeve.

Optionally, the depth to which the shank is screwable into the spacer sleeve is adjustable.

According to another proposed feature of the invention, the region of the shank in contact with the dental prosthesis comprises a plastics covering or the like.

In another embodiment of the invention, the dental prosthesis is mounted so as to be resilient and/or slightly movable relative to the shank in the axial direction thereof.

Optionally, a plastics ring or the like is disposed between the dental prosthesis and the shank.

Alternatively, the resilient mounting of the dental prosthesis relative to the shank is obtained by suitably shaping the plastics covering round the head of the shank.

According to another feature, the wide part of the spacer sleeve, which tightly receives the intermediate element, widens conically towards the open end.

Optionally also, the shank is screwable with adjustable torque into the spacer sleeve.

Another embodiment of the invention is characterised in that the base member and/or the exposed peripheral region of the spacer sleeve is/are coated with hydroxyl apatite or the like.

Optionally also according to the invention, the outer thread of the shank can be coated at the lower region with adhesive.

As also proposed by the invention, the intermediate element is made completely of resilient material such as plastics, and the inner bore of the intermediate element has a stepped width, its diameter, in a region

facing the spacer sleeve, being substantially equal to the outer diameter of the shank, and an adjacent region in the direction of the head securing the dental prosthesis has a diameter greater than the outer diameter of the shank.

As previously described, the invention is based on the surprising discovery that the initially-posed problem can be solved in a very elegant, satisfactory manner if the intermediate element, which in the prior art is an inner sleeve, is not used both for securing the shank and also as an electrically and mechanically insulating or shock-absorbing element, but if the shock-absorption or damping effect is separated from the securing function. The shank, made of metal, co-operates with the spacer sleeve, likewise made of metal, to secure the dental prosthesis accurately and reliably in the base member. The shock-absorption, on the other hand, is provided by the intermediate element which concentrically surrounds the shank, shock being absorbed in the vertical direction via the elastic volume of the intermediate element, which can be altered by varying the torque with which the shank is tightened, whereas lateral shock absorption is provided by the material of the intermediate element in conjunction with the shank, which operates like a vibrating rod and is disposed in an inner bore of the intermediate element, the bore being suitably widened at places. In this manner, when the dental prosthesis pivots in the shank, compressive and tensile forces and also torques are exerted on the intermediate element. The invention eliminates the risk of fatigue fractures under tension, to which previous implants have been subject.

The intermediate element can be made of polyoxymethylene as in the prior art. Optionally the rigidity of the arrangement can also be influenced by suitable choice of the material of the shank. The shank can also optionally be coated with adhesive at the bottom end of the screwed region, so that in addition to screwing into the base member there is an adhesive connection which prevents loosening but which of course can be broken by vigorous untwisting. Of course, the shank can be held in the intermediate element at various levels, and the rigidity can be influenced either thereby or by altering the diameter of the shank.

It has been found that in the previously-described embodiment of the implant according to the invention, in which the intermediate element is made entirely e.g. of plastics and has a stepped inner bore, the diameter of which in a region facing the spacer sleeve is substantially equal to the outer diameter of the shank, whereas an upper region adjacent thereto in the direction towards the head for securing the dental prosthesis has a diameter greater than the outer diameter of the shank, satisfactory vertical elasticity has not hitherto been satisfactorily ensured simultaneously with satisfactory horizontal elasticity.

This is because, to obtain adequate vertical elasticity, the one-piece intermediate element has to be made of a relatively soft plastics, in which case the lateral elasticity will easily become excessive, because a pivoting motion of the shank, similar to a vibrating rod, is not counteracted by sufficient resistance by the intermediate element. More particularly, in the previously-described embodiment of the implant according to the invention, the lateral deflection of the shank, operating like a vibrating rod, is not limited as reliably as is desirable, when the shank during lateral deflection abuts the wall of the inner bore of the intermediate element, if the intermediate element is also made of relatively soft plastics.

In order in simple manner to obtain satisfactory vertical elasticity simultaneously with satisfactory lateral elasticity with reliable lateral deflection of the shank, according to another proposed feature of the invention, the intermediate element comprises a core of relatively rigid material surrounding the shank and a shell of relatively soft resilient material surrounding the region of the annular shoulder and/or the abutment shoulder.

Optionally, the core is made of hard plastics such as polyoxymethylene or the like.

According to another optional feature of the invention, the core is made of metal.

The invention can also be characterised in that the core is made of titanium.

Optionally also according to the invention, the shell is made of soft plastics such as polyurethane or the like.

Another embodiment of the invention is characterised in that the core is in the form of a sleeve and has an annular collar in the region of the annular shoulder and the abutment shoulder.

Optionally the shell is positively connected to the core.

In another embodiment of the invention, the annular collar has an undercut.

Optionally also according to the invention, the shell is integrally formed on the core by injection moulding.

According to another feature of the invention, the inner bore of the core, in the region of the annular shoulder and the abutment shoulder, has a central region in which the inner diameter of the inner bore is substantially equal to the outer diameter of the shank.

Optionally, the smaller inner-diameter central region of the inner bore of the core is at the same distance from the end faces of the intermediate element.

As an alternative according to the invention, optionally the smaller inner-diameter central region of the inner bore of the core is at different distances from the end faces of the intermediate element.

In the previously-described embodiments, the intermediate element is made up of two different components, i.e. a core of rigid hard material, preferably titanium, and a shell surrounding at least parts of the hard core and made of soft resilient plastics. As a result, the lateral deflection of the shank can reliably be limited by the core, so that excessive lateral deflection is prevented, and also satisfactory vertical elasticity is assured in that a compressible soft resilient plastics such as polyurethane in the region of the annular shoulder and the abutment shoulder is available for absorbing vertical compressive stress. In further pursuance of the inventive idea, i.e. of separating the function of the shank-securing part from the function of the electrically and mechanically insulating or shock-absorbing element instead of combining them as in the

prior art, in the case of the last-mentioned embodiments the invention proposes that the two shock-absorbing or damping functions of the intermediate element, i.e. the vertical elasticity on the one hand and the transverse elasticity on the other hand, should again be separated, i.e. by the two-component structure of the intermediate element consisting of a hard core and soft shell.

In the last-described embodiments of the implant according to the invention also, parts of the inner bore of the intermediate element can be reduced in diameter so that the inner diameter is substantially equal to the outer diameter of the shank, although this is not absolutely necessary for operation of the intermediate element according to the invention. If the inner bore of the intermediate element or the core thereof, along its entire length, has a diameter greater than the outer diameter of the shank, the shank can bend to a limited extent inside the inner bore of the core, whereas the transverse deflection is limited when the shank, operating like a vibrating rod, abuts the top edge of the inner bore. According to the invention also, as explained, a central region of the inner bore can optionally correspond to the outer diameter of the shank, in which case, if the central region is symmetrically in the longitudinal centre, the intermediate element will be completely symmetrical and can be installed in either direction, whereas if the central region is asymmetrical with respect to the longitudinal centre of the intermediate element, the intermediate element can be given different lateral elasticity and damping properties depending on the direction in which it is inserted.

Other features and advantages of the invention will be clear from the following description, in which embodiments are explained in detail with reference to the diagrams, in which:

Fig. 1 shows a first embodiment of an endosseous implant according to the invention, in longitudinal section through the longitudinal central axis of the shank;

Fig. 2 shows another embodiment of the endosseous implant;

Fig. 3 shows an embodiment of an intermediate element varying from the implant in Fig. 2;

Fig. 4 shows the core of the intermediate element in Fig. 3;

Fig. 5 shows a variant embodiment of an intermediate element of use in the implant in the embodiment in Fig. 2, and

Fig. 6 shows the core of the intermediate element in Fig. 5, corresponding to a longitudinal section through the longitudinal central axis of the intermediate element as in Figs. 3, 4 and 5.

As Fig. 1 shows, in the embodiment shown the implant has a base member 10 of titanium coated with hydroxyl apatite on the part of its outer surface in contact with body tissue. The function of the base member corresponds to that of the endosseous implant in EP-A-0 216 031, which should be referred to for further explanation of operation, e.g. of the apertures in the base member 10. A spacer sleeve 12, likewise of titanium, is screwed into the base member 10. A shoulder 14 of the spacer sleeve 12 abuts the top edge of the base member 10 as shown in the drawing. The bottom end of the sleeve facing the base member 10 is closed and, at its bottom, closed end, has an internally threaded inner bore. A centring collar is formed by a wide portion 16 at the top end of the spacer sleeve 12. The peripheral surface of the spacer sleeve 12 coming into contact with body tissue is coated, like the base member 10, with hydroxyl apatite, which is compatible with body tissue. A resilient intermediate element 18 made of polyoxymethylene is inserted into the wide part 16 of the spacer sleeve 12, and in the lower region facing the sleeve 12, the inner bore of element 18 has an inner diameter substantially equal to the outer diameter of titanium shank 20, whereas the upper region of the bore is made considerably wider than the outer diameter of shank 20. The bottom end of the shank facing the base member 10 has an outer thread, by means of which it can be screwed into the corresponding inner thread of the spacer sleeve 12. The intermediate element 18 has an annular shoulder 24 abutting the top edge of the spacer sleeve 12. A bottom abutment surface of a dental prosthesis 28 abuts an abutment shoulder 26 of the intermediate element facing the annular shoulder 24, and the shank, which has a plastics covering 30 at its top end, presses the abutment surface of the dental prosthesis 28 against the abutment shoulder 26 of the resilient intermediate element 18.

An important feature of the previously-described structure is that the shank 20 extends freely through the top region 22 of the inner bore of the resilient intermediate element 18, i.e. without abutting the inner wall of the inner bore. The vertical region in which the shank 20 "freely" extends through the intermediate element 18 can be adjusted via the depth to which the shank 20 is screwed in or via the vertical construction, considered in the axial direction of the shank 20, of the top region 22 of the resilient intermediate element 18. The rigidity of the "vibrating rod" formed by the shank 20 varies with the height of the upper portion 22 of the integrated element 18 in which the shank 20 does not abut the inner wall of the bore in the intermediate element 18. The dental prosthesis 28 is mounted so as to be vertically sprung or slightly movable relative to the shank 20 - the length of shank 20 can be adjusted to the respective "installation height" - the springing or freedom of movement being obtainable by inserting a suitable plastics ring or by suitably shaping the plastics covering 30. In all cases, the plastics covering 30 prevents electric contact between the dental prosthesis 28 and the shank 20, the overall result being that the dental prosthesis 28 is reliably electrically insulated from the base member 10, thus preventing harmful leakage currents, which may cause corrosion or the like. The dental prosthesis 28 is also resiliently spring-mounted relative to the base member 10 in all directions, this being ensured on the one hand by the aforementioned vibrating-rod action of the shank 20 and on the other hand by the resilient shock-absorption by the intermediate element 18, which counteracts vertical forces in the axial direction of the shank 20. The elasticity or shock-absorption provided by the intermediate element 18 can be additionally varied by altering the torque with which the shank 20 is tightened.

As Fig. 2 shows, in the embodiment shown therein the implant comprises a titanium base member 10 coated with hydroxyl apatite in the part of its outer surface in contact with body tissue. The function of this base member is similar to that of the endosseous implant in EP-A-0 216 031, which should be referred to for further explanation of the base member 10. A spacer sleeve 12, likewise of titanium, is screwed into the base member 10. A shoulder 14 of the spacer sleeve 12 abuts the top edge of the base member 10 as shown in the drawing. The bottom, closed end facing the base member 10 has an

internally threaded inner bore. A centring collar is formed by a wide part 16 at the top end of the spacer sleeve 12. The peripheral surface of the spacer sleeve 12 in contact with body tissue, like the base member 10, is coated with hydroxyl apatite compatible with body tissue.

A resilient intermediate element 18 is inserted into the wide part 16 of the spacer sleeve 12 and comprises a rigid hard core 18a of titanium and a relatively soft resilient shell 18b of polyurethane. The inner bore of the core 18a, in its lower region facing the shell 16, has an inner diameter substantially equal to the outer diameter of a titanium shank 16, whereas the upper region of the bore is made considerably wider than the outer diameter of shank 20. The shank, at its bottom end facing the base member 10, has an outer thread for screwing into the corresponding inner thread of the spacer sleeve 12. The intermediate element 18 has an annular shoulder 24 abutting the top edge of the spacer sleeve 12. A bottom abutment surface of a dental prosthesis 28 abuts an abutment shoulder 26 of the intermediate element opposite the annular shoulder 24, and the shank, the top end of which has a plastics covering 30, presses the abutment surface of the dental prosthesis 28 against the abutment shoulder 26 of the resilient intermediate element 18.

With regard to the operation of this construction, including the advantages of the embodiment shown in Fig. 2, reference is made to the description of the embodiment in Fig. 1, except as regards the structure of the intermediate element 18 comprising a core 18a and a shell 18b. With regard to the intermediate element 18, as shown in Fig. 1, the core 18a has an annular collar 32 for firmly holding the shell 18b (preferably made by injection-moulding) against the core 18a.

Fig. 3 shows an embodiment in which, as before, the intermediate element 18 has a titanium core 18a comprising an annular collar 32 formed with an undercut behind which the injection-moulded polyurethane shell 18b engages. The construction of the core 18a with its annular collar 32 and undercut is shown more exactly in Fig. 4.

Figs. 5 and 6 show an embodiment of the intermediate element which differs from Figs. 3 and 4 in that the core 18a, in its central region 34 centrally disposed

in the direction of the longitudinal central axis, has a smaller inner diameter, which in this region is substantially equal to the outer diameter of the shank 20 (Fig. 2). The central region 34 is equidistant from the upper and lower end face as shown in the drawing, with the result that the intermediate element 18 can be inserted into the implant in both directions without altering the horizontal elasticity properties. Of course, an embodiment in which the central region 34 is asymmetrical with respect to the longitudinal centre of the intermediate element 18 is also possible, in which case the horizontal elasticity properties can be varied depending on the direction in which the intermediate element 18 is inserted.

The intermediate element 18 is constructed as described, i.e. divided into two components, the hard core 18a and the soft resilient shell 18b, so that the relatively soft resilient plastics material is available in the event of vertical stress in the region of the annular shoulder 24 and the abutment shoulder 26, thus guaranteeing satisfactory vertical deformation, whereas the hard material of the core 18a prevents excessive lateral deflection when the shank bends under transverse stress.



C L A I M S

1. An endosseous implant comprising securing devices in the form of a head and a metal shank (20) screwable to a base member (10) for securing a stationary dental prosthesis (28) which is removable under certain conditions, and also comprising a spacer sleeve (12) provided with a centring collar (16, 24) insertable into the open end of the base member and with a shoulder (14) for abutting the top edge of the base member (10), and also comprising an intermediate element (18) of resilient material such as plastics and concentrically surrounding parts of the shank, characterised in that the spacer sleeve (12) is made of metal and is closed at its end remote from the head for securing the dental prosthesis (28) and is screwable into the base member (10); the intermediate element (18) is insertable into a widened portion (16) at the open end of the spacer sleeve (12) and has an annular shoulder (24) for abutting the top edge of the spacer sleeve; the intermediate element (18) has an inner bore the diameter of which, in a region facing the head for securing the dental prosthesis (28) and remote from the spacer sleeve (12), is greater than the outer diameter of the shank (20); and the shank (20) is screwable into the spacer sleeve, when it presses an abutment surface of the dental prosthesis (28) facing the intermediate element (18) against an abutment shoulder (26) of the intermediate element (18) remote from the spacer sleeve (12).

2. An implant according to claim 1, characterised in that the depth to which the shank (20) is screwable into the spacer sleeve (12) is adjustable.

3. An implant according to claim 1 or 2, characterised in that the region of the shank (20) in contact with the dental prosthesis (28) comprises a plastics covering (30) or the like.

4. An implant according to any of the preceding claims, characterised in that the dental prosthesis (28) is mounted so as to be resilient and/or slightly movable relative to the shank (20) in the axial direction thereof.

5. An implant according to claim 4, characterised in that a plastics ring or the like is disposed between the dental prosthesis (28) and the shank (20).



6. An implant according to claim 4 and claim 2, characterised in that the resilient mounting of the dental prosthesis (28) relative to the shank (20) is obtained by suitably shaping the plastics covering (30) round the head of the shank (20).

7. An implant according to any of the preceding claims, characterised in that the wide part (16) of the spacer sleeve (12), which tightly receives the intermediate element (18), widens conically towards the open end.

8. An implant according to any of the preceding claims, characterised in that the shank (20) is screwable with adjustable torque into the spacer sleeve (12).

9. An implant according to any of the preceding claims, characterised in that the base member (10) and/or the exposed peripheral region of the spacer sleeve (12) is/are coated with hydroxyl apatite or the like.

10. An implant according to any of the preceding claims, characterised in that the outer thread of the shank (20) can be coated at the lower region with adhesive.

11. An implant according to any of the preceding claims, characterised in that the intermediate element (18) is made completely of resilient material such as plastics, and the inner bore of the intermediate element (18) has a stepped width, its diameter, in a region facing the spacer sleeve (12), being substantially equal to the outer diameter of the shank (20), and an adjacent region (22) in the direction of the head securing the dental prosthesis (28) has a diameter greater than the outer diameter of the shank (20).

12. An implant according to any of claims 1 to 10, characterised in that the intermediate element (18) comprises a core (18a) of relatively rigid material surrounding the shank (20) and a shell (18b) of relatively soft resilient material surrounding the region of the annular shoulder (24) and/or the abutment shoulder (26).



13. An implant according to claim 12, characterised in that the core (18) is made of hard plastics such as polyoxymethylene or the like.

14. An implant according to claim ..., characterised in that the core (18a) is made of metal.

15. An implant according to claim 14, characterised in that the core (18a) is made of titanium.

16. An implant according to any of claims 12 to 15, characterised in that the shell (18b) is made of soft plastics such as polyurethane or the like.

17. An implant according to any of claims 12 to 16, characterised in that the core (18a) is in the form of a sleeve and has an annular collar (32) in the region of the annular shoulder (24) and the abutment shoulder (26).

18. An implant according to any of claims 12 to 17, characterised in that the shell (18b) is positively connected to the core (18a).

19. An implant according to claim 17 or 18, characterised in that the annular collar (32) has an undercut.

20. An implant according to any of claims 16 to 19, characterised in that the shell (18b) is integrally formed on the core (18a) by injection moulding.

21. An implant according to any one of claims 12 to 20 formed with an inner bore having a stepped width, characterised in that the inner bore of the core (18a), in the region of the annular shoulder (24) and the abutment shoulder (26), has a central region (34) in which the inner diameter of the inner bore is substantially equal to the outer diameter of the shank (20).

22. An implant according to claim 21, characterised in that the smaller inner-diameter central region (34) of the inner bore of the core (18a) is at the same distance from the end faces of the intermediate element (18).

23. An implant according to claim 21, characterised in that the smaller inner-diameter central region (34) of the inner bore of the core (18a) is at different



distances from the end faces of the intermediate
element (18).



List of reference numbers

10	Base member
12	Spacer sleeve
14	Shoulder
16	Wide part
18	Intermediate element
18a	Core of intermediate element
18b	Shell of intermediate element
20	Shank of implant
22	Top region of inner bore in 18 or 18a
24	Annular shoulder
26	Abutment shoulder
28	Dental prosthesis
30	Plastics covering
32	Annular collar of 18a
34	Central region of 18a