(54) Title: INTERVERTEBRAL DISC PROSTHESIS OR ARTIFICIAL VERTEBRAL BODY

(57) Abstract:
The intervertebral disc prosthesis or the intervertebral implant comprises: a cavity-like middle part (2) with a central longitudinal axis (6), an upper end (4) and a lower end (5); an upper apposition plate (7), which is placed on the upper end (4) of the middle part (2) while being perpendicular to the longitudinal axis (6) and which is suited for resting against the base plate of a vertebral body, and: a lower apposition plate (8), which is placed on the lower end (5) of the middle part (2) while being perpendicular to the longitudinal axis (6) and which is suited for resting against the cover plate of a vertebral body. The middle part (2) comprises an elastic means (19) consisting of at least two coaxially arranged plate springs (20). This elastic means (19) has a progressive spring characteristic.
Abstract: The intervertebral disc prosthesis or the intervertebral implant comprises: a cavity-like middle part (2) with a central longitudinal axis (6), an upper end (4) and with a lower end (5); an upper apposition plate (7), which is placed on the upper end (4) of the middle part (2) while being perpendicular to the longitudinal axis (6) and which is suited for resting against the base plate of a vertebral body, and: a lower apposition plate (8), which is placed on the lower end (5) of the middle part (2) while being perpendicular to the longitudinal axis (6) and which is suited for resting against the cover plate of a vertebral body. The middle part (2) comprises an elastic means (19) consisting of at least two coaxially arranged plate springs (20). This elastic means (19) has a progressive spring characteristic.
(57) Zusammenfassung: Die Bandscheibenprothese oder das Zwischenwirbelimplantat umfasst: ein hohlkörperartiges Mittelteil (2) mit einer zentralen Längsachse (6), einem oberen Ende (4) und einem unteren Ende (5); eine am oberen Ende (4) des Mittelteils (2) quer zur Längsachse (6) angeordnete, obere Appositionsplatte (7), welche zur Anlage an die Grundplatte eines Wirbelkörpers geeignet ist; und eine am unteren Ende (5) des Mittelteils (2) quer zur Längsachse (6) angeordnete, untere Appositionsplatte (8), welche zur Anlage an die Deckplatte eines Wirbelkörpers geeignet ist. Das Mittelteil (2) umfasst ein aus mindestens zwei koaxial angeordneten Tellerfedern (20) bestehendes, elastisches Mittel (19); wobei das elastische Mittel (19) eine progressive Federkennlinie aufweist.
Prosthetic Intervertebral Disc or Artificial Vertebra

The invention relates to a prosthetic intervertebral disc or an artificial vertebra according to the preamble of Patent Claim 1.

DE 101 32 588 FEHLING discloses a generic intervertebral disc comprising two apposition plates with a compression spring element in between. A hollow cylindrical jacket is arranged around the compression spring element. The compression spring element is made of a memory metal alloy which has superelastic properties at body temperature, or in another embodiment, the compression spring element consists of a cup spring column made up of cup springs having the same stiffness. One disadvantage of these known prosthetic intervertebral discs is the linear spring characteristic of the compression spring element, so that in the case of a compression spring element which should also absorb impact forces, the flexibility of the compression spring element is too low, in particular at low compressive forces, and therefore the freedom of mobility of the spinal column is limited in this area.

The present invention seeks to remedy this situation. The invention is based on the object of creating a prosthetic intervertebral disc and/or an artificial vertebra having an elastic middle part assembled from conventional elements and having a progressive spring characteristic.

This object is achieved by the present invention with a prosthetic intervertebral disc or an artificial vertebra having the features of Claim 1.

The advantages achieved through the present invention may be regarded essentially as the fact that, thanks to the inventive prosthetic intervertebral disc or the artificial vertebra:

- sufficiently great elastic flexibility and damping are ensured in the case of low compressive forces; this ensures adequate freedom of mobility of the spinal column in this area; and
- no great spring deflections are necessary to absorb the compressive force at high pressure loads or impact loads; and
- the jump in stiffness between a healthy vertebral segment and the vertebral segment provided with a prosthesis may be reduced in a harmonious manner so as to yield a prosthesis that behaves like a healthy intervertebral disc.

In a preferred embodiment, the elastic means include at least two cup springs arranged coaxially.

In a special embodiment, centering is provided for the elastic means. Due to the centering, the cup springs cannot slip and are held in their positions. Furthermore, due to the centering, the adjacent cup springs may absorb very high forces and may serve as a security means.

In another embodiment, the centering is designed to be flexible, so that it permits an axial guidance within a conical area. The advantage achieved in this way is that not only is the prosthetic intervertebral disc designed to be elastic coaxially, but also the apposition plates may be moved obliquely or rotationally in relation to one another.

In another embodiment, the cup springs have central bores and the centering is designed as internal bellows passing through these bores.

In another embodiment, at least two cup springs have a different stiffness. Therefore, the progressive spring characteristic can be established only by the spring consisting of cup springs. Another advantage is the large supporting surface, which results in a low surface pressure and low abrasion.

In another embodiment, the cup springs are combined to form cup spring assemblies having several stacked parallel cup springs. This has the advantage that the progressive spring characteristic can be created only through a spring consisting of cup springs. In combination with bellows, this yields the additional advantage in that the spring characteristic can be additionally influenced.
In another embodiment, the middle part comprises a spring that is arranged coaxially and acts as both a tension spring and a compression spring. Therefore, the helical spring may also absorb torsional forces.

In another embodiment, only the springs are in contact with both apposition plates up to an axial spring deflection $X \neq 0$. The advantage that can be achieved lies in the progressive spring characteristic. The second spring may also serve as a centering means for the cup springs. Additional advantages are also based on the fact that any particles formed by abrasion cannot escape into the patient's body. This embodiment also allows an extension/flexion movement with a low stiffness and provides protection against the growth of connective tissue into the prosthesis.

In another embodiment, the middle part also has a jacket comprised of bellows on the outside. This jacket provides protection against the penetration of bodily fluids.

In another embodiment, the middle part is detachably connected to the two apposition plates via a snap closure.

In another embodiment, the apposition plates are connected to the middle part via friction bearings which are preferably made of a ceramic material. The friction bearings are advantageously designed so that the apposition plates can execute a limited translational motion across the longitudinal axis with respect to the middle part.

The translational motion preferably amounts to $\pm 0.5$ mm. Thus, all six degrees of freedom are accounted for by the friction bearing and the receptacles of the cup springs and the possible rotation of approx. $\pm 30^\circ$ about the longitudinal axis of the prosthesis.

In another embodiment, the cup springs have a stop which limits their compressibility. The stop protects the cup springs from overstressing. Therefore, higher forces can be absorbed without overloading the cup springs.

The invention and embodiments of the invention are explained in greater detail below on the basis of the partially schematic diagrams of several exemplary embodiments.
Fig. 1 shows a mediolateral section through an embodiment of the inventive prosthetic intervertebral disc; and

Fig. 2 shows a mediolateral section through another embodiment of the inventive prosthetic intervertebral disc; and [sic]

The embodiment of the prosthetic intervertebral disc 1 illustrated in Fig. 1 comprises essentially a hollow cylindrical elastic middle part 1 having a jacket 3 designed as bellows 21, an upper end 4, a lower end 5 and a central longitudinal axis 6 as well as an upper apposition plate 7, which is arranged across the longitudinal axis 6 at the upper end 4 of the middle part 1 and is suitable for coming in contact with the lower plate of a vertebra, and a low apposition plate 8 which is arranged across the longitudinal axis 6 at the lower end 5 of the middle part 1 and is suitable for coming in contact with the upper plate of a vertebra. The two apposition plates 7; 8 have the appearance of a surface 9 with a convex curvature and axial pins 10 and 11 pointing inward. The jacket 3 in this embodiment consists of bellows 12 which are attached to the two apposition plates 7; 8. Depending on the material, the bellows 12 may be welded, glued or pressed to the apposition plates 7; 8.

The upper apposition plate 7 has a lower surface 13 facing the middle part 2, and similarly, the lower apposition plate 8 has an upper surface 14 facing the middle part 2. The lower and upper surfaces 13; 14 provided here each have a groove 15 arranged in the form of a circle to receive the upper plates 26 attached to the ends 16; 17 of the bellows 12. The pins 10; 11 protrude coaxially with the longitudinal axis 6 into recesses 29 on the exterior surfaces of the upper plates 26, said recesses being concentric with the longitudinal axis 6. In order for the apposition plates 7; 8 to be laterally displaceable in relation to the middle part 2, the recesses 29 have a larger diameter across the longitudinal axis 6 than the pins 10; 10 [sic] which are movable therein on the apposition plates 10; 11 [sic]. The outer ring elements 28, which are inserted concentrically with the longitudinal axis 6 into the circular grooves 15 in the lower and upper surfaces 13; 14 of the apposition plates 7; 8, rest on the inner ring elements 27 inserted into the outer surfaces of the upper plates 26. The inner and outer ring elements 27; 28 which rest in pairs one on the other
each form a friction bearing 25 such that the apposition plates 7; 8 are displaceable laterally within the play allowed by the pins 10; 11 and the recesses 29 in relation to the center part 2.

Elastic means 19, which are assembled from cup springs 20, are arranged around the helical spring 21. In the embodiment illustrated here, only the helical spring 21 is in contact with the two upper plates 26 in the no-load state of the prosthetic intervertebral disc 1, so that at first only the helical spring 21 is compressed when there is load on the prosthetic intervertebral disc. After a spring deflection \( s = X \), the elastic means 19 also come in contact with both apposition plates 7; 8, so that with a further displacement of the two apposition plates 7; 8 toward one another \( s > X \), a higher spring rate becomes effective. In the embodiment depicted here, the elastic means 19 are comprised of cup spring assemblies 22a; 22b; 22c; 22d with identical cup springs 20, but the first cup spring assembly 22a consists of a cup spring assembly comprising three stacked cup springs 20 pointing in the same direction, the second and third cup spring assemblies 22b; 22c each consist of two oppositely directed groups of two stacked cup springs 20 facing in the same direction and the fourth cup spring assembly 22d consists of two cup springs 20 directed in opposite directions. A progressive spring characteristic of the elastic means 19 can be achieved due to this design of the cup spring assemblies 22a; 22b; 22c; 22d.

The embodiment of the prosthetic intervertebral disc 1 illustrated in Fig. 2 differs from the embodiment illustrated in Fig. 1 only in that, firstly, instead of the spring 18, an internal bellows 23 is arranged between the apposition plates 7; 8; secondly, the elastic means 19 comprises a first cup spring assembly 22a having first cup springs 20a and four additional cup spring assemblies 22b; 22c; 22d; 22e having second cup springs 22b; thirdly, the middle part 2 is attached to the apposition plates 7; 8 without upper plates 26 (Fig. 1). The first cup springs 20a have a greater stiffness than the second cup springs 20b, so the elastic means 19 have a progressive spring characteristic. The internal bellows 23 are guided through the bores 24 in the
cup springs 20 in parallel with the longitudinal axis 6 and serve as a centering means for the cup springs 20. The internal bellows 23 are flexible axially and in bending, so that the apposition plates 7; 8 can also be moved obliquely with respect to one another and the longitudinal axis 6 can be curved within a conical area.
REVISED CLAIMS

[received by the International Office on January 1, 2005 (01/01/05);
  original Claims 1–15 replaced by Revised Claims 1–14 (3 pages)]

Patent Claims

1. Prosthetic intervertebral disc (1) or intervertebral implant, comprising:
   A) a middle part (2) having a central longitudinal axis (6), an upper end (4) and a lower end (5);
   B) an upper apposition plate (7), which is arranged across the longitudinal axis (6) on the upper end
      (4) of the middle part (2) and is suitable for coming in contact with the lower plate of a vertebra;
   C) a lower apposition plate (8) which is arranged across the longitudinal axis (6) on the lower end (5)
      of the middle part (2) and is suitable for coming in contact with the upper plate of a vertebra; and
   whereby
   D) the middle part (2) comprises elastic means (19);
   characterized in that
   E) the elastic means (19) have a progressive spring characteristic; and
   D) [sic] centering is provided for the elastic means (19).

2. Prosthetic intervertebral disc (1) according to Claim 1, characterized in that the elastic means (19)
   comprise at least two cup springs (20) arranged coaxially.

3. Prosthetic intervertebral disc (1) according to Claim 2, characterized in that at least two of the cup
   springs (20) have a different stiffness.

4. Prosthetic intervertebral disc (1) according to Claim 2 or 3, characterized in that the cup springs
   (20) are joined together to form cup spring assemblies (22) having a plurality of cup springs (20) that
   are stacked together and point in the same direction.

5. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 4, characterized in that
   the middle part (2) is designed like a hollow body.

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6. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 5, characterized in that the centering is designed to be flexible and allows axial guidance within a conical area.

7. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 6, characterized in that the cup springs (20) have central bores (24) and the centering is designed as internal bellows passing through these bores (24).

8. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 7, characterized in that the middle part (2) comprises a spring (18) arranged coaxially, acting as both a tension spring and a compression spring.

9. Prosthetic intervertebral disc (1) according to Claim 8, characterized in that up to an axial spring deflection \( X \neq 0 \), only the springs (18) are in contact with both apposition plates (7; 8).

10. Prosthetic intervertebral disk (1) according to any one of Claims 1 through 9, characterized in that the middle part (2) has a jacket (3) consisting of bellows (12) on the outside.

11. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 10, characterized in that the middle part (2) is detachably connectable to the two apposition plates (7; 8) by means of a snap closure.

12. Prosthetic intervertebral disc (1) according to any one of Claims 1 through 11, characterized in that the apposition plates (7; 8) are connected to the middle part (2) via friction bearings (25), which are preferably made of a ceramic material.

13. Prosthetic intervertebral disc (1) according to Claim 12, characterized in that the friction bearings (25) are designed so that the apposition plates (7; 8) can execute a limited translational motion across the longitudinal axis (6) with respect to the middle part (2).
14. Prosthetic intervertebral disc (1) according to any one of Claims 2 through 13, characterized in that the cup springs (20) have a stop which limits their compressibility.