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(54) Title: ARTIFICIAL INTERVERTEBRAL DISK

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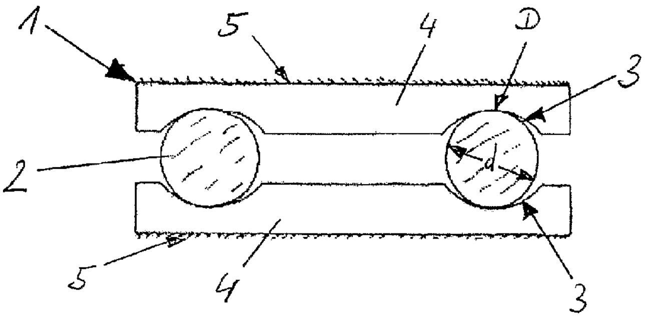

(57) **Abstract:** The invention relates to an artificial intervertebral disk (1) which can be inserted between two adjacent vertebral bodies of a patient and by means of which two adjacent vertebral bodies of a patient are joined in an articulated manner. Said artificial intervertebral disk (1) comprises an intermediate element (2) that is embodied as an elastic ring and is inserted into one respective molded portion (3) of two outer elements (4) which are configured as metal plates. The outer elements (4) are joined to the bones of the vertebral bodies via anchoring pins (5), especially titanium anchorings previously known in hip endoprosthetics. The radius (D) of the concave molded portion (3) is greater than the diameter (d) of a circular cross-sectional area of the intermediate element (2) such that compression of the intermediate element (2) caused particularly by the patient's movement allows for a defined deformation.

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Veröffentlicht:
— *mit internationalem Recherchenbericht*

Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

(57) Zusammenfassung: Die Erfindung betrifft eine zwischen zwei benachbarten Wirbelkörpern eines Patienten einsetzbare künstliche Zwischenwirbelscheibe (1) durch die zwei nicht dargestellte benachbarte Wirbelkörper eines Patienten gelenkig verbunden sind. Die künstliche Zwischenwirbelscheibe (1) hat ein als elastischer Ring ausgeführtes Zwischenelement (2), das in jeweils eine Ausformung (3) von zwei als Metallplatten ausgeführten äußeren Elementen (4) eingesetzt ist. Die äußeren Elemente (4) werden mit den Knochen der Wirbelkörper über Verankerungsdorne (5), insbesondere Titanverankerungen, die an sich aus der Hüftendoprothetik bekannt sind, verbunden. Der Radius (D) der konkaven Ausformung (3) weist gegenüber dem Durchmesser (d) einer kreisförmigen Querschnittsfläche des Zwischenelementes (2) ein Übermaß auf, so dass eine insbesondere durch die Bewegung des Patienten bedingte Kompression des Zwischenelementes (2) eine definierte Verformung gestattet.

ARTIFICIAL INTERVERTEBRAL DISC

The invention relates to an artificial intervertebral disc which can be inserted between two adjacent vertebral bodies of a patient, each having an element assigned to the respective vertebral body, whereby the element are joined together in an articulated manner to a limited extent by means of an intermediate element such that both torsional moments and shearing forces can be transmitted in this way.

In the human spinal column and the lumbar spinal column in particular, the intervertebral disc connects an upper bony vertebral body to a lower bony vertebral body in an articulated manner.

Such an artificial intervertebral disc is known from European Patent EP 0610837 B1, for example, in which two plates are joined together by an elastomer core. The elastomer core has a top part and a bottom part enclosing an intermediate part having a concave peripheral surface. Therefore, when bending moments or transfer forces act on the intervertebral disc, the forces induced on the contact surface between the plates and the core are reduced in comparison with a core having straight sides.

United States Patent 3,867,728 describes an intervertebral disc consisting of a single piece, for example, and having a concave outer surface.

In addition, United States Patent 5,071,437 also describes an intervertebral disc prosthesis which has an upper flat plate, a lower flat plate and a flat elastomeric core which is enclosed between the plates.

European Patent EP 0 747 025 B1 describes an artificial intervertebral disc interposed between adjacent vertebral bodies, having a first component with a concave recess and a second component with a protrusion which fits into the recess in the first component in such a way as to result in an unrestricted rotational and tilting movement between the first and second components.

Furthermore, additional prosthetic intervertebral discs are disclosed in German Patent DE 10024922 C1, European Patent EP 1041945 A1, WO 02/080818 A1, United States Patent 6,368,350 B1, German Patent DE 4213771 C1, European Patent EP 0560140 B1, European Patent EP 1344508 A1, European Patent EP 1344507 A1, German Patent DE 4208115 A1, European Patent EP 1287795 A1 and German Patents DE 10242329 A1 and DE 19710392 C1.

With all the artificial intervertebral discs known in the past, it has proven to be a disadvantage that the natural properties of the joint can be simulated only inadequately. This restriction of the natural freedom of movement is especially problematical for the patient when multiple vertebral bodies are replaced and therefore the detrimental properties of the artificial intervertebral discs become cumulative.

The object of the present invention is to significantly improve the properties of an artificial intervertebral disc that can be perceived by the patient.

This object is achieved according to this invention with an artificial intervertebral disc according to the features of Claim 1. The subclaims pertain to especially expedient refinements of the invention.

Consequently, according to the invention, an artificial intervertebral disk is provided wherein the two elements have a contour by means of which the elements are joined to the intermediate element in a form-fitting manner. The

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invention is based on the notion that the desired range of motion can replicate the natural range of motion of the verterbral column in an optimal manner using an artificial intervertebral disk if the intermediate element is held positively in a corresponding contour of the element, since this means that torsional moments as well as shear forces can be transmitted without any problem and without having to forgo good deformation properties of the intervertebral disk. As a result, the intervertebral disk can be configured especially so that, at the same time, the relative mobility of the elements with the respect to each other, that is to say, especially a tilting movement, can be greatly optimized, i.e. the mobility can be improved. In other words, when the function of the transmission of torsional moments and shear forces between adjacent vertebral bodies in uncoupled from the function of the articulated connection of the elements that are associated with the vertebral bodies - the latter function being uniformly achieved according to the state of the art by the elastic properties of the intermediate element in an inadequate manner as a compromise among the various properties - this uncoupling results in essentially divergent degrees of freedom corresponding to the optimum in each case, Thus according to the invention, it is possible to join adjacent vertebral bodies in such an articulated manner that mechanical properties are attained that are similar to those of the natural intervertebral disk.

An especially advantageous embodiment of the vertebral disk according to the invention is achieved in that the contour is concave, thereby forming, for example, a recess for form-fit receiving the intermediate element. The contact surfaces are configured here in such a way that, in any case, the cohesive friction cannot be overcome by the shear and torsional load.

In practice, it has proven to be especially promising if the molded portion has friction-optimized surface properties because this yields a reduction in or prevention of possible abrasion of the material of the intermediate element by a simple method. For example, the surfaces of the molded portion may be polished to a mirror gloss in the contact area, so that when there are relative movements in the contact surfaces, the friction is minimal and thus the abrasion on the intermediate element is also minimal.

In contrast, another likewise practical modification is achieved if the contour has a surface texture or roughness that increases the friction, at least in sections, in order to create a frictional connection between the two elements and the intermediate element. In this manner, a design of the contact surfaces is achieved with which, in any case, the cohesive friction is not overcome by the shear and torsional load.

In addition, it has proven to be especially practical for the molded portion to be provided with an excess in comparison with the intermediate element, such that compression of the intermediate element due to movement by the patient in particular permits a defined deformation. The surface curvature of the molded portion is designed to be slightly smaller in comparison with the cross-sectional area of the intermediate element, so that deforming of the ring-shaped intermediate element occurring in compression, for example, allows expansion of the ring-shaped intermediate element in parallel with the plane of elements.

The intermediate element could be configured as a disk whose edge area has beads that engage in the correspondingly shaped contour. In contrast, an especially promising configuration is achieved if the intermediate element has an annular closed shape. In this manner, the torsional moments and shear forces that occur during movement can be transmitted in an optimal manner and, in addition to circular intermediate elements, it is also suitable to use oval or kidney-shaped intermediate elements since these already allow a form-fit transmission of torsionals moments due to their basic shape, which diverges from the circular shape.

According to another especially advantageous embodiment, the ring-shaped intermediate element has an ogival, oval or circular cross-sectional area across its ring-shaped central axis in at least some sections to ensure an optimum transmission of forces between the elements while at the same time achieving the desired mobility. The corresponding molded portion is shaped accordingly, especially as a function of the different planes of the body.

Moreover, it has proven to be especially advantageous for the intermediate element to have a cross sectional surface that differs in sections in the direction of its annular central axis and that interacts with a correspondingly shaped contour so that a form-fit connection between the intermediate element and the outer elements allows torsional moments to take place. For example, constrictions can be provided in sections for this purpose. The diameter of the ring cross sectional surface can be modulated along the ring so that even in the case of a ring that has a circular shape as seen from above, a rotational movement of the ring between the plate-shaped outer elements can be ruled out. To this end, the cross-sectional area may be expanded in some sections in the sagittal plane, the frontal plane and/or the transverse plane of the patient, for example.

Essentially, the material properties may be determined in accordance with the particular requirements. This design has proven to be especially advantageous in practice; in this design, the intermediate element is made of a polymer, in particular polyethylene, in at least some sections and therefore has a lower susceptibility to wear with a high toughness at the same time, allowing limited elastic deformability. In addition, an especially reliable connection between the intervertebral disc and the elements for anchoring in the bone is provided with anchoring mandrels or elements on the sides facing the vertebral bodies, these anchoring elements being anchored in the vertebral bodies at the time implantation as a result of the load. The elements with their anchoring mandrels or elements are advantageously coated with titanium or other biocompatible materials on their sides facing the vertebral bodies to permit a direct bone connection. The invention allows various embodiments. To further illustrate the basic principle, one of these embodiments is illustrated in the drawing and is described in greater detail below. The drawings show:

Figure 1 a sectional side view of an inventive artificial intervertebral disc;

Figure 2 a top view of various intermediate elements for an inventive artificial intervertebral disc;

Figure 3 various cross-sectional shapes of the intermediate elements, as shown in Figure 2;

Figure 4 an enlarged side view shown only in sectional details of an intermediate element shown in Figure 2;

Figure 5 another inventive artificial intervertebral disc in a sectional side view;

Figure 6 the arrangement of the artificial intervertebral disc shown in Figure 1 between two vertebral bodies of a spinal column.

Figure 1 shows a sectional side view of an inventive artificial intervertebral disc 1 through a patient's two adjacent vertebral bodies (not shown) that are connected in an articulated manner. The artificial intervertebral disc 1 has an intermediate element 2, which is designed as an elastic ring and is inserted into a molded portion 3 of two outer elements 4 designed as metal plates, for example. The outer elements 4 are connected to the bones of the vertebral bodies via anchoring mandrels 5, in particular titanium anchors, which are known from hip endoprosthetics. The radius D of the concave molded portion 3 has an excess dimension in comparison with the diameter d of a circular cross-sectional area of the intermediate element 2, so that compression of the intermediate element 2 caused by movement of the patient in particular allows a defined deformation.

Figure 2 shows a top view of various possible embodiments of the intermediate element 2 of the inventive artificial intervertebral disc 1, each having a closed basic ring shape. Intermediate elements 2a, 2b, 2c having a circular, oval or kidney-shaped basic shape are shown here as examples. Of course these basic shapes may also be provided in the same way even with intermediate elements (not shown) that have no perforation.

Figure 3 shows as an example various cross-sectional shapes of the intermediate element 2 which may be designed to be oval, circular or ogival on both sides. The cross-sectional shape may also be designed to deviate in some sections in the direction of the ring-shaped central axis 7 of the intermediate element 2 shown in Figure 4 and may vary between the different cross-sectional shapes shown here, for example.

Such varying cross sectional shape is depicted in greater detail in Figure 4, which shows an enlarged side view of an intermediate element 2 shown in Figure 2. one can see regular constrictions 6 of the circular cross sectional shape in the direction of the annular central axis 7 of the intermediate element 2 through which the occurring torsional moments can be transmitted due to a form-fit connection of the intermediate element 2 to the outer elements 4 shown in Figure 1

Figure 5 shows a sectional side view of a different embodiment of another inventive artificial intervertebral disc 8 deviating from that in Figure 1. The intervertebral disc 8 has outer elements 9 designed as perforated discs with a central passage 10 to thereby improve the integration of the vertebral bodies 11 shown in Figure 6.

Figure 6 shows an arrangement of the artificial intervertebral disc 1 illustrated in Figure 1 between two vertebral bodies 11 of a spinal column (not shown here). For anchoring in the vertebral bodies 11, the intervertebral disc 1 is provided with anchoring mandrels 5 on its outsides facing the vertebral bodies 11, so the anchoring mandrels become anchored in the vertebral bodies 11 at the time of implantation due to the load applied. A biocompatible coating provided on the sides facing the vertebral bodies 11 permits a direct bone connection.

CLAIMS

1. An artificial intervertebral disc insertable between two adjacent vertebral bodies of a patient, the artificial intervertebral disc including two outer elements, each associated with one of the two vertebral bodies, an intermediate element having an annular closed shape and joining the two outer elements in a restricted, articulated manner such that torsional moments and shear forces are transmittable, wherein each of the two outer elements have an annular and concave contour and is joined in a form-fitting manner to the intermediate element at the contour and wherein the contour is oversized relative to the intermediate element such that a compression of the intermediate element allows a defined deformation of the disk.

2. An intervertebral disc according to claim 1, wherein the contour forms a recess.

3. An intervertebral disc according to claim 1 or claim 2, wherein the contour has a friction-optimized surface texture.

4. An intervertebral disc according to claim 3, wherein the contour has a surface texture that increases the friction at least in sections so as to create a frictional connection between the two elements and the intermediate element at the sections.

5. An intervertebral disc according to any one of the preceding claims, wherein the compression stems from a movement by the patient.

6. An intervertebral disc according to any one of the preceding claims, wherein the intermediate element defines an annular central axis and has at least one of an ogival, an oval and a circular cross section crosswise to the axis, at least in sections.

7. An intervertebral disc according to any one of the preceding claims, wherein the intermediate element is designed to be circular, oval or kidney-shaped.

8. An intervertebral disc according to any one of the preceding claims, wherein the intermediate element defines an annular central axis and has differing cross sections in a direction of the central axis and wherein the contour is correspondingly shaped.

9. An intervertebral disc according to any one of the preceding claims, wherein a cross-section of an intermediate element is widened in at least one sagittal plane, an intermediate plane, a frontal plane and a transverse plane of the patient.

10. An intervertebral disc according to any one of the preceding claims, wherein the intermediate element is at least partially made from a polymer.

11. An intervertebral disc according to claim 10, wherein the polymer includes polyethylene.

12. An intervertebral disc according to any one of the preceding claims, wherein the two outer elements

include anchoring elements disposed on a side facing the vertebral bodies and configured to anchor the outer elements in the bone of the vertebral bodies.

13. An intervertebral disc according to claim 12, wherein the anchoring elements include anchoring pins.

14. An intervertebral disc according to claim 12 or claim 13, wherein the outer elements and anchoring elements are coated with a biocompatible material on the side facing the vertebral bodies.

15. 15 An intervertebral disc according to claim 14, wherein the biocompatible material includes titanium.

16. An artificial intervertebral disc substantially as hereinbefore described with reference to Figs 1, 5 and 6 of the accompanying drawings.

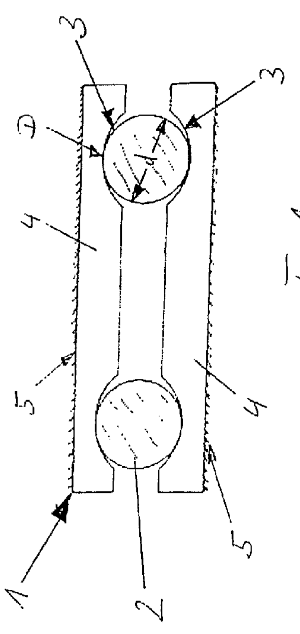

Fig. 1

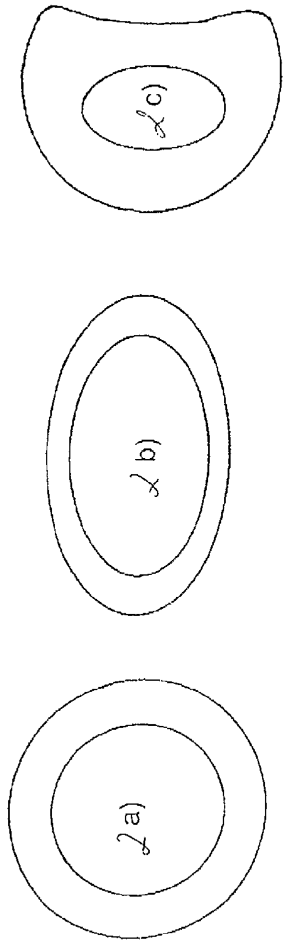

Fig. 2

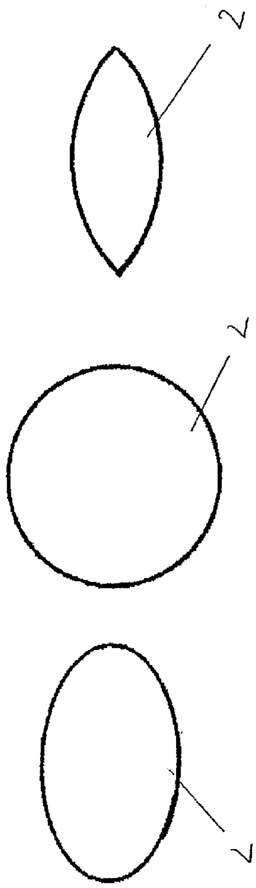

Fig. 3

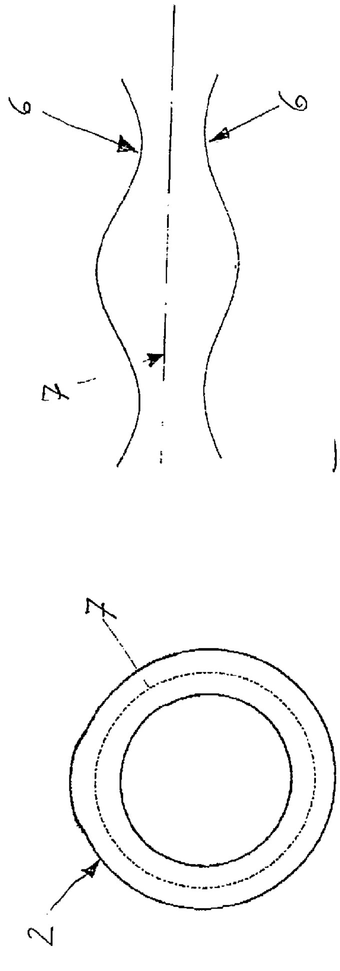

Fig. 4

Fig. 5

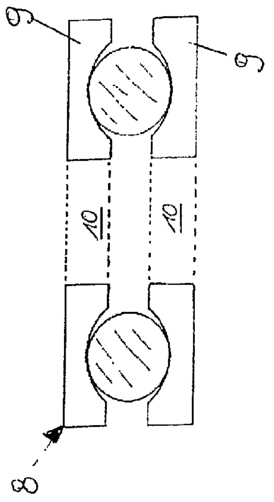

Fig. 6