FLEXIBLE KERATOPROSTHESIS DEVICES AND USES THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of and priority to co-pending U.S. Provisional Patent Application No. 62/491,438, filed on April 28, 2017, entitled “Keratoprosthesis with flexible component for treatment of corneal blindness,” the contents of which is incorporated by reference herein in its entirety.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH

This invention was made with government support under grant number 5K12EY021475 awarded by the National Institutes of Health. The government has certain rights in the invention.

BACKGROUND

Keratoprosthesis implantation is a procedure that involves full-thickness removal of the cornea and replacement with an artificial cornea. The need for keratoprosthesis implantation arises from failed cornea transplants, unsuitable candidacy for cornea transplants, and a shortage of donor corneas. As such there exists a need for the development of keratoprosthesis devices.

SUMMARY

According to an aspect of the present invention, there is provided a keratoprosthesis (Kpro) device comprising: an anchor body; and a plurality of flexible haptics, wherein the plurality of flexible haptics are attached to and are capable of extending radially from the anchor body, wherein each of the plurality of haptics is in a first position prior to implantation and a second position after implantation, wherein each of the plurality of haptics is folded relative to the anchor body in a direction towards the anchor body, along a plane that includes a longitudinal axis of the anchor body, when in the first position and is unfolded relative to the anchor body along the plane that includes the longitudinal axis of the anchor body so as to extend radially away from the anchor body when in the second position.

The Kpro device can further include a front plate, wherein the front plate can be attached to the anchor body such that the Kpro device is a single implantable device.

In some embodiments the anchor body is a cannula or a cylinder. The anchor body can have an inner diameter and an outer diameter, wherein the inner diameter ranges from about 1 mm to about 8 mm, and wherein the inner diameter ranges from about 1 mm to about 8 mm.

In some embodiments, the diameter of the front plate is substantially the same as the outer diameter of the anchor body. In some embodiments, the diameter of the front plate is different than the outer diameter of the anchor body. The diameter of the front plate can be larger than the outer diameter of the anchor body.

The anchor body can have a height of about 0.5 mm to about 3 mm as measured from the bottom of the anchor body to the bottom of the front plate.

The front plate can be curved along the portion of the front plate that is distal to the anchor body. In some embodiments the front plate forms a half-sphere.

In some embodiments the plurality of haptics are all attached to the anchor body at substantially the same height along the circumference of the anchor body as measured from the bottom of the anchor body. In some as embodiments pects, at least two of the plurality of haptics are attached to the anchor body at different heights along the circumference of the anchor body as measured from the bottom of the anchor body. In some embodiments, the plurality of haptics are positioned on the anchor body such that plurality of haptics form two groups of haptics, wherein each group comprises at least one haptic, wherein the at least one haptic of the first group is attached to the anchor body along its circumference at a first height and the at least one haptic of the second group is attached to the anchor body along its circumference at a second height, wherein the first and the second height are measured from the bottom of the anchor body and the first and the second height are different.

In some embodiments, all components of the Kpro device are flexible.

In some embodiments, the Kpro device is implantable using a minimally invasive incision. The minimally invasive incision can be about 3 mm.

In some embodiments the anchor body can be configured to couple to a front plate during implantation. In some embodiments the anchor body can be a ring having an inner diameter and an outer diameter can range from about 1 mm to about 8 mm, and wherein the inner diameter can range from about 1 mm to about 8 mm. The front plate can include an anterior portion and a posterior stem portion, wherein the stem portion is configured to couple to the anchor body during implantation. The anterior portion of the front plate can be substantially round as measured along a first axis. The stem portion can be a cannula or a solid cylinder and the stem portion can have an outer diameter. The diameter of the anterior portion of the front plate as measured along the first axis can be substantially the same as the outer diameter of the stem portion as measured along the same axis. The diameter of the anterior portion of the front plate as measured along the first axis can be different than the outer diameter of the stem portion as measured along the same axis. The stem portion can be threaded and the anchor body can be configured to be screwed onto the stem during implantation.

In some embodiments, at least one of the plurality of haptics can have a hole.

In some embodiments, the plurality of haptics can be in a first position prior to implantation and a second position after implantation, wherein the plurality of haptics can be folded in towards the anchor body when in the first position and can be extended radially away from the anchor body when in the second position.

We Claim:

1. A keratoprosthesis (Kpro) device comprising:

an anchor body; and

a plurality of flexible haptics, wherein the plurality of flexible haptics are attached to and are capable of extending radially from the anchor body, wherein each of the plurality of haptics is in a first position prior to implantation and a second position after implantation, wherein each of the plurality of haptics is folded relative to the anchor body in a direction towards the anchor body, along a plane that includes a longitudinal axis of the anchor body, when in the first position and is unfolded relative to the anchor body along the plane that includes the longitudinal axis of the anchor body so as to extend radially away from the anchor body when in the second position.

2. The Kpro device of claim 1, further comprising a front plate, wherein the front plate is attached to the anchor body such that the Kpro device is a single implantable device.

3. The Kpro device of claim 2, wherein the anchor body is a cannula or a cylinder.

4. The Kpro device of any one of claims 2-3, wherein the anchor body has an inner diameter and an outer diameter, wherein the inner diameter ranges from 1 mm to 8 mm, and wherein the outer diameter ranges from 1 mm to 8 mm.

5. The Kpro device of claim 4, wherein the diameter front plate is substantially the same as the outer diameter of the anchor body.

6. The Kpro device of claim 4, wherein the diameter front plate is different than the outer diameter of the anchor body.

7. The Kpro device of claim 6, wherein the diameter of the front plate is larger than the outer diameter of the anchor body.

8. The Kpro device of any one of claims 2-3, wherein the anchor body can have a height of 0.5 mm to 3 mm as measured from the bottom of the anchor body to the bottom of the front plate.

9. The Kpro device of any one of claims 2-3, wherein the front plate is curved along the portion of the front plate that is distal to the anchor body.

10. The Kpro device of any one of claims 2-3, wherein the front plate forms a half-sphere.

11. The Kpro device of any one of claims 2-3, wherein the plurality of haptics are all attached to the anchor body at substantially the same height along the circumference of the anchor body as measured from the bottom of the anchor body.

12. The Kpro device of any one of claims 2-3, wherein at least two of the plurality of haptics are attached to the anchor body at different heights along the circumference of the anchor body as measured from the bottom of the anchor body.

13. The Kpro device of claim 12, wherein the plurality of haptics are positioned on the anchor body such that plurality of haptics form two groups of haptics, wherein each group comprises at least one haptic, wherein the at least one haptic of the first group is attached to the anchor body along its circumference at a first height and the at least one haptic of the second group is attached to the anchor body along its circumference at a second height, wherein the first and the second height are measured from the bottom of the anchor body and the first and the second height are different.

14. The Kpro device of any one of claims 2-3, wherein all components of the Kpro device are flexible.

15. The Kpro device of claim 1, wherein the anchor body is configured to couple to a front plate during implantation.

16. The Kpro device of claim 15, wherein the anchor body is a ring having an inner diameter and an outer diameter ranges from 1 mm to 8 mm, and wherein the inner diameter ranges from 1 mm to 8 mm.

17. The Kpro device of any one of claims 15-16, wherein the front plate comprises an anterior portion and a posterior stem portion, wherein the stem portion is configured to couple to the anchor body during implantation.

18. The Kpro device of claim 17, wherein the anterior portion of the front plate is substantially round as measured along a first axis.

19. The Kpro device of claim 17, wherein the stem portion is a cannula or a solid cylinder, and wherein the stem portion has an outer diameter.

20. The Kpro device of claim 19, wherein the diameter of the anterior portion of the front plate as measured along the first axis is substantially the same as the outer diameter of the stem portion as measured along the same axis.

21. The Kpro device of claim 19, wherein the diameter of the anterior portion of the front plate as measured along the first axis is different than the outer diameter of the stem portion as measured along the same axis.

22. The Kpro device of claim 17, wherein the stem portion is threaded and wherein the anchor body is configured to be screwed onto the stem during implantation.

23. The Kpro device of claim 1, wherein at least one of the plurality of haptics can have a hole.