A bone graft port 26 in fluid communication with a bone graft opening 28 extending through the implant body.
STRUCTURALLY SUPPORTING INSERT FOR SPINAL FUSION CAGE

CROSS-REFERENCE TO RELATED APPLICATIONS
[0001] This application claims benefit of U.S. Provisional Patent Application No. 61/909,667, filed November 27, 2013, the disclosure of which is incorporated by reference herein.

BACKGROUND OF THE INVENTION
[0002] The present invention generally relates to medical devices for stabilizing the vertebral motion segment. More particularly, the present invention relates to a composite spinal intervertebral body cage for distraction and fusion.
[0003] Certain known spine cages or implants are characterized by a body comprising a hydroxyapatite coated surface provided on the exterior surface for contact with adjacent vertebral segments or endplates. A cage of this type may be inserted posteriorly through the neuroforamen of the distracted spine after a surgeon removes disc, bone, and ligament material to create a pathway.
[0004] Such existing devices for interbody stabilization have important and significant limitations. Current devices for interbody stabilization include static spacers composed of titanium, PEEK, and high performance thermoplastic polymer produced by VICTREX, (Vixtrex USA Inc, 3A Caledon Court; Greenville, SC 29615), carbon fiber, or resorbable polymers.
[0005] One problem with conventional devices for interbody stabilization made of PEEK, other high performance thermoplastics or resorbable polymers is the relative weakness and/or brittleness of these materials compared to the forces required to insert the device between bones of the spinal column. A review of the Food and Drug Administration's Medical Device Reporting (MDR) database for intervertebral body cages show that the greatest reported failure rate, at 36% of all reports, is for breakage of the cage during insertion. Therefore there is a need
for intervertebral body cages made from materials that can withstand the insertion forces without breaking.

[0006] The failure point for most cages experiencing breakage during insertion is the point of attachment between the intervertebral body cage and the inserter attached to the cage which is used to place the cage between the vertebrae. There are many means known to those skilled in the art for attaching a spinal fusion cage to an inserter instrument, including, but not limited to a threaded hole and threaded screw, an impression or indentation and hooks or projections, and a supporting surface and a clamping mechanism. In all cases, the attaching means must not only secure the spinal fusion cage to the inserter and then release the cage once it is properly located in the intervertebral space, but the attaching means must also provide a secure attachment during the insertion step when significant forces may be required to advance the cage between vertebral bodies that have come in contact or near contact around a "collapsed" disc space.

[0007] Impact loads of greater than 50 pounds force have been measured during the insertion of intervertebral spinal cages between vertebrae. Even more challenging can be the rotational moments placed on the implant as it is forced into a rigidly defined space as more than 90 inch-pounds of torque have been recorded during insertion. Therefore there is a need for intervertebral body cages with robust insertion attachment which can withstand the insertion forces without separation.

BRIEF SUMMARY OF THE INVENTION

[0008] An expandable implant according to one aspect of the disclosure preferably comprises a body having an attachment port and a bone graft port, a top member moveable with respect to the body, and a structural insert positioned at least partially within the body and configured to couple to an inserter instrument, wherein the structural insert is made from a different material than the body.
[0009] An expandable implant according to another aspect of the disclosure comprises a body having an attachment port and a bone graft port, a top member, a bottom member, and a structural insert coupled to the bottom member and configured to couple to an insertion instrument, wherein the structural insert is made from a different material than the body.

[0010] The body may be constructed of a polymer and the structural insert constructed of metal. The body could also be composed of PEEK and the insert could be one of titanium alloy, stainless steel alloy, and cobalt chromium alloy.

[0011] An expandable implant can be configured to expand hydraulically. The body may have a bone graft opening extending through the top member and body, wherein the bone graft port is in fluid communication with the bone graft opening. An expandable implant can also have a torque resistant port formed in the body configured to couple to a tab on an insertion instrument to prevent the body from rotating relative to the insertion instrument. In at least one embodiment, the structural insert can provide a threaded connection with an insertion instrument. The attachment port may have a smooth surface and be concentric with a threaded opening of the structural insert. The body can have an opening into which the structural insert is placed.

[0012] A method of inserting an expandable implant according to one aspect of the disclosure comprises providing an expandable implant having a top member and a body, wherein the implant is expandable from a first, contracted state to a second, expanded state, coupling an insertion instrument to the expandable implant by extending the instrument through an attachment port and into a structural insert made from a different material than the body, inserting the expandable implant through an incision, and expanding the implant.

[0013] The expanding step preferably includes expanding the top member away from the body via hydraulic fluid. The coupling step may include coupling an insertion instrument to the structural
insert by threading a threaded end of the insertion instrument into a threaded opening in the structural insert.

BRIEF DESCRIPTION OF THE DRAWINGS
[0014] A more complete appreciation of the subject matter of the present invention and the various advantages thereof can be realized by reference to the following detailed description, in which reference is made to the accompanying drawings:
[0015] Figure 1 is a perspective view of an embodiment of the invention.
[0016] Figure 2 is a top view of the embodiment in Figure 1.
[0017] Figure 3 is a partial cross-sectional view through Line A-A of the embodiment in Figure 2.
[0018] Figure 4 is a partially exploded perspective view of the embodiment in Figure 1.
[0019] Figure 5 is a partially exploded perspective view of an alternative embodiment of the invention.
[0020] Figure 6 is a perspective view of an embodiment in Figure 5.

DETAILED DESCRIPTION
[0021] In exemplary embodiments, the present disclosure is directed to a device for providing spinal support for fusion wherein the device contains a structural insert to support the loads placed on the device during insertion.
[0022] Figure 1 shows an embodiment of a spinal fusion cage 10 including a top surface 12, a bottom surface 14, a distal face 16 and a proximal surface 18. The proximal surface 18 is configured to contain an attachment port 20, a torque resistant port 22, a fluid port 24 and a bone graft port 26. The attachment port is used as a means for attaching the spinal fusion cage 10 to an insertion instrument (not shown) for placing the spinal fusion cage into the prepared intervertebral space.
[0023] In this exemplary embodiment, the attachment port 20 is a circular opening that is in communication with a structural
threaded insert 30 (best shown in Figures 3 and 4). The structural threaded insert is comprised of a material that is typically stronger than the material of the body of the spinal fusion cage. For example, if the body of the implant is made of a material such as PEEK or other biocompatible polymer, the structural threaded implant 30 can be made from a metal such as a titanium alloy, a stainless steel alloy, a cobalt chromium alloy, or other suitable, biocompatible high strength materials as will be appreciated by persons of ordinary skill in the art. In this manner the structural threaded insert 30 is configured to withstand greater insertion forces placed on the spinal fusion cage 10 and thus lessen the possibility that the threaded connection for the insertion tool or the spinal fusion cage 10 itself will fail.

[0024] The fluid port 24 is configured to accept expansion fluid into the spinal fusion cage 10 when the spinal fusion cage is configured to expand hydraulically. The bone graft port 26 is configured to accept a bone graft or bone ingrowth promoting substances such as a demineralized bone matrix, the patient's own autogenous bone or cadaveric allograft bone, and direct the substance into the central bone graft opening 28.

[0025] When a structural insert 30 is provided as is shown in this exemplary embodiment, there may be a need for a torque resistant feature to help prevent rotational forces placed on the spinal fusion cage 10 from unthreading the inserter from the spinal fusion cage 10. The torque resistant port 22 as shown can be a slot or other recess configured to accept a mating torque supporting projecting tab on the inserter. Alternately, the fluid port 24 or the bone graft port 26 can be configured to accept projecting tabs from the inserter.

[0026] Figures 3 and 4 show how the structural threaded insert 30 is placed inside the spinal fusion cage 10. The structural threaded insert 30 may be fit into an opening 40 on the bottom surface 14 of the spinal fusion cage 10. It can be seen that the attachment port 20 of the spinal fusion cage 10 is a smooth wall
that does not have threads. When attached to the inserter the structural threaded insert 30 and inserter produce a compressive load on the spinal fusion cage 10. This is desirable as the polymer material of the spinal fusion cage 10 is much stronger under the compression loads than it is under tension loads that would occur during insertion if the inserter were to be threaded directly into the polymer.

[0027] Figures 5 and 6 show an alternative exemplary embodiment of a spinal fusion cage 110, including a top surface 112, a bottom surface 114, and an attachment port 120. In this embodiment, the bottom surface 114 forms the base of the structural threaded insert 130, and also include one or more supporting tabs 116a-c. The spinal fusion cage 110 has an opening 140, which is configured to contain both the structural threaded insert 130 as well as the supporting tabs 116a-b and the bottom surface 114. The addition of the bottom surface 114 and the supporting tabs 116a-c distribute the insertion loads placed on the spinal fusion cage 110 over a greater area and further reduce the percentage of spinal fusion cages that would experience breaks during insertion.

[0028] Exemplary embodiments described herein are particularly well suited to be employed with selectively extendable implants such as disclosed, for example, in U.S. Patent Application No. 12/787,281, filed May 5, 2010, entitled "Adjustable Distraction Cage With Linked Locking Mechanisms," the disclosure of which is incorporated herein by reference in its entirety.

[0029] For instance, figure 3 shows a cylinder 32 configured to receive a piston (not shown). The spinal fusion cage 10 could comprise any number of cylinders (e.g. two, three, four) although only one cylinder is shown. The cylinder is pressurized by introducing a fluid through the fluid port 24 and into the cylinder 32. When the cylinder 32 is pressurized, the pistons are displaced, translating the top surface 12 away from the body 34, thereby expanding the spinal fusion cage 10. The fluid can be, for example, hydraulic fluid. It is contemplated to include
mechanisms associated with the cylinder and piston arrangement to maintain their displacement, such as upper lock supports, lower lock supports, and a locking actuator. The upper and lower lock supports may have an inverted staircase and upright staircase configuration, respectively. As shown in Figure 3, the portion of the cylinder 32 closer to the bottom surface 14 illustrates one configuration of an upper lock support. The locking actuator may be a spring for example which rotates the lower lock support relative to the upper lock support when the spinal fusion cage 10 is expanded. The lower lock support engages the upper lock support as it is rotated by the locking actuator so as to lock the spinal fusion cage in an expanded configuration.

[0030] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.
CLAIMS

1. An expandable implant comprising:
   a body having an attachment port and a bone graft port;
   a top member moveable with respect to the body; and
   a structural insert positioned at least partially within the
   body and configured to couple to an insertion instrument,
   wherein the structural insert is made from a different
   material than the body.

2. The expandable implant of claim 1, wherein the body is
   constructed of a polymer and the structural insert is constructed
   of a metal.

3. The expandable implant of claim 2, wherein the body is
   PEEK and the structural insert is one of titanium alloy,
   stainless steel alloy, and cobalt chromium alloy.

4. The expandable implant of claim 1, wherein the
   expandable implant is configured to expand hydraulically.

5. The expandable implant of claim 1, further comprising a
   bone graft opening extending through the top member and body,
   wherein the bone graft port is in fluid communication with the
   bone graft opening.

6. The expandable implant of claim 1, further comprising a
   torque resistant port formed in the body configured to couple to
   a tab on an insertion instrument to prevent the body from
   rotating relative to the insertion instrument.

7. The expandable implant of claim 1, wherein the
   structural insert provides a threaded connection with an
   insertion instrument.

8. The expandable implant of claim 1, wherein the
   attachment port has a smooth surface and is concentric with a
   threaded opening of the structural insert.

9. The expandable implant of claim 1, wherein the body has
   an opening into which the structural insert is placed.

10. An expandable implant comprising:
    a body having an attachment port and a bone graft port;
    a top member;
a bottom member; and
a structural insert coupled to the bottom member and
configured to couple to an insertion instrument;
wherein the structural insert is made from a different
material than the body.

11. The expandable implant of claim 10, wherein the body is
constructed of a polymer and the structural insert is constructed
of a metal.

12. The expandable implant of claim 2, wherein the body is
PEEK and the structural insert is one of titanium alloy,
stainless steel alloy, and cobalt chromium alloy.

13. The expandable implant of claim 10, wherein the
expandable implant is configured to expand hydraulically.

14. The expandable implant of claim 10, further comprising
a torque resistant port formed in the body configured to couple
to a tab on an insertion instrument to prevent the body from
rotating relative to the insertion instrument.

15. The expandable implant of claim 10, wherein the
structural insert provides a threaded connection with an
insertion instrument.

16. The expandable implant of claim 10, further comprising
a bone graft opening extending through the top member, body, and
bottom member, wherein the bone graft port is in fluid
communication with the bone graft opening.

17. A method of inserting an expandable implant comprising:
providing an expandable implant having a top member and a
body, wherein the implant is expandable from a first, contracted
state to a second, expanded state;
coupling an insertion instrument to the expandable implant
by extending the instrument through an attachment port and into a
structural insert made from a different material than the body;
inserting the expandable implant through an incision; and
expanding the implant.
18. The method of claim 16, further comprising passing bone graft through a bone graft port and into a bone graft opening extending through the top member, body, and bottom member.

19. The method of claim 16, wherein the expanding step comprises expanding the top member away from the body via hydraulic fluid.

20. The method of claim 16, wherein coupling an insertion instrument to the structural insert comprises threading a threaded end of the insertion instrument into a threaded opening in the structural insert.
1. An expandable implant comprising:
   a body having an attachment port and a bone graft port;
   a top member moveable with respect to the body;
   a proximal most portion; and
   a structural insert positioned at least partially within the body and configured to
couple to an insertion instrument,
   wherein the structural insert is configured to fix the orientation of the proximal most
portion of the implant with respect to an insertion instrument.

2. The expandable implant of claim 1, wherein the body is constructed of a
polymer and the structural insert is constructed of a metal.

3. The expandable implant of claim 2, wherein the body is PEEK and the
structural insert is one of titanium alloy, stainless steel alloy, and cobalt chromium alloy.

4. The expandable implant of claim 1, wherein the expandable implant is
configured to expand hydraulically.

5. The expandable implant of claim 1, further comprising a bone graft opening
extending through the top member and body, wherein the bone graft port is in fluid
communication with the bone graft opening.

6. The expandable implant of claim 1, further comprising a torque resistant port
formed in the body configured to couple to a tab on an insertion instrument to prevent the
body from rotating relative to the insertion instrument.

7. The expandable implant of claim 1, wherein the structural insert provides a
threaded connection with an insertion instrument.

8. The expandable implant of claim 1, wherein the attachment port has a smooth
surface and is concentric with a threaded opening of the structural insert.

9. The expandable implant of claim 1, wherein the body has an opening into
which the structural insert is placed.

10. An expandable implant comprising:
    a body having an attachment port and a bone graft port;
    a top member;
    a bottom member;
a structural insert coupled to the bottom member and configured to couple to an
insertion instrument; and
at least one supporting tab coupled to the bottom member configured to distribute
insertion loads placed on the expandable implant;
wherein the structural insert is made from a different material than the body.
11. The expandable implant of claim 10, wherein the body is constructed of a
different material than the body.
12. The expandable implant of claim 2, wherein the body is PEEK and the
structural insert is one of titanium alloy, stainless steel alloy, and cobalt chromium alloy.
13. The expandable implant of claim 10, wherein the expandable implant is
configured to expand hydraulically.
14. The expandable implant of claim 10, further comprising a torque resistant port
formed in the body configured to couple to a tab on an insertion instrument to prevent the
body from rotating relative to the insertion instrument.
15. The expandable implant of claim 10, wherein the structural insert provides a
threaded connection with an insertion instrument.
16. The expandable implant of claim 10, further comprising a bone graft opening
extending through the top member, body, and bottom member, wherein the bone graft port is
in fluid communication with the bone graft opening.
17. A method of inserting an expandable implant comprising:
providing an expandable implant having a top member and a body, wherein the
implant is expandable from a first, contracted state to a second, expanded state;
coupling an insertion instrument to the expandable implant by extending the
instrument through an attachment port and into a structural insert made from a different
material than the body;
inserting the expandable implant through an incision; and
expanding the implant.
18. The method of claim 16, further comprising passing bone graft through a bone graft
port and into a bone graft opening extending through the top member, body, and bottom
member.
19. The method of claim 16, wherein the expanding step comprises expanding the top member away from the body via hydraulic fluid.

20. The method of claim 16, wherein coupling an insertion instrument to the structural insert comprises threading a threaded end of the insertion instrument into a threaded opening in the structural insert.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61F2/46 A61F2/44

According to International Patent Classification (IPC) and to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

Date of the actual completion of the international search 4 February 2015

Date of mailing of the international search report 12/02/2015

Name and mailing address of the ISA /

European Patent Office, P.B. 5818 Patentlaan 2 NL 2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016

Authorized officer

Dydenko, Igor

Form PCT/ISA/210 (search sheet) (April 2009)
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### Box No. II  Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. **X** Claims Nos.: 17-20  
   because they relate to subject matter not required to be searched by this Authority, namely:  
   see FURTHER INFORMATION sheet PCT/ISA/2 10

2. **☐** Claims Nos.:  
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. **☐** Claims Nos.:  
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III  Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. **☐** All required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. **☐** As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. **☐** As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. **☐** No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**  
- **☐** The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- **☐** The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- **☐** No protest accompanied the payment of additional search fees.
Continuation of Box III

Claims Nos.: 17-20

Claims 17-20 relate to a method for treatment of the human or animal body surgery, because they all comprise the step of inserting the implant through an incision, which is an invasive (i.e. surgical) procedure. This Authority is not required to search the present application with respect to the aforementioned claims (Article 17(2) (b) PCT and Rule 39.1(iv) PCT).
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