Title: SEGMENTAL LAMINA GRAPPLE HOOKS

Abstract

A grapple hook spinal fixation system. The grapple hook system comprises a lower hook (10) attached to the lamina on the sacrum side of a vertebrae and an upper hook (30) attached to the lamina on the cranium side of a vertebrae. Bolts (50) are provided for attaching the lower hook (10) to the upper hook (30) to thereby attach the lower and upper hooks to the vertebrae, and clamps (100) are provided for attaching the lower and upper hooks to spine rods (92).
| AT  | Austria       | GB | United Kingdom | MR | Mauritania  |
| AU  | Australia     | GE | Georgia       | MW | Malawi      |
| BB  | Barbados      | GN | Guinea        | NE | Niger       |
| BE  | Belgium       | GR | Greece        | NL | Netherlands |
| BF  | Burkina Faso  | HU | Hungary       | NO | Norway      |
| BG  | Bulgaria      | IE | Ireland       | NZ | New Zealand |
| BJ  | Benin         | IT | Italy         | PL | Poland      |
| BR  | Brazil        | JP | Japan         | PT | Portugal    |
| BY  | Belarus       | KE | Kenya         | RO | Romania     |
| CA  | Canada        | KG | Kyrgyzstan    | RU | Russian Federation |
| CF  | Central African Republic | KP | Democratic People's Republic of Korea | SD | Sudan |
| CG  | Congo         | CH | Switzerland   | SE | Sweden      |
| CI  | Côte d'Ivoire | KZ | Kazakhstan    | SI | Slovenia    |
| CM  | Cameroon      | LI | Liechtenstein | SK | Slovakia    |
| CN  | China         | LK | Sri Lanka     | SN | Senegal     |
| CS  | Czechoslovakia | LU | Luxembourg    | TD | Chad        |
| CZ  | Czech Republic | LV | Latvia        | TG | Togo        |
| DE  | Germany       | MC | Monaco        | TJ | Tajikistan  |
| DK  | Denmark       | MD | Republic of Moldova | TT | Trinidad and Tobago |
| ES  | Spain         | MG | Madagascar    | UA | Ukraine     |
| FI  | Finland       | ML | Mali          | US | United States of America |
| FR  | France        | MN | Mongolia      | UZ | Uzbekistan  |
| GA  | Gabon         |    |               | VN | Viet Nam   |
SEGMENTAL LAMINA GRAPPLE HOOKS

Field of the Invention

This invention relates to an implantable spinal fixation system for the surgical treatment of spinal disorders. More specifically, it relates to a clamping system which reduces any damage to the vertebrae of the spine when installed.

Background of the Invention

Various types of spinal column disorders are known and include scoliosis (abnormal lateral curvature of the spine), kyphosis (abnormal backward curvature of the spine), excess lordosis (abnormal forward curvature of the spine), spondylolisthesis (forward displacement of a lumbar vertebra) and other disorders, such as ruptured or slipped discs, broken or fractured vertebrae and the like. Patients who suffer from such conditions usually experience extreme and debilitating pain. A technique known as spinal fixation uses surgical implants which mechanically immobilize areas of the spine assisting the eventual fusion of the treated vertebrae. Such techniques have been used effectively to treat the above-described conditions and, in most cases, to relieve the pain suffered by the patient.

One technique for spinal fixation includes the immobilization of the spine by the use of a pair of spine rods that run generally parallel to the spine. In practicing this technique, bone screws are first fastened to the pedicles of the appropriate vertebrae or to the sacrum and act as anchor points for the spine rods. The bone screws are generally placed two per vertebra, one at each pedicle on either side of the spinous process. Clamp assemblies join the spine rods to the screws. The spine rods are generally custom-bent to achieve the desired curvature of the spinal column. Examples of such spinal fixation devices can be found in U.S. Patent Nos. 4,653,481 and 5,030,220, which are incorporated herein by reference. These types of systems are very stable but require implanting screws into each vertebrae over the area to be treated. Also, since the pedicles of vertebrae above L2 are very small, only small screws can be used. To stabilize the implanted system sufficiently, one vertebra above and one vertebra below the area to be treated are often used for implanting pedicle screws.
Other fixation systems use hooks which fasten a spine rod to a vertebra for distraction or compression. The hook systems which are currently in use attach to the vertebrae lamina (such as that described in U.S. Patent No. 5,005,562) or to the transverse process (such as that described in U.S. Patent No. 4,269,178) of the vertebrae. These types of locations for attachment of the hooks place load onto parts of the vertebrae which lead to the possibility of damage to the vertebrae and failure of the system during use.

It is desirable that a fixation device be provided which not only reduces the need to implant pedicle screws into the vertebrae but also which connects to the strong sections of the vertebrae thus reducing the damage to the vertebrae after installation of the fixation system. Preferably the point of attachment of such a fixation device is to the lamina or the intersection of the lamina and the spinous process of the vertebrae in the area of the spine to be treated. This area has proven to be the strongest bone structure of the vertebrae.

Summary of the Invention

The present invention relates to a grapple hook spinal fixation system which attaches to the lamina region of vertebrae to which it is attached. The grapple hook system comprises a lower hook attached to the lamina on the sacrum-side of a vertebrae and an upper hook attached to the lamina on the cranium-side of a vertebrae. Means are provided for attaching the lower hook to the upper hook to thereby attach the lower and upper hooks to the vertebrae and for attaching the lower and upper hooks to spine rods. Spine rods attached to the grapple hook system are placed along the center-line of the spine, on either side of the spinous process of the vertebrae.

Brief Description of the Drawings

Features, aspects and advantages of the invention will be more fully understood when considered with respect to the following detailed description, appended claims and accompanying drawings where:

FIG. 1 is a perspective view, looking down the spine toward the sacrum, of a first embodiment of the present invention;

FIG. 2 is an exploded perspective view of the components of the first embodiment of the present invention;

FIG. 3 is a front plan view of a lower hook of the first embodiment of the present invention;
FIG. 4 is top plan view taken along lines 4-4 of FIG. 3;
FIG. 5 is a side plan view taken along lines 5-5 of FIG. 3;
FIG. 6 is a front plan view of an upper hook of the first embodiment of the present invention;
FIG. 7 is a side plan view taken along lines 7-7 of FIG. 6;
FIG. 8 is a side view, partially in section, of the upper and lower hooks of FIGS. 11 to 13 shown as oriented when assembled;
FIG. 9 is a 45° lateral view, toward to sacrum, of a second embodiment of the present invention attached to a vertebrae;
FIG. 10 is an exploded perspective view of the components of the second embodiment of the present invention, for fitting to the right side of the spine;
FIG. 11 is a perspective view of an upper hook of the second embodiment of the present invention;
FIG. 12 is a front plan view of a lower hook of the second embodiment;
FIG. 13 is a side plan view taken along lines 13-13 of FIG. 12;
FIG. 14 is a side view of a clamp bolt;
FIG. 15 is a side view of a "T" wrench handle for use in the present invention;
FIG. 16 is a side view of a driver for use in the present invention;
FIG. 17 is a bottom view of the driver taken along line 17-17 of FIG. 16;
and
FIG. 18 is a bottom view of the driver taken along line 18-18 of FIG. 16.

Detailed Description

The present invention relates to a lamina/spinous process hook connector for use in attaching spine rods to vertebrae for treating various spinal disorders. When the components of the present invention are attached to the area of the spine to be treated, the rods are located close to the spinous process of the vertebrae, i.e., along the center-line of the vertebrae.

One embodiment of the present invention is illustrated in FIGS. 1 to 7. FIG. 1 illustrates the combined grapple hook system attached to a vertebrae of the spine. The grapple hook system (see FIG. 2) comprises a lower hook 10 which attaches to the sacrum-side of the vertebrae (see FIG. 1). An upper hook 30 attaches to the superior side of the vertebrae opposite the lower hook and is attached to the lower hook by hex bolts 50. The hex bolts, when installed, are locked in place by lock washers 70. C-spacers 90 that fits over the major diameter of the hex bolt 50 are used to space the lower hook from the
upper hook to prevent crushing of and damage to the vertebrae when the system is tightened down on final assembly. These components attach the hook system to the lamina/spinous process region of the vertebrae.

The hook system is also attached to points along the length of a pair of spine rods 92, such as at one end of the rods (see FIG. 1), by clamping top clamps 100 to the lower hook with clamp bolts 120. Other points along the length of the spine rods may then be attached to other vertebrae by conventional clamping systems such as those described in U.S. Patent No. 5,030,220 or by additional grapple hook systems like those of the present invention. The components of the grapple hook system are described in detail below.

The lower hook 10, as illustrated in FIGS. 3 to 5, comprise a three armed member. The first arm 12 is, when viewed from its front face (see FIG. 3), generally an inverted triangular shape which includes a hook 14 at its apex. When installed, the hook is placed on the inferior side of the vertebrae. Face 16 of the first arm abuts against the spinous process of the vertebrae, as illustrated in FIG. 1. At an upper end of the first arm (the base of the triangle), and extending out from the first arm on opposite sides, are second and third arms 18. The top of first arm 12, the base of the triangle, is recessed to provide clearance for the end of the spinous process when the lower hook is installed.

The second and third arms are mirror images of each other and extend from the first arm at an angle of about $20^\circ$ from the horizontal centerline of and toward the first arm centerline. At the junctions of the second and third arms with the first arm are threaded apertures 20 extending through the lower hook perpendicular to the arms for receiving hex bolts 50 to attach the lower hook to the upper hook. The generally cylindrical portions of the lower hook forming threaded apertures 20 extend outwardly from the body of the lower hook in the same direction as hook 14 (FIG. 2). The extended portions of the lower hook around threaded apertures 20 provide spacing between the lower hook and the upper hook, when the grapple hook assembly is installed, and extend on opposite sides of the spinous process.

When viewed from the top, the lower hook is generally oval shaped with the second and third arms forming the ends of the oval and the first arm at the center of the oval (FIG. 4). On one side of the lower hook and in the middle of the oval, above hook 14 and between apertures 20, is a groove 29 for providing clearance for the spinous process.
At each end of the oval, i.e., each end of the second and third arms, opposite the ends attached to the first arm, are threaded apertures 24 for receiving clamp bolts 120 (see FIGS. 2 and 14) and attaching top clamps 100 to the lower hook. Between apertures 20 and apertures 24 are located half-apertures 26 extending across the top surfaces of the second and third arms for receiving spine rods 92. The half-apertures include serrations, indicated at 28, for mating with and gripping serrations which run along the length of the linear support rods.

Top clamps 100 are also provided for use in the present invention for attaching spine rods to the lower hook. The top clamp apertures mate with half-aperture 26 of the lower hook to define openings or rod receiving apertures for receiving spine rods 92. Clamp bolts 120 are used to attach the top clamp to the lower hook to securely grip the rods.

The top clamps comprise a roughly cylindrical body (see FIG. 2) with an aperture 110 through the center of the cylinder. The internal diameter of aperture 110 is stepped. A lower section 102 of the aperture has a diameter such that, when the clamp bolt is attached to the top clamp, tapered section 122 of the top clamp will fit securely against lower section 102. The clamp bolt 120 loads its flange face 123 against the shoulder load face 103 in top clamp 100. An upper section 104, is greater in diameter than the diameter of the lower section and is dimensioned so that it can receive head 126 of the clamp bolt.

The top clamps also each include an arm 106, projecting from the cylindrical body of top clamp, in which is located half-aperture 108. The half-aperture is serrated, as indicated at 112, for mating and gripping the serrated rod. When assembled, the serrated surfaces of the half-apertures of the top clamps and the half-apertures of the lower hook are in facing relation to each other and form rod receiving apertures in which the serrated rods are firmly gripped.

Clamp bolts 120 (see FIG. 2) are used to hold the lower hook and top clamps together and to ensure a firm grip on the rod. Clamp bolts 120 have a threaded section 124 to mate with threaded aperture 24 of the lower hook.

Between the clamp bolt head 126 and the threaded section 124, is an unthreaded tapered midsection 122 where the diameter of the clamp bolt is intermediate that of the head and the threaded shaft and is sized such that the clamp bolt midsection will fit into the stepped region 102 of the top clamp. The taper 122 provides strength to the top clamp and inhibits breakage. At the upper end of the clamp bolt is a larger-diameter head 126. The larger-diameter portion
is sized so that it will slip-fit into the stepped region 104 of the top clamp and
face 123 abuts face 103 thus holding the top clamp and the lower hook securely
on the spine rod when the clamp bolt is screwed in place. The stepped interior
of the top clamp allows a distribution of the force conferred by the clamp bolt
on the top clamp over a relatively larger area of the top clamp.

The top face 128 of the clamp bolt includes four radial notches 130,
spaced at equal distances from each other. The notches align with prongs of a
driver so that the surgeon can more easily tighten the clamp bolt and top clamp
to the lower hook. A driver and "T" handle are illustrated in FIGS. 15 to 18.
The handle 150 comprises a shaft 152. At a first end of the shaft is a
handle 154 which is perpendicular to the shaft. At a second end of the shaft is
a square shaped attachment site 156. In one side of the attachment site is a
spring-loaded ball detent 158. The attachment site 156 of the handle 150 fits
into driver 160. The driver comprises a shaft 162. At a first end of the shaft is
a square shaped recess 164 for mating with the square shaped attachment
site 156 of the handle. Located in opposite sides of the square are recesses 164
for mating with the spring-loaded ball detent 158 to secure the driver to the
handle. Located within recess 164 are chamfers 167 which allow depression of
spring loaded ball detent 158. The spring loaded ball detent catches in
indents 165 to secure the driver to the handle. At a second end of the driver are
four prongs 166 for mating with radial notches of 130 of clamp bolt 120. In use
the handle is fitted into the driver and the prongs of the driver are mated with the
radial notches of clamp bolts 120. The handle is then rotated to tighten or
loosen the clamp bolts as required.

The upper hook comprises a member which has an open-centered,
generally inverted triangular shaped member, when viewed from its front face
(see FIGS. 1 and 6). At the top of the upper hook, at the two corners of the
base of the triangle, are apertures 32 for receiving hex bolts 50 to thereby attach
the upper hook to the lower hook, and to draw the hooks together onto the
vertebrae. When viewed from the side (see FIG. 7) the upper hook is generally
rectangular shaped with a "cut out" section 34 at the bottom, or third corner of
the triangle. The cut out section forms hook 36 for attaching the upper hook to
a vertebrae. In one embodiment of the present invention blind apertures or
recesses 38 are located, adjacent to each other, on the front face portion of the
triangle between apertures 32 (see FIGS. 6 and 7).
The upper hook is attached to the lower hook by hex bolts 50. The hex bolts include threaded section 52 and head 54 (FIG. 2). Included around the side surface of head 54 are four recesses 56, spaced equi-distance from each other around the perimeter of the head.

A locking assembly comprising a locking washer 70 is provided to lock each hex bolt in place when the grapple hook assembly is installed. The locking washer comprises at least two tangs 72 and 74. In use one of the tangs, 72 is deformed into blind aperture 38 on the upper hook. Hex bolt 50 is threaded into aperture 32 and tightened and the remaining tang 74 is deformed against one of the hex surfaces 54 on the head of bolt 50. When tang 72 is deformed against the hex it locks the bolt in place and prevents it from loosening after installation. In some cases, apertures 56 are used for wiring to further stabilize and assist in the installation of the fixation system.

In use, the lower hook is placed on one side of a vertebrae adjacent to the area of the spine to be treated. The upper hook is then positioned in facing relation to the lower hook on the other side of the vertebrae (see FIG. 1). C-spacers 90 are installed between the aperture faces of 20 of the lower hook and 32 of the upper hook. The size of the C-spacers may be varied as needed to correctly distance the lower and upper hooks to fit around the lamina of the vertebrae to be treated. Hex bolts 50 are threaded through the apertures 32, the C-spacers and into threaded apertures 20 and screwed into place thus securing the lower and upper hooks to the vertebrae. Tangs 74 are deformed into blind apertures 38 on the upper hook and the tangs 72 are deformed into one of the hex flats 54 on the head of the hex bolt to prevent rotation and loosening of the hex bolt after installation.

Spine rods 92 are placed in half-apertures 26 of the lower hook and clamp bolts 120 are then threaded through aperture 110 of the top clamp and into threaded aperture 24 of the lower hook, using a driver, illustrated in FIGS. 15 to 18 and described above. The prongs of the driver are mated with the notches of the clamp bolt and the driver is then used to tighten the clamp bolt into the top clamp, thus securing the spine rod to the lower hook. The clamp bolt, when tightened, is completely contained within section 104 of the top clamp, leaving exposed a small portion of the upper edge of wall 114 of the top clamp.

After the clamp bolt is in place, the exposed portion of wall 114 is crimped at one point along its periphery corresponding to one of the radial notches. The crimp ensures that the clamp bolt is firmly locked in place and that undesired rotation of the clamp bolt is inhibited once the system is installed.
In the event that some adjustment, and hence removal of the clamp bolt is necessary, the crimp is easily overcome by using the driver to remove the clamp bolt, when the clamp bolt is unscrewed to release the top clamp. After any required adjustments have been made, the screw-and-clamp assembly is secured in place, as described above.

The other ends of spine rods 92 can then by attached to conventional clamps, such as those described in U.S. Patent Nos. 4,653,481 and 5,030,220, or other grapple hook assemblies which are placed on the opposite side of the attachment site of the described grapple hook of the area of the spine to be treated. Clamping of the spine rods thereby stabilizes the region of the spine to be treated.

Another embodiment of the present invention is illustrated in FIGS. 8 to 13. This embodiment of the invention allows the surgeon to clamp only one side of the spine (unilateral attachment) where damage to the spinous process occurs as a result of the surgery or the initial injury or condition. The grapple hook system (see FIG. 10, the clamps for fitting to the right side of the spine are shown; Components for fitting to the left side of the spine are mirror-images of these components) of this other embodiment is similar to that described above, except that two sets of components are installed on a vertebrae, one on each side of the spinous process, without encircling the spinous process. Since the components of this embodiment of the present invention are similar to the embodiment described above, similar part numbers are used for similar parts.

This other embodiment of the present invention comprises a lower hook 10 which attaches to one side of a vertebrae lamina, on one side of the spinous process. An upper hook 30 is attached to the lamina of the vertebrae opposite the lower hook, and on the same side of the spinous process, and is attached to the lower hook by hex bolt 50. The hex bolt, when installed, is locked in place by lock washer 70. C-spacer 90 that fits over the major diameter of the hex bolt is used to space the lower hook from the upper hook to prevent crushing of and damage to the lamina when the system is installed.

These components attach the hook system to the lamina region of the vertebrae. The hook system is also attached to a point along the length of a spine rod 92, such as at one end of the spine rod (see FIG. 9), by clamping top clamp 100 to the lower hook with clamp bolt 120. Another point along the length of the spine rod, such as its other end, can then be attached to other vertebrae by conventional clamping systems or by grapple hook clamping.
systems according to the present invention. The components of this embodiment of the grapple hook system are described in detail below.

The lower hook 10, as illustrated in FIGS. 12 and 13, is an L-shaped member, when viewed from the front face (see FIG. 12). One arm 12 of the "L" includes a hook 14 at its end that is configured to grip the lamina region of a vertebrae on the sacrum-side of the vertebrae. The hook 14 illustrated in FIG. 12 is to grip the lamina region of the vertebrae to the right of the spine, as illustrated in FIG. 9 looking down the spine toward the sacrum. A second lower hook, identical to the lower hook 10 shown in FIG. 10, except that it is its mirror image, is attached to the left side of the spine, as illustrated in FIG. 9. When installed the hook is placed on the lower side of the lamina. The face 16 of the "L" above hook 14 abuts the edge of the lamina of the vertebrae, as illustrated in FIG. 9. On the other arm 18 of the "L" is a threaded aperture 24 for receiving clamp bolt 120 and attaching top clamp 100 to the lower hook (FIG. 10).

Adjacent to and extending perpendicular to aperture 24 across the top surface of lower hook 10 is located half-aperture 26 for receiving spine rod 92. The half-aperture includes serrations, shown at 28, for mating and gripping the rod which includes serrations along its length. At the junction of the arms of the "L" and extending generally parallel to half-aperture 26 is a threaded aperture 20 for receiving hex bolt 50 and attaching the lower hook to the upper hook.

Upper hook 30 (see FIG. 11) when installed mates with the lower hook described above by gripping the lamina region of a vertebrae on the cranial-side of the vertebrae (see FIGS. 8 and 9). A second upper hook which is identical, except it is its mirror image, is used to mate with the lower hook placed on the other side of the spine. The upper hook comprises a member with an aperture 32 extending through the top of the upper hook, for receiving hex bolt 50 to thereby attach the upper hook to the lower hook, and to the vertebrae. A blind aperture or recess 38 is located on the surface of the upper hook adjacent to one opening of aperture 32. Extending away from the section of the upper hook which includes aperture 32 is a hook 36. Hook 36 projects from the body of the lower hook in a direction opposite the surface containing recess 38. The section which includes the hook, is off-set from the aperture, such that when the bottom of the hook is held in a horizontal position the aperture is not directly above the hook, but offset to one side. For attaching to the right side of the vertebrae (see FIG. 9), aperture 32 is offset to the right relative to the hook. For attaching to the left side of the vertebrae (see FIG. 9), aperture 32 is offset to the left relative to the hook. This offset allows the upper hook to be
placed at the lamina of the vertebrae but avoids contact with the spinous process.

The upper hook is attached to the lower hook by hex bolt 50 as described above for the first embodiment.

In use, a lower hook is placed on one side of the lamina and on one side of the spinous process. The upper hook is then positioned in facing relation to the lower hook on the other side of the lamina and on the same side of the spinous process, as illustrated in FIG. 9. C-spacer 90 (not shown in FIG. 8) is installed between the face of aperture 20 of the lower hook and the face of aperture 32 of the upper hook. The size of the C-spacer may be varied as needed to correctly distance the lower and upper hooks to fit around the lamina to be treated. Hex bolt 50 is threaded through the aperture 32, the C-spacer and into threaded aperture 20 and screwed into place thus securing the lower and upper hooks to the vertebrae.

A spine rod is placed in the half-aperture of the lower hook and clamp bolt 120 is then threaded through aperture 110 of the top clamp and into threaded aperture 24 of the lower hook, as described above for the first embodiment.

The assembly process is then repeated to attach a second grapple hook assembly to the other side of the spinous process, on the same vertebrae.

The components of the grapple hook of the present invention are preferably made of an alloy capable of resisting corrosion when installed in a human body. It has been found that 316 stainless steel which has been electropolished and passivated to resist corrosion works well. Other metal alloys, such as alloys of titanium also may be used.

The present invention is not to be limited to the specific designs shown which are merely illustrative. Various and numerous other arrangements may be devised by one skilled in the art without departing from the spirit and scope of this invention. The scope of the invention is defined in the following claims.
WHAT IS CLAIMED IS:

1. A grapple hook spinal fixation system comprising:
   a lower hook adapted to grip the lamina on the sacrum-side of a
   vertebrae;
   an upper hook adapted to grip the lamina on the cranium-side of
   a vertebrae; and
   means of adapted to grip the lower hook to the upper hook to
   thereby attach the lower and upper hooks in a facing relationship to the
   vertebrae.

2. A grapple hook spinal fixation system as recited in claim 1 wherein
   the means for attaching the lower hook to the upper hook comprises bolts
   attached through apertures in each of the upper and lower hooks.

3. A grapple hook spinal fixation system as recited in claim 2 wherein
   the means for attaching the lower hook to the upper hook further comprises a
   spacer for spacing the upper hook from the lower hook.

4. A grapple hook spinal fixation system as recited in claim 2 wherein
   the means for attaching the lower hook to the upper hook further comprises a
   lock washer.

5. A grapple hook spinal fixation system as recited in claim 4 wherein
   the washer further comprises deformable tangs for locking the bolts in place
   when installed.

6. A grapple hook spinal fixation system as recited in claim 1 wherein
   the upper hook and lower hook are in facing relation to each other when
   attached to the vertebrae.

7. A grapple hook spinal fixation system as recited in claim 1 further
   comprising a means for attaching the lower and upper hooks to spine rods.

8. A grapple hook spinal fixation system as recited in claim 7 wherein
   the means for attaching the lower and upper hooks to spine rods comprises
   clamps for clamping the spine rods to the lower hooks.
9. A grapple hook spinal fixation system as recited in claim 1 wherein a single upper hook and a single lower hook, when attached to the lamina, encircle the lamina.

10. A grapple hook spinal fixation system comprising:
    a lower hook, wherein the lower hook comprises:
    a hook for attaching to the lamina of the vertebrae at a first end of the lower hook; and
    a clamp for attaching to a spine rod at a second end of the lower hook; and
    means for attaching the lower hook to an upper hook, wherein the upper hook comprises:
    a hook for attaching to the lamina of the vertebrae; and
    means for attaching the upper hook to the lower hook to thereby secure the grapple hook to the lamina.

11. A grapple hook spinal fixation system as recited in claim 10 wherein the means for attaching the lower hook to the upper hook comprises bolts attached through apertures in each of the upper and lower hooks.

12. A grapple hook spinal fixation system as recited in claim 11 wherein the means for attaching the lower hook to the upper hook further comprises a spacer for spacing the upper hook from the lower hook.

13. A grapple hook spinal fixation system as recited in claim 11 wherein the means for attaching the lower hook to the upper hook further comprises a lock washer.

14. A grapple hook spinal fixation system as recited in claim 13 wherein the washer further comprises deformable tangs for locking the bolts in place when installed.

15. A grapple hook spinal fixation system as recited in claim 10 wherein the means for attaching the lower and upper hooks to spine rods comprises clamps for clamping the spine rods to the lower hooks.
16. A method for treating a region of the spine comprising:
   placing a lower hook on the lamina on the sacrum-side of a vertebrae in a region of the spine to be treated;
   placing an upper hook on the lamina on the cranium-side of the vertebrae;
   attaching the lower hook to the upper hook to thereby attach the lower and upper hooks to the lamina;
   attaching the lower and upper hooks to a first end of a spine rod; and
   attaching a second end of the spine rod to a clamp attached to vertebrae in the region of the spine to be treated.

17. A method as recited in claim 16 wherein the lower hook is attached to the upper hook by threading a bolt through apertures located in the lower hook and the upper hook.

18. A method as recited in claim 16 wherein the lower and upper hooks are attached to a first end of a spine rod by clamping the rods to the lower hook.

19. A grapple hook spinal fixation system comprising:
   a lower hook for attaching to a first side of a vertebrae, wherein the lower hook comprises:
   a hook at a first end of the lower hook for attaching to the lamina of the vertebrae;
   clamps for attaching to spine rods at a second end of the lower hook; and
   apertures at the second of the lower hook for attaching the lower hook to an upper hook, wherein the upper hook comprises:
   a hook at the first end of the upper hook for attaching to a second side of the lamina; and
   apertures at a second end of the lower hook for attaching the upper hook to the lower hook;
   bolts for attaching the upper hook to the lower hook, wherein the upper and lower hooks and bolts when attached to the vertebrae, encircle the lamina.
## INTERNATIONAL SEARCH REPORT

### A. CLASSIFICATION OF SUBJECT MATTER

- **IPC(6)**: A61B 17/70
- **US CL**: 606/61

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

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- **U.S.** : 606/53, 60, 61, 72, 73, 86; 623/16, 17

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

**NONE**

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

**NONE**

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US, A, 5,360,429 (JEANSON ET AL.) 01 November 1994, see Fig. 9.</td>
<td>1, 6-10, 15-18</td>
</tr>
<tr>
<td>Y</td>
<td>US, A, 5,380,326 (LIN) 10 January 1995, see Fig. 3.</td>
<td>2-5, 11-14, 19</td>
</tr>
<tr>
<td>Y, P</td>
<td>US, A, 5,334,203 (WAGNER) 02 August 1994, see Fig. 1.</td>
<td>3-5, 12-14</td>
</tr>
<tr>
<td>Y</td>
<td>US, A, 4,653,481 (HOWLAND ET AL.) 31 March 1987, see Fig. 3.</td>
<td>18, 19</td>
</tr>
</tbody>
</table>

Further documents are listed in the continuation of Box C.

See patent family annex.

- **Special categories of cited documents:**
  - "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  - "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  - "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  - "A" document member of the same patent family

Date of the actual completion of the international search: **06 FEBRUARY 1996**

Date of mailing of the international search report: **27 FEB 1996**

Name and mailing address of the ISA/US Commissioner of Patents and Trademarks:
- **Authorized officer**: GUY TUCKER
- **Telephone No.**: (703) 308-3271

Authorized officer's signature: [Signature]

Form PCT/ISA/210 (second sheet)(July 1992)*