A protective device is provided for protecting the back of a wearer against injury. The device includes an array of support elements that extend along the wearer's back adjacent his spine and is held in position on his back by attachment means, which can include a neck brace attached to the upper end of array, a chest strap, a waist strap and/or webbing that are spaced apart axially along the array. The support elements are attached to each other in such a way that they can move relative to each other to allow free, but limited bending, extension and contraction of the array, but the connection means between the elements is configured to prevent further movement between them once a predetermined limited movement has taken place, so that the array becomes practically rigid and can bear further loading that may otherwise have been born by the spine.
ACCESSORY FOR INHIBITING BACK INJURY

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a national stage application under 35 USC §371(c) of PCT Application No. PCT/IB2008/051675, entitled “ACCESSORY FOR INHIBITING BACK INJURY,” filed on Apr. 30, 2008, which claims priority from U.S. Provisional Patent Application No. 60/915,089, entitled “ACCESSORY FOR INHIBITING BACK INJURY,” filed on Apr. 30, 2007. The entire disclosure and contents of the above applications are hereby incorporated by reference herein.

BACKGROUND

[0002] 1. Field of the Invention
[0003] This application generally relates to protective equipment to be worn by participants in activities such as motorcycling, in which they are potentially exposed to injury. In particular, the invention relates to a protective device to protect a wearer’s thoracic and lumbar spine.

[0004] 2. Related Art
[0005] In activities where the bodies of participants and particularly their spines, are often exposed to extreme motions such those that can result during a motorcycling accident, the spine can be injured, often resulting in neurological fallout e.g. paralysis.

[0006] Particularly in motorcycling, injuries to the thoracic and lumbar spine often occur as a result of the trunk of the rider being flexed or extended in relation to the pelvis and head and neck. The spine is also often exposed to axial loading or compression which could result in compression fractures. Further, after any of these types of injury, the spine can be unstable, especially if fractured, and movement of the spine in this condition can also result in neurological fallout or paralysis.

[0007] It may be possible to prevent injuries of this kind by stabilizing the spine and preventing movement of the spine, but this would be too inhibiting for a motorcyclist to control the motorcycle and/or too uncomfortable. The same applies to other sports such as skiing or horse riding, where freedom of movement is required.

[0008] Attempts have been made at providing protection against these injuries, by providing supports worn on the backs of motorcyclists, which comprise a number of resilient elements that are fitted together or attached to a flexible base. The elements interact teleologically in some instances, with interference between the elements that increases as the support is bent with the wearer’s back. In other supports, resiliently compressible elements are provided between support elements and similarly, the support allows some bending, but its stiffness increases as it bends further. However, these supports only stabilize the spine under relatively moderate bending loads, such as light impacts, but their stiffness increases with bending up to a point where the supports fail, with the result that they offer insufficient or no support to the spine under severe loads, e.g. during severe accidents.

[0009] The present invention seeks to inhibit the exposure to injuries of the thoracic and lumbar spine, while allowing sufficient freedom of movement when not exposed to extreme loads on the spine. In particular, the invention seeks to inhibit extreme movements of the spine, e.g. by limiting extreme flexion and extension.

SUMMARY

[0010] In accordance with one aspect of the present invention, a protective device is provided. The protective device comprises an elongate array of support elements configured to extend along the back of a wearer of the device, adjacent the wearer’s spine; and attachment means for removably attaching the array of support elements to the wearer’s body in at least two locations that are spaced apart axially along the array; pivotal connection means for attaching the support elements to each other, wherein the pivotal connection means configured to allow pivotal movement between adjacent support elements only to a limited, predetermined extent, said pivotal connection means between adjacent support elements including: pivot formations that interact to allow pivoting movement between the adjacent support elements and limit formations that interact with predetermined play when the elements are pivoted relative to each other and that abut when the play has been taken up, to inhibit further pivotal movement, along at least one pivot axis, wherein the limit formations include at least one protruberance extending from one element, which is receivable with said predetermined play in a recess defined in the adjacent element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Illustrative embodiments of the present invention will now be described with reference to the accompanying figures, in which:

[0012] FIG. 1 is a three-dimensional view of the protective device of the present invention, from the front;

[0013] FIG. 2 is a three-dimensional view of the device of FIG. 1, from the rear;

[0014] FIG. 3 is a sectional side view of the device of FIG. 1;

[0015] FIG. 4 is a detail sectional side view of two adjacent support elements of the device of FIG. 1, in alignment;

[0016] FIG. 5 is a detail sectional side view of the support elements of FIG. 4, at an angular orientation and

[0017] FIG. 6 is an inverted (upside-down) three-dimensional view of a single element of the device of FIG. 1.

DETAILED DESCRIPTION

[0018] Referring to the drawings, a protective device in accordance with the present invention is generally indicated by reference numeral 10.

[0019] The device 10 includes six support elements 12 that resemble links in a chain and that are attached to each other to form an elongate array in the form of an external vertebral construct 14, which is shaped and dimensioned so that it can extend along the back of a wearer along his spine in the thoracic and lumbar regions. The number of support elements 12 in the device 10 can be different, e.g. to suit a larger wearer of the device.

[0020] Each of the support elements 12 is a unitary component of resilient material, such as a fiber reinforced polymer composite and includes a central wall 16 and two outer walls 18,20 that are spaced from the central wall and extend to the front and rear of the central wall, but the walls are joined in a region about two thirds from the top of the element in a joining region 22 of the element.
A part cylindrical recess 24 is defined in the joining region 22 of each element 12 along a pivot axis that extends transverse to the vertebral construct 14. The central wall 16 extends centrally in the element 12 from the joining region 22, directly above the recess 24 and at the upper edge of the central wall, a cylindrical ridge 26 is defined that is complementary in shape to the recess 24 and that extends parallel to the recess.

At the upper end of the front wall 18, it forms a protuberance in the form of a hook formation 28 that extends rearward and similarly, a hook formation 30 extends forward from the upper edge of the rear wall 20. Each of the hook formations 28,30 defines an internal passage 32 that extends along its length. The upper part of each of the outside walls 18, 20 narrows towards its top, so that each hook formation 28,30 is significantly narrower than the rest of the element 12.

Near the lower end of the front wall 18, it forms a recess in the form of an aperture 34 with a width slightly more than that of the front hook formation 28 and similarly, a rear aperture 36 is defined near the lower end of the rear wall 20 with a width slightly more than that of the rear hook formation 30. The width of the element in the region of the apertures 34,36 is less than the distance between the insides of the walls 18, 20 in the regions of the hook formations 28,30, i.e. each element 12 tapers towards its lower end.

The interaction of the elements 12 in the vertebral construct 14 is best illustrated in FIGS. 4 and 5, which shows two adjacent elements in a straight configuration and a pivoted configuration, respectively.

The elements 12 are attached together by receiving the ridge 26 of the lower element in the recess 24 of the upper element, but to achieve this, the outer walls 18, 20 of the lower element have to be flexed outwardly, to clear the lower edges of the outer walls of the upper element. When the ridge 26 of the lower element is received in the recess 24 of the upper element, the hook formations 28,30 of the lower element are generally in register with the apertures 34,36 of the upper element and the resilience of the outer walls 18, 20 of the lower element causes their hook formations to be flexed inwardly, into the apertures. The resilience of the element 12 is sufficient to prevent the hook formations 18, 20 from flexing outwardly and disengaging their respective apertures 34,36, but in order to ensure that this does not happen in cases of extreme loading, a metal clip (not shown) is passed through the passages 32 of both the hook formations of the lower element 12, to hold them together.

The complemental, part cylindrical shapes of the recess 24 of the upper element and the ridge 26 of the lower element allows these formations and thus the two elements 12 to pivot relative to each other about the pivot axis, while the ridge rotates inside the recess. The ridge 24 and recess 26 together comprise pivot formations of the elements 12.

Each aperture 34,36 is slightly wider than its associated hook formation 28,30 as mentioned above and is significantly higher than the (vertical) thickness of its hook formation, with the result that each hook formation 28,30 can move up and down inside its associated aperture 34,36 with clearance, while the elements pivot relative to each other about the pivot axis or the ridge 24 and recess 26. However, the shape and thickness of each hook formation 28,30 and the height of each aperture 34,36 is configured to limit the pivotal movement to a predetermined extent.

As can be seen in FIG. 5, once the lower element 12 has pivoted forward relative to the upper element to a certain degree, the front hook formation 28 of the lower element abuts the upper edge of the front aperture 34 of the upper element and similarly, the rear hook formation 30 of the lower element abuts the lower edge of the rear aperture 36 of the upper element (although there is still some space left in the rear aperture 36 in FIG. 5 because the lower element has not been pivoted forward to the maximum).

The shape and configuration of the hook formations 28,30 and of the apertures 34,36 are thus deliberately and precisely selected to allow pivotal movement between adjacent elements to take place with minimal or no interference until the pivotal movement has reached a predetermined limit, in which case the hook formations interact with the peripheries of the apertures and allow practically no further movement. It could be added that the structure of each element 12 is sufficiently sturdy to avoid any significant deflection or deformation, so that pivotal movement between elements 12 is practically arrested when the hook formations 28,30 abut the peripheries of their associated apertures 34,36. Accordingly, the hook formations 28,30 and apertures 34,36, together comprise limit formations of the elements 12. The pivot formations 24, 26 and the limit formations 28,30, 34,36 together comprise the pivotal connection means of the elements 12.

Bending or deflection of the vertebral construct 14 has thus far only been described with reference to pivoting relative to the pivot axes of the pivot formations, 24, 26. However, each recess 24 is generally U-shaped in cross-sectional profile and does not hold its associated ridge 26 captive inside it. As a result, one or both ends of the ridge 26 of the lower element 12 can be withdrawn from the recess 24 of the upper element and the elements can thus pivot also relative to an axis that extends front-to-back, i.e. sideways or lateral flexion between elements 12 is possible. Further, in the same way that limitation of the movement of each hook formation 28,30 in its associated aperture 34,36 limits pivotal movement relative to the pivot axis between adjacent elements 12, it also limits lateral flexion between the elements.

Further, if an axial load is applied along the vertebral construct 14 i.e. generally vertically between adjacent elements 12, these loads are also born by the elements. In case of axial compression loads, the compression is transferred through the pivot formations 24, 26 and along the central walls 16. If buckling occurs in the case of axial compression, either one of the hook formations 28,30 abuts the upper edge of its associated aperture 34,36 to stop further buckling and to bear some of the load. Even if further buckling occurs, the extent to which the vertebral construct 14 will bend is limited by the limit formations 28,30, 34,36 as described above. In the event of axial extension loads, both the hook formations 28,30 of the lower element 12 abut the lower edges of their associated apertures 34,36 to transfer a tensile load between the elements 12.

The vertebral construct 14 is thus configured to allow free axial compression and axial extension, backwards-forwards flexion and lateral flexion, but in the cases of each of these degrees of freedom, the pivotal connection means is configured to allow movement between each pair of adjacent elements 12 only to a predetermined extent. Further, once the limit of movement in any of these directions has been reached, the construct 14 is configured to bear the axial compression or extension, backwards-forwards flexion and/or lateral flexion loads, as the case may be.
The pivotal connection means between the elements 12 does not allow any significant movement along other axes than those described herein.

Referring to FIGS. 1 to 3, the uppermost support element 12 is removably connected to a neck brace 38 that is configured to extend around the wearer's neck and to protect the upper cervical spine of the wearer by interacting with a helmet worn by the wearer. Preferably, the neck brace 38 is a neck brace as described in International Patent Application No PCT/ZA94/00148. The attachment of the uppermost element 12 to the neck brace 38 can allow limited relative movement, e.g., it can include pivotal connection means as described above in relation to adjacent elements 12. However, in a preferred embodiment, the thoracic column of the neck brace 38 is removed and the uppermost element 12 of the construct 14 is rigidly attached to the neck brace 38 using the attachment means configured for attaching the thoracic column.

The lowermost support element 12 includes a lower or coccygeal protuberance 40 that extends downwardly from the support element and that is curved forward to follow the shape of the wearer's coccyx. At the lower end of the coccygeal protuberance 40 there is a support plate 42 in a region and at an orientation that correspond to the position where the wearer's buttocks would rest on a seat.

The lowest support element 12 further includes two lateral or pelvic protuberances 44 that are curved to extend generally along the posterior edges of the wearer's pelvis.

The device 10 includes attachment means in the form of a number of elongate flexible elements or straps with which it can be removably attached to the wearer's body at a number of locations that are spaced apart along the vertical axis of the vertebral construct 14. The neck brace 38 can also be viewed as "attachment means" in the sense that it also serves to keep the upper end of the construct 14 in position.

The device 10 includes a chest strap 46 that is shown in the drawings to pass through the body of the third lowest element 12 and that is configured to fit tightly around the upper body of the wearer in the mid torso or chest region. The chest strap 46 should preferably be tight enough to keep the middle part of the construct 14 generally in close contact with the wearer's back, but it should also not inhibit breathing. Accordingly, the chest strap 46 includes an expansion region 48, which is configured to expand elastically, e.g., with breathing movements of the wearer. Further, the expansion region 48 includes tensile elements that prevent further expansion of the strap 46 once a predetermined tensile load is reached in the strap, i.e. once a "controlled endpoint" has been reached. A practical limit for such a load has been found to be about 10% of the weight of the wearer. The chest strap 46 should preferably be pre-tensioned to a percentage of the body weight of the wearer.

In a preferred embodiment, the chest strap 46 is not directly connected to the construct 14, but the device 10 includes a sheath 54 in which the construct 14 is housed and the chest strap is attached to the sheath. The sheath is wider in the region of the chest strap 46, to allow the construct 14 to move laterally inside the sheath, curing normal use of the device 10.

The device 10 includes a waist strap 50 that extends from the lateral ends of the pelvic protuberances 44 and that is configured to extend tightly around the wearers waist, to hold the lower end of the construct 14 generally in contact with the wearer's lower back. The waist strap 50 should preferably also be pre-tensioned to a percentage of the body weight of the wearer. The waist strap 50 is assisted in its function by webbing 52 extending between the support plate 42 and the waist strap.

During normal use, when the device 10 is fitted to a wearer's back with the straps 46, 50 extending tightly around the wearer's chest and waist and with the neck brace 38 around the wearer's neck, the vertebral construct 14 flexes and twists with the wearer's spine, without inhibiting movement to any significant extent.

If extreme bending loads are exerted on the wearer's spine, e.g., when the trunk is flexed relative to the head and neck or relative to the pelvis, the vertebral construct 14 flexes up to a predetermined limit, when the peripheries of the apertures 34, 36 prevent further movement of the hook formations 28, 30 and the construct resists further flexion. The attachment of the device 10 to the wearer's back and the condition of the construct 14 that resists further flexion, causes the device 10 to act as a rigid support for the spine, inhibiting further flexion of the spine beyond what is anatomically appropriate and thus inhibiting spinal injury.

If extreme extension loads are exerted on the spine, e.g. during rapid deceleration, the peripheries of the apertures 34, 36 prevent movement beyond a predetermined extent and thus prevents the elements 12 of the construct 14 from being separated and thus prevents the vertebral construct from extending axially beyond a predetermined degree, with the result that the device 10 resists axial extension of the spine beyond what is anatomically appropriate.

If extreme compression loads are exerted on the spine from below, the load is transferred from the support plate 42 to the vertebral construct 14 via the coccygeal protuberance 40 and is borne largely by the construct, thus relieving the axial load borne by the spine. At the same time, the vertebral construct 14 inhibits excessive flexion of the spine.

In the event that the wearer's spine has been injured and even if the spine is unstable as a result of the injury, the device 10 inhibits post loading injury by inhibiting spinal movement as described above.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive.

1. A protective device comprising:
   an elongate array of support elements configured to extend along the back of a wearer of the device, adjacent the wearer's spine; and
   attachment means for removably attaching the array of support elements to the wearer's body in at least two locations that are spaced apart axially along the array;
   pivotal connection means for attaching the support elements to each other, wherein the pivotal connection means is configured to allow pivotal movement between adjacent support elements only to a limited, predeter-
   mined extent, said pivotal connection means between adjacent support elements including:
   pivot formations that interact to allow pivoting movement between the adjacent support elements and
   limit formations that interact with predetermined play when the elements are pivoted relative to each other and
that abut when the play has been taken up, to inhibit further pivotal movement, along at least one pivot axis, wherein the limit formations include at least one protuberance extending from one element, which is receivable with said predetermined play in a recess defined in the adjacent element.

2. The device as claimed in claim 1, wherein the limit formations include two protuberances extending from one element, which are receivable with said predetermined play, in two recesses defined in the adjacent element.

3. The device as claimed in claim 1, wherein the pivot formations of the adjacent support elements are configured to bear loads longitudinally along the device, while allowing pivotal movement between the adjacent support elements, to said limited, predetermined extent.

4. The device as claimed in claim 1, wherein the attachment means includes at least one elongate flexible element for attaching the device to the waist of the wearer, said elongate flexible element being configured to expand elastically to a predetermined extent and to inhibit further expansion once it has expanded to a limit of said predetermined extent.

5. The device as claimed in claim 4, wherein the device includes lateral protuberances that are attached to at least one support element in the pelvic region, with the flexible element attachable to said lateral protuberances.

6. The device as claimed in claim 1, wherein the attachment means includes at least one elongate flexible element for attaching the device to the upper body of the wearer, said elongate flexible element being configured to expand elastically to a predetermined extent and to inhibit further expansion once it has expanded to a limit of said predetermined extent.

7. The device as claimed in claim 1, wherein the operational upper end of the array is configured to be attachable to a neck brace to be worn by the wearer of the device, said neck brace being configured to extend around the wearer's neck and to interact with a helmet worn by the wearer.

8. The device as claimed in claim 7, wherein the attachment between the array and the neck brace provides for limited pivotal movement between the upper end of the array and the neck brace.

9. The device as claimed in claim 1, wherein the device includes a lower protuberance extending from the support element at the operational lower end of the array adjacent the coccyx of the wearer, to a position where the wearer's buttocks would rest on a seat.

10. The device as claimed in claim 9, wherein the lower protuberance has a support plate at its end that is remote from the array of support elements.